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Challenges and Opportunities

Marla Hahnraths

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CHAPTER 1

General Introduction

Children's Health Status: Room for Improvement

Both worldwide and in the Netherlands, the prevalence of childhood overweight and obesity has been increasing over the last years [1]. In 2021, 15.5% of Dutch children aged 4–12 years were overweight and 3.6% were obese, compared with 11.9% and 2.6%, respectively, in 2016 [2]. It is known that childhood overweight and obesity can track into adulthood and increase the risk of both immediate and long-term health problems such as psychological problems, cardiovascular diseases, and type 2 diabetes, which underpins the importance to reduce their prevalence in early stages of life [3]. Important causes of the increasing prevalence of childhood overweight and obesity are unhealthy lifestyle behaviours (e.g., unhealthy dietary habits and insufficient physical activity (PA)). The current lifestyle behaviours of Dutch children show significant room for improvement. Over the period of 2014–2016, 42% of children (aged 4–9 years) consumed at least 150 grams of fruit per day; this percentage dropped to 20% for 9–12 year-olds. For vegetable intake, similar percentages were reported: 41% of 4–9 year-olds and 25% of 9–12 year-olds consumed at least 150 grams of vegetables per day [4]. Furthermore, in 2021, only 62% of Dutch children (aged 4–12 years) met the PA guidelines of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day and engaging at least three times per week in bone- and muscle-strengthening activities (e.g., rope skipping and trampoline jumping) [5]. Because lifestyle habits that are formed during childhood are likely to persist (to some extent) throughout adulthood, the promotion of a healthy lifestyle at a young age is expected to result in immediate as well as long-term health benefits [6,7].

Health literacy (HL) is a concept defined as 'the motivation, knowledge, and competencies to access, understand, appraise, and apply health information to make judgements and take decisions in everyday life concerning healthcare, disease prevention, and health promotion to maintain or improve quality of life throughout the course of life' [8]. Multiple studies have demonstrated the positive association between HL and healthy lifestyle behaviours and health outcomes in adults [9–14]. As HL is hypothesised to be a skill that changes and develops throughout the life course, improving HL skills at a young age is likely to result in improved HL and health outcomes later in life [8,15–17]. Despite this potential, little evidence is available on children's HL, which is partly due to a lack of comparable, valid, and age-appropriate measurement tools to assess the concept in children [18–20]. To further investigate HL's potential role in health promotion in children, it is therefore important to develop and test age-appropriate measurement instruments and subsequently investigate the relationship between children's HL and various health outcomes (e.g., body mass index (BMI) and dietary intake).

School as a Setting for Health Promotion

In the Netherlands, primary school consists of study years one to eight, which include children from age four to 12. From the age of five, children are obliged to attend school. In 2021, roughly 1.5 million children were enrolled in 6,080 primary schools in the Netherlands [21,22]. Children spend approximately 25–30 hours per week at school. A traditional Dutch primary school day lasts from approximately 8.30am to 3.00pm on Monday to Friday, except for Wednesday, when children finish school around 12.30pm. Over the last years, more and more Dutch primary schools adopted a so-called 'continuous schedule', where every school day lasts from approximately 8.30am to 2.00pm. Schools have a morning break of about 15 minutes that allows children to go outside to play and eat their morning snack brought from home. Lunch break time varies between 30 and 60 minutes: a 15-minute lunch during which children eat their sandwiches brought from home (generally, no meals are offered at school), and 15–45 minutes of free play outside after lunch. In some schools that do not adopt a continuous schedule, children can go home during lunch break to have lunch. Approximately 60–120 minutes/week is spent on physical education classes. Some schools have a sports hall on site, whilst in other schools, children have to commute to the sports hall by foot, bike, or bus.

Schools are key environments when it comes to shaping lifestyle habits, and they can therefore play an important role in the promotion of healthy lifestyle behaviours [23–25]. At school, children from various socioeconomic backgrounds come together on a regular basis for several critical developmental years. Furthermore, teachers have the opportunity to teach children about health and to serve as role models with regard to health behaviours. Currently, health (promotion) is not part of the standard curriculum in Dutch schools, as schools mainly focus on attaining educational goals. However, many different school-based health-promoting interventions have been developed and evaluated, showing positive intervention effects on various health outcomes in children (e.g., BMI and dietary and PA behaviours) [26–33]. Despite the potential of these interventions, they are often not widely disseminated and/or adequately integrated in the school system, resulting in limited effects and/or effects that are not sustained over time. This is partly due to a great diversity in school contexts. Schools can be defined as complex systems with a unique context and dynamics influenced by various interacting elements from within and beyond the school-setting [34–36]. Health-promoting activities that work in one school might therefore not work in another school if no attention is given to the specific context of a school and the intervention is not adapted accordingly.

School-Based Health-Promoting Interventions Addressed in Present Dissertation

Kokkerelli

The Dutch organisation Kids University for Cooking developed a school-based nutrition education curriculum (Kokkerelli) specifically for children in study years 5–8 of primary school (internationally comparable to grades 3–6). The curriculum employs concepts from the self-determination theory, experiential learning, and imagineering (e.g., self-experience in an interactive environment) [37–39] and aims to let children experience different aspects of fruit and vegetables (FVs) in a positive context and to teach children where FVs come from, how they are processed, and how they can be used for the preparation of healthy meals. The curriculum consists of nine different 'learning streets', which all focus on one specific FV product. Each learning street consists of multiple components, which schools can plan in a way that suits their schedule (although all activities should be planned in a specific order and within a three-week period). A learning street starts with an introduction lesson at school, during which the teacher introduces children to (the taste of) the specific product. Next, children visit a grower's farm where they receive information about the planting, growing, and harvesting processes. After visiting the grower's farm, children prepare a dish containing the specific FV product at the cooking facilities of Kids University for Cooking with the help of a professional chef and volunteers. Afterwards, they eat the self-prepared meal together with their peers. The last component is an evaluation lesson, which again takes place at school under guidance of the teacher. Although Kokkerelli is already being implemented in the southern part of the Netherlands (Venlo and surrounding villages), its effectiveness had not yet been evaluated. Before this programme is disseminated to the rest of the Netherlands, the evidence regarding its impact on children's (determinants of) FV intake should be established.

Healthy Primary School of the Future

The 'Healthy Primary School of the Future' (HPSF) is a Dutch primary school-based intervention that was previously implemented in the Parkstad region in Southern Limburg (the Netherlands) and aimed to promote healthy lifestyle habits by sustainably integrating health and well-being in the school system. Compared to other areas in the Netherlands, Parkstad can be defined as a low to moderate socioeconomic area, characterised by a high prevalence of chronic diseases and a low life expectancy [40,41]. HPSF was the result of a co-creation movement within schools and consisted of five key elements:

- *A healthy school lunch,* which children consumed together. The lunch was provided by school or an external caterer and its contents were in accordance with the guidelines from the Netherlands Nutrition Centre;
- *A longer lunch break* of at least one-and-a-half hours a day. In this way, there was more time for lunch (30 minutes), and structured PA and cultural activities (60 minutes);
- *Childcare staff* guided the lunch break. Although volunteers were still welcome to help, the lunch break was mainly guided by professionals;
- *Sports and cultural coaches* supported childcare staff during the structured PA and cultural activities. External partners were active within the school environment;
- *Parents were actively involved* from the start of HPSF. They shared their views on further development of HPSF and volunteered during lunch breaks.

In 2015, a quasi-experimental trial was initiated to evaluate HPSF. It involved eight primary schools in the Parkstad region: four intervention schools and four control schools. Two of the intervention schools implemented a healthy school lunch as well as structured PA and cultural sessions during lunch break time (full HPSFs). The other two intervention schools only implemented the structured PA and cultural sessions (partial HPSFs). The control schools continued with their regular curriculum that is common practice in the Netherlands [42]. The effects of HPSF have been investigated on a broad range of effect measures, revealing positive intervention effects on children's BMI z-score, waist circumference, and dietary and PA behaviours [43–45]. Although various positive effects of HPSF have been reported, the exact working mechanisms behind these intervention effects were not always clear. Also, the potential impact of HPSF on health behaviours in the home context was not specifically investigated, something which is seldom done for school-based health-promoting interventions [26,30]. Gaining more insight into potential working mechanisms of HPSF and into how changes in the school context might affect the home setting would therefore be beneficial to optimise HPSF's and other school-based health-promoting interventions' impact.

Scaling-Up HPSF

Inspired by the promising results of the HPSF trial in Parkstad, Prisma, an educational board comprising 12 primary schools in Peel en Maas (a rural municipality in Northern Limburg), expressed its interest in implementing changes fitting the HPSF initiative. Educational board Prisma collaborates with Hoera childcare centres; both primary education (Prisma) and childcare outside school hours (Hoera) for children aged 0–12 years are located in the Prisma schools. Prisma and Hoera's interest in the HPSF-initiative created the opportunity to 'scale-up' HPSF. Scale-up is 'the process by which health interventions shown to be efficacious on a small scale and/or under controlled conditions are expanded under real-world conditions into broader policy or practice' [46]. In HPSF's case, this scaling-up meant working with a significantly lower budget than during the HPSF trial and dealing with various schools with complex and unique contexts.

Together with Maastricht University and aided by funding from the provincial authorities, Prisma and Hoera initiated the scaling-up HPSF project. Aim of the project was to sustainably implement health-promoting activities fitting the HPSF initiative in the 12 participating schools. In contrast to the HPSF trial, no clear-cut intervention was allocated to the schools in this project. Rather, schools were free to decide whether, when, and to what degree they would implement health-promoting activities in their setting. These activities had to fall in at least one of the following four categories: (1) healthy and sustainable nutrition, (2) sufficient PA, (3) sufficient rest and relaxation, and (4) social involvement. The categories were developed by the educational board and researchers to match the main aspects targeted in the original HPSF trial (categories 1 and 2) and to include other aspects that were hypothesised to be important to improve children's health and well-being (categories 3 and 4). The initial aim was that eventually, all schools would implement a healthy school lunch and structured PA and cultural sessions during lunch break time; a situation comparable with the intervention allocated in the HPSF trial. However, the road towards the implementation of these activities was less controlled by researchers than in the HPSF trial. Schools were free to select and implement health-promoting activities fitting their unique context, wishes, and needs. Within Prisma, a process coordinator was appointed to guide and support all schools during this process. Researchers played an observing role within the project to gain insight into the implementation and impact of health-promoting activities in real-world, complex school settings and to identify any influencing factors. The research consisted of two parts:

- *Implementation research*: a mixed methods multisite comparative case study design was used to gain insight into project implementation in the various schools and to identify influential factors. For this purpose, data were collected between 2019 and 2022 using various methods. First, two questionnaires were administered in teachers, managers, and directors of all participating schools to gain insight into the (factors influencing the) implementation processes. Furthermore, semi-structured interviews were conducted with a purposive sample of teachers, managers, and directors to get an in-depth insight into the schools' project operationalisation and any factors influencing implementation. In addition, one researcher observed and took notes during all project meetings with the educational board, school directors, working groups with parents and/or teachers, and children's voice groups.

- *Effect evaluation*: to investigate the impact of the implemented health-promoting activities on children's health and well-being, an effect evaluation was executed. A wide range of health- and well-being-related data was collected in participating children from the 12 schools (e.g., BMI, waist- and hip-circumference, data on PA and dietary behaviours, and data on school well-being). Data were gathered through anthropometric measurements and questionnaires for parents and children that were administered yearly between 2019 and 2022 during so-called 'measurement weeks' at each school.

COVID-19

The COVID-19 pandemic that developed in early 2020 had a considerable influence on the scaling-up of HPSF and the corresponding research. In March 2020, all Dutch schools were forced to close for several weeks, which was again the case in December 2020 and 2021. Children had to stay at home, parents had to guide their children's home schooling, and teachers had to stay in contact with children and parents through digital communication. Plans and activities that schools had developed as part of the project had to be postponed or cancelled. Due to the pandemic and its related restrictions (e.g., social distancing and other safety regulations, high absenteeism, and no volunteers/parents allowed to enter the school buildings) and the continuously changing situation, the capacity, opportunity, and enthusiasm of schools to work on the project was limited. This made it impossible to implement all plans and activities that were developed at the start of the project.

Not only did the pandemic influence the development and implementation process in the various schools, it also affected (some of) the research that was performed as part of this dissertation. During the school closures, schools could not participate in the Kokkerelli intervention, which resulted in delayed data collection and a lower than anticipated number of school classes that could be included in the intervention group of the effect evaluation. Within the research on the scaling-up of HPSF, the baseline measurements for the effect evaluation had to be postponed several times due to the school closures, and when they were performed, various safety measures had to be taken (e.g., working with a limited amount of researchers). Additionally, the interviews with various stakeholders (directors, managers, and teachers) that were part of the implementation research and various meetings with directors, teachers, and other stakeholders had to be organised in an online setting instead of face-to-face.

Current Dissertation

Aim

The research presented in this dissertation had several aims. To gain more insight into children's HL and its potential role in health promotion in children, two studies on the translation of an instrument to measure children's HL and the subsequent investigation of a potential relationship between children's HL and various health outcomes are presented. Furthermore, included studies investigated how and to what degree health-promoting activities are developed and implemented in diverse school settings, which factors are important during the development and implementation process, and to what extent and in what way the implemented activities influence children's health (behaviours).

Outline

The first two chapters (Chapters 2 and 3) describe the translation of the Dutch HLS-Child-Q15 questionnaire to assess children's HL and the investigation of the relationship between children's HL and various health outcomes (e.g., BMI and PA and dietary behaviours). Chapter 4 describes the quantitative evaluation of the effects of the Kokkerelli intervention on children's determinants of FV intake (knowledge, taste preferences, attitude, and intention). Next, the effectiveness of HPSF (specifically the daily provision of a healthy school lunch) on children's FV familiarity, preferences, and intake is quantitatively investigated in Chapter 5. In Chapter 6, the impact of HPSF on the health behaviours of children and parents in the home setting is qualitatively explored through the use of semi-structured interviews. Chapters 7–9 comprise the research performed concerning HPSF's scaling-up project in Peel en Maas. In Chapter 7, we propose an approach for data categorisation inspired by Rogers' Diffusion of Innovations theory [47] that could be of use for researchers performing implementation and effectiveness research in complex settings. The approach could facilitate structuring a study's results and relating the degree of implementation to any impact on effectiveness outcomes that might be observed. Next, a detailed description of the project's development and implementation processes in the various schools is presented in Chapter 8, together with important barriers and facilitators for implementation (structured using the theoretical framework of Fleuren et al. [48]) and practical guidelines for the future implementation and integration of health-promoting activities within schools. Chapter 9 describes the effectiveness of the implemented health-promoting activities within the project on various health outcomes (e.g., BMI z-score, dietary and PA behaviours). The dissertation ends with a General Discussion and Valorisation, which describes the dissertation's impact on research and practice.

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CHAPTER 2

Measuring and Exploring Children's Health Literacy in the Netherlands: Translation and Adaptation of the HLS Child-Q15

Hahnraths MTH, Heijmans M, Bollweg TM, Okan O, Willeboordse M, Rademakers J. Measuring and Exploring Children's Health Literacy in the Netherlands: Translation and Adaptation of the HLS-Child-Q15.

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Abstract

As health literacy (HL) is hypothesised to develop throughout life, enhancement during childhood will improve HL and health during life. There are few valid, age-appropriate tools to assess children's HL. The German-language European Health Literacy Survey Questionnaire Adapted for Children (HLS-Child-Q15-DE) is a self-report questionnaire adapted from the adult European Health Literacy Survey Questionnaire. This study aims to translate the HLS-Child-Q15 to Dutch and explore the sample's HL distribution. The HLS-Child-Q15-DE was translated following WHO guidelines and administered digitally to 209 Dutch schoolchildren (8–11-year-olds). Its psychometric properties were assessed and the sample's HL distribution was explored by demographic characteristics. The HLS-Child-Q15-NL had high internal consistency (Cronbach's $\alpha = 0.860$) and moderate to strong item-total correlations (mean = 0.499). For 6 of the 15 items, > 10% of participants answered 'do not know', indicating comprehension problems. Higher HL scores were observed for 10–11-year-olds (compared with 8–9-year-olds; $p = 0.021$) and fourth-grade students (compared with third-grade; $p = 0.019$). This supports the idea that HL evolves throughout life and the importance of schools in this process. With the HLS-Child-Q15-NL, a Dutch measurement instrument of children's HL is available, although it needs further tailoring to the target group. More research is needed to decrease comprehension problems and to investigate test-retest reliability and construct validity.

Introduction

Health literacy (HL) is defined as 'people's motivation, knowledge and competences to access, understand, appraise, and apply health information to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life throughout life' [1]. Multiple studies have demonstrated positive associations between HL and health outcomes in adults (e.g., diabetes outcomes, hospitalisations) [2,3]. Over the last years, children's HL has received increasing attention. As HL is hypothesised to be a skill that develops throughout life, enhancing it at a young age (when various prerequisite competencies for HL also evolve) will likely result in improved HL and health outcomes later in life [4–6]. Despite the growing interest, little knowledge is available on children's HL; partly due to the fact that until recently, children and adolescents generally have been overlooked in health research [7]. The scarcity of valid, age-appropriate instruments to assess children's HL further contributes to this research gap [8–10].

The European Health Literacy Survey Questionnaire (HLS-EU-Q47) is a 47-item measurement instrument to assess HL in adults (15+ years). It was developed and validated by the HLS-EU Consortium to compare HL across eight European countries [1,11,12]. An age-adapted version of the HLS-EU-Q47 was developed and tested for German-speaking children aged 9–10 years. The development and validation process, resulting in the 15-item HLS-Child-Q15-DE, is presented elsewhere [13,14]. In a first study investigating HLS-Child-Q15-DE's psychometric properties, good internal consistency was demonstrated [15]. Since its development, efforts are being made to translate the HLS-Child-Q15 into other languages (e.g., English, French, Portuguese [16]). Currently, no Dutch translation of the HLS-Child-Q15 (or any other Dutch-language instrument to assess children's HL) is available. To be able to assess Dutch children's HL and to make comparisons with other countries, the present study was initiated. More specifically, the study aims to:

1. Translate the HLS-Child-Q15 into Dutch;
2. Test the Dutch HLS-Child-Q15 in a sample of Dutch primary school children:
    a. To verify its internal consistency and investigate data quality;
    b. To explore the distribution of children's HL over various demographic characteristics (sex, age, grade, ethnicity, socioeconomic status (SES)).

Materials and Methods

Translation and Adaptation Process

For translating and adapting the HLS-Child-Q15, a systematic five-step approach conforming to WHO guidelines was followed, including forward translation, expert panel meeting, backward translation, pre-testing/cognitive interviewing, and consensus about the final version [17]. Two independent professional Dutch translators performed the forward translation. The expert panel included both translators and four professionals/researchers with expertise in HL, child development, health promotion, and development of measurement instruments. During the expert panel meeting, discrepancies between the two translations were discussed and resolved. This resulted in agreement upon a single translation of the HLS-Child-Q15, which was then translated back to German by a third independent professional translator. As there were only minor textual discrepancies between the backward translation and the original version, it was concluded that the Dutch translation was satisfactory and ready for pre-testing. Pre-testing was done in individual cognitive interviews in a sample of ten children aged 9–10 years (five male, five female). All 15 translated HLS-Child-Q15 items were discussed and participants were asked to think aloud, contemplating about their interpretations and the items' meanings and phrasing. Furthermore, the response categories were discussed, and the interviewer asked questions about the questionnaire's general comprehensiveness. The cognitive interviews did not lead to major alterations in the translated HLS-Child-Q15, although rephrasing of some items was needed (e.g., 'to find out' instead of 'to learn', and 'on which moment' instead of 'when'). Most children comprehended the items as intended, which demonstrated adequate face validity of the questionnaire. The final version of the instrument (HLS-Child-Q15-NL) is attached as Appendix A.

Questionnaire Administration

After translation, the final version of the HLS-Child-Q15-NL was incorporated in a larger online questionnaire on children's health, well-being, and dietary and physical activity behaviours. Children filled out the questionnaire in class during school hours; they were instructed to answer the questions individually and to ask questions to available researchers if something was unclear. Filling out the complete questionnaire (39 multi-item questions) took about 30 minutes. The digital format did not allow participants to skip questions, but for every item, it was possible to select the 'do not know' option.

Participants

The present study is part of a larger research project involving 12 primary schools in Limburg, a province in the south of the Netherlands. This project investigates the effects of school-based health-promoting initiatives on children's health and well-being (e.g., body mass index, dietary and physical activity behaviours). Data collection for the current study was incorporated in the projects' baseline measurements.

All students of grades three and four (aged 8–11 years; corresponding to study years five and six in the Netherlands) of these 12 schools (*n* = 436) were eligible to participate in the present study; there were no further inclusion or exclusion criteria. Recruitment for the study was done through brochures for parents, which contained information about the research aims, procedures and data handling. Furthermore, researchers visited classrooms to inform children about the project and encourage them to participate. After school time, parents could ask questions to the researchers. All participating children were required to hand in a completed informed consent form, signed by both parents/guardians. The need for ethical approval for the overall research project was waived by the Medical Ethics Committee Zuyderland in Heerlen (METC-Z no. METCZ20190144). The project was registered in the ClinicalTrials.gov database on 9 December 2019 (NCT04193410).

Measures

Covariates

Children's age and sex were collected through the educational board's database. A digital parental questionnaire was used to obtain information about the children's SES and ethnicity. SES was calculated as the mean of standardised scores on maternal and paternal educational level [18]. The mean scores were categorised into low, middle, and high SES scores on the basis of tertiles. Children's ethnicity was determined by parental country of birth and divided into (1) Dutch, (2) Western (i.e., all other European countries (excluding Turkey), and North America, Japan, Indonesia, and Oceania), and (3) non-Western [19]. If at least one parent was born in a Western (other than the Netherlands) or non-Western country, the child's ethnicity was labelled Western or non-Western, respectively.

Outcomes

HL was measured using the HLS-Child-Q15-NL, which contained 15 items assessing the child's perceived ease or difficulty in finding, understanding, appraising, and applying health information. All items were phrased 'How easy or difficult is it for you to…'. Responses were given on a four-point Likert scale (i.e., 'very difficult', 'difficult', 'easy', 'very easy'). Additionally, a 'do not know' response category was incorporated. Higher scores indicate perceived ease in dealing with health information (i.e., higher HL).

Statistical Analyses

To maximise comparability with the original development study, similar statistical protocols were used [15]. All analyses were performed using IBM SPSS Statistics for Windows (version 25.0). Due to the digital questionnaire's nature, participants could not skip questions, resulting in no true missings in the collected data. However, participants could select the 'do not know' option, and questionnaires with ≥ 14 times 'do not know' (maximum missing rate of 80%) were excluded from analyses, as these participants either had no intention of filling in the questionnaire or were unable to do so due to language problems. Since the literature does not provide hard cut-off points for missing values, the cut-off point of 80% is arbitrary and based on agreement between the Dutch researchers and the developers of the original German questionnaire. For other participants, 'do not know' responses were handled as missing data.

To investigate the instrument's data quality, each item was examined separately by looking at the mean (with standard deviation (SD)), percentage of 'do not know' answers, proportion of maximum agreement (i.e., item difficulty), and variance. If > 10% of participants answered 'do not know' for an item, this was interpreted as indicative of comprehension problems. For proportion of maximum agreement, the percentage of participants selecting the maximum possible response option (i.e., 'very easy') was assessed, with desirable values between 20% and 80% [20]. As a second measure of differentiation, item variance was assessed (higher values are desirable) [21]. Internal consistency (i.e., degree of similarity between items) was measured as Cronbach's alpha coefficient and Spearman Brown split-half reliability coefficient. Values of ≥ 0.70 indicate sufficient internal consistency [22]. Inter-item correlations and corrected item-total correlations (ITCs; correlation between an item and the overall score formed by all other items) were calculated. A correlation $r \geq 0.50$ is considered strong, $r \geq 0.30$ moderate, and $r \geq 0.10$ weak [23].

Furthermore, the sample's overall HL scores were calculated. No HL scores were calculated for respondents with > 3 missing responses (maximum missing rate of 20%), meaning that HL scores were calculated for a more restricted sample than the sample used to assess the instrument's data quality (where a maximum missing rate of 80% was used) [12,15]. For maximum transparency, three HL estimates were provided: (1) overall mean scores (calculated by dividing the sum of valid responses by the total number of valid responses); (2) quintiles (first quintile = 'lowest HL', second to fourth quintile = 'medium HL', fifth quintile = 'highest HL'); and (3) HL levels corresponding to the HLS-EU-Q47 health literacy indices [12]. For the latter, mean overall HL scores were transformed from a range of one to four to a unified metric with a minimum of zero (least possible HL score) and a maximum of 50 (best possible HL score). Subsequently, HL estimates were categorised using four previously defined levels [12]: 'inadequate' (0–25), 'problematic' (> 25–33), 'sufficient' (> 33–42), and 'excellent' (> 42–50).

Normality of the distribution of overall mean HL scores in the sample was checked using histograms. Independent-sample t-tests and one-way ANOVA were used to explore the HL distribution in the sample by sex, age, grade, ethnicity, and SES, whilst Welch tests were used in case the Levene's test showed that variances were significantly different. For all analyses, a two-sided p-value ≤ 0.05 was considered statistically significant.

Results

Sample

Of the 436 students eligible for study participation, parental consent was obtained for 215 students (49.3%). Six participants were excluded from analyses due to having selected 'do not know' ≥ 14 times, resulting in 209 participants included in the present study. Slightly less than half were male (46.4%) and the sample's mean age was 9.71 years (SD: 0.68). The majority of the sample had a Dutch background (95.1%) and a SES in the highest tertile (49.1%). Table 1 reports the sample characteristics.

Psychometric Properties

Table 2 presents an overview of the 15 items tested and the statistics from item analyses.

Item difficulty. Item difficulty parameters ranged from 14.8% (item 1) to 58.6% (item 15). One item (item 1) was observed in the 'difficult' answer spectrum (item difficulty parameter < 20%). All other items had 'medium' difficulty (item difficulty parameter between 20% and 80%).

Variance. Standard deviations ranged from 0.627 (item 15) to 1.08 (item 8), with an average SD of 0.847 for all items.

Internal consistency. Cronbach's alpha coefficient (α = 0.860; 95% CI (0.815; 0.898)) and Spearman Brown split-half reliability coefficient (r = 0.838; 95% CI (0.497; 0.947)) indicated high internal consistency. Inter-item correlations ranged from 0.009 (between item 4 and 9) to 0.558 (between item 4 and 11). No items had inter-item correlations < 0.30 with all other items (Table S1). ITCs ranged from 0.412 to 0.654, with an average ITC of 0.499. No items had an ITC < 0.30, nine items had an ITC between 0.40 and 0.50, and six items an ITC > 0.50.

Distribution of HL Levels

HL scores were calculated for participants with ≤ 3 missing responses, resulting in mean scores for 180 of 209 participants (86.1%).

Overall mean HL scores. Overall mean scores ranged from 1.53 to 4.00, indicating that respondents used nearly the complete response range (1 = 'very difficult' to 4 = 'very easy'). The sample's mean score was 3.14 (SD: 0.465). Table 3 shows the HL distribution based on quintiles, with the categories 'lowest HL' (mean score ≤ 2.73), 'medium HL' (mean score > 2.73 and < 3.53), and 'highest HL' (mean score ≥ 3.53).

HL scores based on HLS-EU-Q47 indices. The sample's mean HL score based on the HLS-EU-Q47 indices was 35.68 (SD: 7.76). Scores ranged from 8.89 to 50.00. When looking at the HL distribution across the four levels (Table 3), most participants had a 'sufficient' HL level (45.6%), whilst an 'inadequate' HL level was least frequently observed (9.4%).

Independent-sample t-tests indicated that 10–11-year-olds had significantly higher HL scores (3.20 ± 0.463) compared to 8–9-year-olds (3.04 ± 0.453), $t(178) = -2.33$, $p = 0.021$. Additionally, HL scores for students from grade four were significantly higher (3.21 ± 0.455) compared with students from grade three (3.05 ± 0.465), $t(178) = -2.36$, $p = 0.019$. No significant differences in overall mean HL scores were found for other background characteristics (Table 4).

Table 1. Sample characteristics (*n* = 209).

Characteristic	***n***	**% / M (± SD)**
Sex (% boys)	209	46.4
Age (years)	209	9.7 (0.682)
8–9 years	78 [1]	37.3
10–11 years	131 [2]	62.7
Grade	209	
Grade three		45.0
Grade four		55.0
Ethnicity	162	
Dutch		95.1
Western		2.5
Non-Western		2.5
SES (%) [3]	163	
Lowest tertile		20.2
Middle tertile		30.7
Highest tertile		49.1

[1] 8–year-olds (*n* = 4) and 9–year-olds (*n* = 74). [2] 10–year-olds (*n* = 110) and 11–year-olds (*n* = 21). [3] Due to clustering of SES scores around several scores, the tertile group sizes are unequal. Abbreviations: M, mean; SD, standard deviation; SES, socioeconomic status.

Table 2. Data quality and corrected item-total correlations of the HLS-Child-Q15-NL (*n* = 209).

Question	'How Easy or Difficult Is It for You to…'	M	SD
1	find out how to recover quickly when you have a cold?	2.59	0.882
2	find out what you can do so that you don't get too fat or too thin?	3.21	0.814
3	find out how you can best relax?	3.05	0.864
4	find out which food is healthy for you?	3.34	0.786
5	understand when and how you should take your medicine when you are ill?	2.82	0.969
6	understand what your doctor says to you?	2.94	0.849
7	understand why you sometimes need to see the doctor even though you are not ill?	2.93	0.966
8	understand why you need vaccinations?	2.84	1.08
9	understand what your parents tell you about your health?	3.30	0.791
10	understand why you need to relax sometimes?	3.38	0.809
11	judge what helps a lot for you to stay healthy and what does not help much?	3.19	0.811
12	do what your parents tell you to do so that you can get well again?	3.28	0.763
13	take your medicine in the way you're told to?	3.08	0.914
14	stick to what you have learned in road safety lessons?	3.41	0.789
15	have a healthy diet?	3.53	0.627

Note. Items translated from Dutch. [1] Percentage of participants selecting the maximum possible response option (i.e., 'very easy'). [2] > 10% of participants selected the 'do not know' response category. Abbreviations: M, mean; SD, standard deviation; ITC, corrected item-total correlations.

2

'Do Not Know' (%)	Proportion of Maximum Agreement (%) [1]	Variance	ITC
22.5 [2]	14.8	0.778	0.440
12.4 [2]	41.0	0.663	0.464
8.1	33.9	0.746	0.483
7.2	50.0	0.618	0.424
14.8 [2]	28.1	0.939	0.570
5.7	26.4	0.721	0.417
14.8 [2]	34.3	0.933	0.476
11.5 [2]	35.7	1.16	0.590
7.2	47.9	0.625	0.583
5.7	54.3	0.654	0.536
10.5 [2]	39.6	0.658	0.654
6.2	44.4	0.582	0.432
9.1	38.9	0.835	0.551
6.2	56.1	0.622	0.450
5.3	58.6	0.393	0.412

Missing values. The percentage of participants selecting the 'do not know' response ranged from 5.3% (item 15) to 22.5% (item 1), with a mean of 9.8% (SD: 4.77) per item. Six items had a missing rate > 10%.

Table 3. Distribution of mean HL scores by quintiles and by HLS-EU-Q47 indices (*n* = 180).

Distribution of Mean HL Scores by Quintiles		
HL Level	***n***	**Frequency (%)**
Lowest HL *(first quintile)*	31	17.2
Medium HL *(second to fourth quintile)*	110	61.1
Highest HL *(fifth quintile)*	39	21.7
Distribution of HL by HLS-EU-Q47 Indices		
HL Level	***n***	**Frequency (%)**
'Inadequate' HL	17	9.4
'Problematic' HL	42	23.3
'Sufficient' HL	82	45.6
'Excellent' HL	39	21.7

Abbreviations: HL, health literacy.

Table 4. Distribution of participants' overall mean HL scores (*n* = 180).

Characteristic	***n***	**M (SD)**	***t*-value / F-value**	***p*-value**
Sex			1.422	0.157 [1]
Boys	85	3.19 (0.511)		
Girls	95	3.09 (0.417)		
Age			-2.334	0.021 *
8–9 years	67 [2]	3.04 (0.453)		
10–11 years	113 [3]	3.20 (0.463)		
Grade			-2.361	0.019 *
Grade three	80	3.05 (0.465)		
Grade four	100	3.21 (0.455)		
Ethnicity			1.010	0.367
Dutch	131	3.13 (0.436)		
Western	4	3.44 (0.611)		
Non-Western	3	3.06 (0.448)		
SES			0.184	0.832 [3]
Lowest tertile	23	3.08 (0.574)		
Middle tertile	45	3.13 (0.444)		
Highest tertile	71	3.15 (0.406)		

[1] Analysed by Welch test. [2] 8–year-olds (*n* = 3) and 9–year-olds (*n* = 64). [3] 10–year-olds (*n* = 97) and 11–year-olds (*n* = 16). * Significant difference ($p \leq 0.05$). Abbreviations: M, mean; SD, standard deviation; SES, socioeconomic status.

Discussion

In the present study, the HLS-Child-Q15 was translated to Dutch and subsequently tested in a sample of primary school children in Limburg, the Netherlands. Furthermore, the sample's HL distribution was explored across various demographic variables.

Translation, Adaptation, and Psychometric Properties

Psychometric analyses revealed high internal consistency and moderate to strong ITCs, with slightly higher values than observed in the German sample [15]. During questionnaire administration, various participants asked questions, indicating problems with item interpretation. Participants tended to answer on the basis of their knowledge and experience (e.g., 'I know what to do to relax' or 'I relax often'), instead of on the basis of their perceived ease or difficulty to deal with health information. Similar problems were reported in the qualitative pre-test of the HLS-Child-Q15-DE [13]. This might indicate that HL is a difficult concept for children to grasp, and that the HLS-Child-Q15 needs further tailoring to the target group (e.g., by simplifying item phrasing or adding pictures/example items). Additionally, adult guidance might be beneficial for successful administration, although excessive adult interference should be avoided to minimise influencing children's answers. A general supervision protocol might be helpful to ensure adequate adult guidance.

The relatively high percentage of 'do not know' answers could also be due to interpretation problems. Possibly, children interpreted 'do not know' as 'I do not know how to do that' (e.g., 'I do not know what to do to relax') or 'I never do that' (e.g., 'I never find out what to do to relax'). Although further research is needed to gain more specific insight into any problems, the 'do not know' category could be further specified to 'I do not understand the question' to avoid misinterpretation. Administration procedures could also have influenced children's responses. In the present study, the HLS-Child-Q15 was included at the end of a questionnaire assessing diverse aspects of health and well-being (total administration time approximately 30 min). Possibly, this questionnaire was too long for children and therefore decreased their ability to adequately fill in the HLS-Child-Q15. Administration of the HLS-Child-Q15-NL in isolation would therefore be beneficial to investigate if interpretation problems persist.

To further improve the HLS-Child-Q15-NL, it might be useful to specifically look at the first item ('How easy or difficult is it for you to find out how to recover quickly when you have a cold?'), which had the highest percentage of 'do not know' answers and was the only item within the 'difficult' answer spectrum. This could be due to formulation and interpretation problems, but it could also be that the item does not connect adequately to children's everyday lives, as parents might be responsible for this task instead of children themselves. This further supports the notion that the current HLS-Child-Q15-NL is not yet optimally tailored to the target group.

Distribution of HL Levels

The Dutch mean HL score (3.14) is slightly lower than the German score (3.34) [15], which could be due to actual HL differences, although other factors (e.g., differences in setting, administration and item interpretation) might also have played a role. The present sample's significantly higher HL scores for older participants and for participants from grade four as compared with grade three support the idea that HL is a dynamic concept developing throughout life. Education might have important influences on children's HL development; making schools powerful settings in this process. With regard to HL scores based on the HLS-EU-Q47 indices, the present sample's mean score (35.68) is lower than the score previously observed in Dutch adults (37.06), which might be another indicator of evolving HL throughout life [12]. However, as both scores were acquired using different instruments (HLS-Child-Q15-NL and HLS-EU-Q47, respectively) it is not known if and how they can be compared, and more research is necessary before any conclusions can be drawn.

Study Limitations and Implications for Further Research

The present study has several limitations. The fact that all participants are from the same area in the Netherlands (i.e., Limburg) and that information about the non-response group is lacking limits the results' generalisability. Concerning the psychometric analyses, the sample size was fair, with a total of 180 participants for whom HL scores was calculated (subject-to-item ratio = 12) [24,25]. With regard to the analyses of the HL distribution across demographic characteristics, however, the relatively low number of participants might have limited the ability to detect significant differences. Additionally, due to the present study's practical constraints, the questionnaire was only administered once, making it impossible to assess test-retest reliability. Furthermore, as no other HL-related questions were included in the questionnaire, it was impossible to investigate the instrument's discriminant and convergent validity. Lastly, children's lack of experience in relation to the addressed tasks might decrease their answers' validity, although this needs further investigating.

Further research within a larger, more diverse sample (e.g., in terms of ethnicity, educational quality, and/or SES), using repeated assessments and other HL-related questions is necessary to investigate the results' generalisability and the instrument's test-retest reliability and discriminant and convergent validity. Multilevel analyses could furthermore clarify the effects different school environments might have on children's HL. Further investigating children's interpretation of the 'do not know' category would provide more insight into any interpretation problems. Lastly, experimenting with simplified item formulation and various layouts (e.g., adding pictures/examples) and administration methods (e.g., adult guidance, providing solely the HLS-Child-Q15) is needed to further tailor the HLS-Child-Q15 to the target group.

Conclusions

The HLS-Child-Q15-NL is a promising instrument to measure children's HL. The questionnaire has high internal consistency, and ITCs are moderate to strong. However, the relatively high percentage of 'do not know' responses and the number of questions asked during questionnaire administration indicated comprehension problems. Further refinement of the instrument is necessary to increase its suitability for the target group. Additionally, adult guidance might be beneficial for successful administration, although this should be done with care to avoid influencing children's answers.

In the present sample, HL scores were higher for older participants and participants from grade four as compared with grade three, which supports the idea that HL evolves throughout life. Education (and therefore schools) can play an important role in HL development, although more research is needed to further investigate this potential working mechanism. The present study's efforts are first steps towards HL measurement in Dutch children and they increase comparability with other countries.

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Appendix A. Final Version of the HLS-Child-Q15-NL

DE VOLGENDE VRAGEN GAAN OVER WAT JE KUNT DOEN OM GEZOND TE BLIJVEN EN OVER WAT JE KUNT DOEN ALS JE ZIEK BENT.

Wil jij ons vertellen of de volgende dingen voor jou makkelijk of moeilijk zijn?
Als je het niet weet of je begrijpt de vraag niet goed, dan kun je 'weet niet' antwoorden.

Zet bij elke zin een kruisje in het hokje dat voor jou klopt.
Je mag één antwoord per rij geven.

Hoe makkelijk of moeilijk is het voor jou…
...om erachter te komen hoe je snel beter kunt worden als je verkouden bent?
...om erachter te komen wat je kunt doen om niet te dik of te dun te worden?
...om erachter te komen hoe je het beste kunt ontspannen?
...om erachter te komen welk eten voor jou gezond is?
...om te begrijpen wanneer en hoe je je medicijnen moet innemen als je ziek bent?
...om te begrijpen wat de dokter tegen je zegt?
...om te begrijpen waarom je soms naar de dokter moet, zelfs als je helemaal niet ziek bent?
...om te begrijpen waarom je moet worden ingeënt (een prik krijgt)?
...om te begrijpen wat je ouders je vertellen over je gezondheid?
...om te begrijpen waarom je soms ook moet uitrusten?
...om te kiezen wat voor jou wel en niet helpt om gezond te blijven?
...om te doen wat je ouders tegen je zeggen om weer beter te worden?
...om je medicijnen in te nemen zoals het je is verteld?
...om je te houden aan de verkeersregels die je hebt geleerd?
...om gezond te eten?

Heel Moeilijk	Best Moeilijk	Best Makkelijk	Heel Makkelijk	Weet Niet
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o
o	o	o	o	o

Table S1. Inter-Item Correlations of the HLS-Child-Q15-NL.

Table S1. Inter-item correlations of the HLS-Child-Q15-NL.

Inter-Item Correlation Matrix							
	Item 1	**Item 2**	**Item 3**	**Item 4**	**Item 5**	**Item 6**	**Item 7**
Item 1	1.000	0.461	0.299	0.115	0.336	0.166	0.275
Item 2	0.461	1.000	0.311	0.338	0.310	0.091	0.208
Item 3	0.299	0.311	1.000	0.258	0.237	0.093	0.252
Item 4	0.115	0.338	0.258	1.000	0.295	0.117	0.250
Item 5	0.336	0.310	0.237	0.295	1.000	0.284	0.368
Item 6	0.166	0.091	0.093	0.117	0.284	1.000	0.301
Item 7	0.275	0.208	0.252	0.250	0.368	0.301	1.000
Item 8	0.413	0.292	0.328	0.226	0.456	0.264	0.441
Item 9	0.191	0.171	0.400	0.419	0.330	0.340	0.262
Item 10	0.223	0.188	0.368	0.120	0.373	0.431	0.336
Item 11	0.341	0.436	0.309	0.558	0.333	0.345	0.327
Item 12	0.151	0.198	0.209	0.009	0.226	0.331	0.208
Item 13	0.358	0.238	0.391	0.132	0.472	0.266	0.302
Item 14	0.130	0.226	0.212	0.290	0.275	0.232	0.266
Item 15	0.104	0.392	0.298	0.411	0.290	0.182	0.025

2

Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15
0.413	0.191	0.223	0.341	0.151	0.358	0.130	0.104
0.292	0.171	0.188	0.436	0.198	0.238	0.226	0.392
0.328	0.400	0.368	0.309	0.209	0.391	0.212	0.298
0.226	0.419	0.120	0.558	0.009	0.132	0.290	0.411
0.456	0.330	0.373	0.333	0.226	0.472	0.275	0.290
0.264	0.340	0.431	0.345	0.331	0.266	0.232	0.182
0.441	0.262	0.336	0.327	0.208	0.302	0.266	0.025
1.000	0.370	0.403	0.356	0.324	0.358	0.310	0.179
0.370	1.000	0.455	0.523	0.444	0.369	0.201	0.278
0.403	0.455	1.000	0.344	0.348	0.262	0.365	0.110
0.356	0.523	0.344	1.000	0.282	0.263	0.391	0.508
0.324	0.444	0.348	0.282	1.000	0.388	0.207	0.249
0.358	0.369	0.262	0.263	0.388	1.000	0.419	0.277
0.310	0.201	0.365	0.391	0.207	0.419	1.000	0.185
0.179	0.278	0.110	0.508	0.249	0.277	0.185	1.000

CHAPTER 3

Children's Health Literacy in Relation to their BMI z-Score, Food Intake, and Physical Activity: A Cross-Sectional Study among 8–11-Year-Old Children in the Netherlands

Rademakers J*, Hahnraths MTH*, van Schayck CP, Heijmans M. Children's Health Literacy in Relation to Their BMI z-Score, Food Intake, and Physical Activity: A Cross-Sectional Study among 8–11-Year-Old Children in the Netherlands. *Children.* 2022;9(6):925.

**Authors contributed equally to the manuscript.*

Abstract

Overweight and obesity in children are an increasing public health problem. Health literacy (HL) is a determinant of obesity and body mass index (BMI) rates in adults, but few studies have addressed the impact of children's own HL on their weight and lifestyle. In this study, we aim to assess the impact of Dutch children's HL on (1) their BMI z-score, (2) dietary behaviours, and (3) the amount of physical activity (PA) they engage in. A sample of 139 children (age 8–11 years) filled out a digital questionnaire, including an HL measurement instrument and questions regarding their food intake and PA. Furthermore, the height and weight of the children were measured, and background information was collected using a parental questionnaire. Multiple regression revealed a significant positive relation between children's HL and their PA. No significant association between children's HL and their BMI z-score or dietary behaviours was found. In conclusion, HL of children in primary school has an impact on some aspects of children's lifestyle, although more research in a larger, more diverse sample is needed to further investigate this.

Introduction

Overweight and obesity in children are worldwide increasing health problems. Globally, the prevalence of overweight and obesity among children and adolescents (age 5–19 years) has risen from 4% in 1975 to over 18% in 2016. In 2016, over 340 million children and adolescents (age 5–19 years) were overweight or obese [1]. In 2021, 15.5% of Dutch primary school children (age 4–12 years) were overweight, of which 3.6% were obese [2]. Overweight and obesity in children can have serious health consequences. Furthermore, children who are overweight or obese are more likely to also have weight problems in adulthood and to develop illnesses such as type 2 diabetes, cardiovascular diseases, and musculoskeletal disorders in later life [3–5]. Preventing overweight and obesity in childhood is therefore an important public health priority. The main causes of overweight and obesity in childhood are an unhealthy diet (intake of food high in fat and sugars and low in vitamins, minerals, and other healthy nutrients) and little physical activity (PA) [3]. In the Netherlands, the majority of children do not lead a healthy lifestyle. Over the period of 2014–2016, only 20% of 9–12-year-old Dutch children consumed at least 200 grams of fruit per day, and only 25% consumed the recommended daily 150–200 grams of vegetables [6]. In 2020, almost four out of every ten 4–11-year-old Dutch children (39.3%) did not engage in sufficient PA according to the relevant age-appropriate norms [7].

There is a clear association between children's weight and their socio-economic background; having a low socio-economic status (SES) is one of the most prominent risk factors for developing obesity in Western countries [8–10]. This is partly caused by poverty and lack of financial resources, which make a healthy lifestyle less accessible since fresh and healthy food is generally more expensive [11]. Psychosocial aspects such as childhood adversity, family dysfunction, insecurity, chronic stress, and emotional factors also play a role in the unequal prevalence of childhood overweight and obesity across populations [12]. Health literacy (HL) is another important determinant of health inequity. HL can be defined as 'people's motivation, knowledge, and competences to access, understand, appraise, and apply health information to make judgements and take decisions in everyday life concerning healthcare, disease prevention, and health promotion' [13]. There is strong evidence of a social gradient in HL: people with a lower SES more often have limited HL skills [14]. A recent systematic literature review demonstrated that limited HL is a determinant of obesity and higher body mass index (BMI) rates in both children and adult populations [15].

With respect to children's health outcomes, studies often look at the influence of the HL level of parents and caregivers [16,17]. This is understandable, as especially for young children, parents and caregivers are the persons who make most decisions impacting the life and health of their children. For example, they make decisions regarding grocery shopping, dinner preparation, and enrolment in sports clubs. Evidence suggests that children of parents with high HL, in general, have better health outcomes (e.g., regarding their weight status) than children of parents with low HL [15,16]. However, as children grow older, they become more autonomous in their preferences and behaviours regarding food intake and PA. They become more susceptible to the influence of their peers and to marketing efforts aimed at promoting certain foods and beverages [18,19]. Peers' influence on children's eating behaviour is often found to be negative, leading to an increase in consumption of foods that are energy-dense and have little nutritional value [18]. Furthermore, unhealthy food and beverage marketing through media popular among children can negatively impact diet-related outcomes, such as food choice and intake [19].

Only very few studies have addressed children's own HL in relation to their weight, food intake, and/or PA [20–22]. The scarcity of studies in this domain has been partly due to the lack of appropriate instruments to measure children's HL [23–25]. However, in 2018–2019 a children's version of the European Health Literacy Survey Questionnaire was developed and tested in Germany [26–28]. The instrument, the HLS-Child-Q15, is tailored to fourth graders (9–10 years old) and was subsequently translated and validated in other countries, among which was the Netherlands [29]. In a Dutch sample of 8–11-year-old children (n = 209), 17.2% had a low HL score (lowest quintile), 61.1% had a medium score (second to fourth quintile), and 21.7% had a high HL score (fifth quintile). Older children (10–11 years) had significantly higher HL scores compared to younger children (8–9 years). No significant differences in overall mean HL scores were found across sex, ethnicity, and SES [29]. The availability of the HLS-Child-Q15 generates new opportunities to gain insight into the association between children's own HL and their health status and lifestyle. In the study presented in this article, we aimed to assess the impact of Dutch children's HL on (1) their BMI z-score, (2) their dietary behaviour (fruit consumption, vegetable consumption, water consumption, and soft drink consumption), and (3) the amount of PA they engage in. It was hypothesised that children's HL would be negatively correlated with their weight and positively with their health-related behaviours.

Materials and Methods

Participants

This cross-sectional study is part of a larger research project. This project investigates the effects of school-based health-promoting initiatives on children's health and well-being. Outcome measures include BMI, and dietary and PA behaviours. The study was conducted in 12 primary schools in Limburg, a province in the south of the Netherlands.

Data collection for the present study was part of the overall project's baseline measurements. All pupils of grades three and four (aged 8–11 years; corresponding to study years five and six in the Netherlands) of the 12 schools (*n* = 436) were eligible to participate in the present study; there were no further inclusion or exclusion criteria. Recruitment for the study was done through brochures for parents, with information on the study aims, procedures, and handling of the data. In addition, researchers went to the classrooms to give information to the children about the project and to encourage them to take part. A special session was organised in which parents could ask questions to the researchers about the project. All children who participated were required to hand in a completed informed consent form, signed by both parents/guardians. The Medical Ethics Committee Zuyderland in Heerlen waived the need for ethical approval of the research project (METC-Z no. METCZ20190144). The project was registered in the ClinicalTrials.gov database on 9 December 2019 (NCT04193410).

Measures

Data Collection Procedures

BMI: Height and weight of all participating children were measured to establish BMI. Children were measured outside at the playground, wearing light clothes and no shoes. All measurements were conducted two times, with a third measurement if the difference between the first two was too large (pre-set limit; weight ≥ 0.2 kg, height ≥ 0.5 cm). Weight was measured to the nearest 0.1 kg (Weighing Scale 803, Seca, Hamburg, Germany), and height was measured to the nearest 0.1 cm (Stadiometer 213, Seca, Birmingham, UK).

Questionnaire: All participating children filled out a digital questionnaire, including questions regarding their diet and PA. At the end of the questionnaire, the HLS-Child-Q15 was included [29]. The questionnaire was filled out in class during class hours and took about 30 minutes to complete. During questionnaire administration, a minimum of one member of the research team was present in the classroom. Due to the digital questionnaire's nature, participants could not skip questions, resulting in no true missings in the collected data. However, participants could select the 'do not know' option when answering the HLSChild-Q15, and no mean HL scores were calculated for respondents with > 3 'do not know' responses (maximum missing rate of 20%).

Covariates

Data on children's age and sex were collected through the school's administrative database. Through a (digital) parental questionnaire, data on children's SES and ethnicity were collected. SES was calculated as the mean of standardised scores on the educational level of both parents. The mean scores were categorised into low, middle, and high SES (on the basis of tertiles). Children's ethnicity was determined by the parental country of birth and divided into (1) Dutch, (2) Western (i.e., all other European countries (excluding Turkey), North America, Japan, Indonesia, and Oceania), and (3) non-Western. If at least one parent was born in a Western (other than the Netherlands) or non-Western country, the child's ethnicity was labelled Western or non-Western, respectively.

Outcomes

BMI z-score: BMI was assessed by combining weight and height. BMI z-scores (BMI scores adjusted for child age and sex) were calculated by using Dutch reference values [30,31].

Dietary behaviour: To assess children's dietary behaviour, four questions on the frequency of fruit, vegetable, water, and soft drink consumption were asked. Questions were formulated in the following way: 'How often do you normally consume fruit/ vegetables/water/soft drinks?' with response options (1 = 'never', 2 = 'almost never', 3 = 'sometimes (1–3 times per week)', 4 = 'often (4–6 times per week)', 5 = 'every day').

PA behaviour: The digital questionnaire contained ten items from the International Physical Activity Questionnaire for Children (IPAQ-C). Each item resulted in an activity score ranging from 1 to 5, and the mean of these scores was calculated to obtain the total activity summary score (ranging from 1 (lowest PA) to 5 (highest PA)) [32].

HL: HL was measured with the Dutch version of the HLS-Child-Q15, which contains 15 items that assess the child's perceived ability to find, understand, appraise, and apply health information. All items were phrased as 'How easy or difficult is it for you to…'. Responses were given on a four-point Likert scale (response options 'very difficult', 'difficult', 'easy', and 'very easy'). Furthermore, a 'do not know' response category was incorporated for each item. Higher scores correspond with higher HL (higher perceived ease in dealing with health information).

Statistical Analyses

Analyses were performed using IBM SPSS Statistics for Windows (version 25.0) and Stata 16.1. Participants who selected the 'do not know' answer option in the HLS-ChildQ15 > 3 times and/or had missing values on any of the other outcomes (sex, age, grade, SES, BMI z-score, PA score, fruit, vegetable, water, and/or soft drink consumption) were excluded from the analyses. Next to the overall mean HL scores (calculated by dividing the sum score of valid responses by the total number of valid responses), HL was examined using quintiles (first quintile = 'low HL', second to fourth quintile = 'medium HL', fifth quintile = 'high HL').

The variables for children's mean HL scores and age were centred by subtracting the old variables' mean from the old variable.

After checking if the data met the necessary assumptions, regression analyses were performed to examine the relationship between mean HL scores/HL quintiles and BMI z-scores, PA summary scores, and fruit, vegetable, water, and soft drink consumption. As participants were nested in classes, which were nested in schools, it was checked whether there was a significant variance in class and/or school level for the various outcome variables. If this was the case, multi-level regression analyses were used. In all other cases, multiple linear regression analyses were used. Children's age, SES, and sex were included as covariates in all analyses. For all analyses, a two-sided p-value ≤ 0.05 was considered statistically significant.

Results

Sample

Parental consent was obtained for 215 of the 436 students eligible for study participation (49.3%). Thirty-five participants were excluded from analyses due to having selected 'do not know' > 3 times, and 41 were excluded due to missing values on SES, resulting in 139 children being included in the present study. Almost half of the sample was male (49.6%), and the mean age of the participating children was 9.7 years (standard deviation (SD): 0.656). The majority had a Dutch background (94.9%) and an SES in the highest tertile (51.1%). Table 1 reports the sample characteristics.

Children's HL and Their BMI z-Score

No significant variance in class and/or school level was found for children's BMI z-scores, which is why a multiple regression was run to predict BMI z-score from mean HL, sex, age, and SES. These variables did not significantly predict BMI z-score, F(4, 134) = 0.354, p = 0.841, adjusted R^2 = -0.019. None of the four variables added statistically significantly to the prediction, p > 0.05. A second multiple regression was run to predict BMI z-score from HL quintiles, sex, age, and SES. These variables did not significantly predict BMI z-score, F(4 134) = 0.479, p = 0.751, adjusted R^2 = -0.015. None of the four variables added statistically significantly to the prediction, p > 0.05 (Table 2).

Table 1. Sample characteristics (*n* = 139).

Characteristic	***n***	**% / M (± SD)**
Sex (% boys)	139	49.6
Age (years)	139	9.7 (0.656)
Grade	139	
Grade three	61	43.9
Grade four	78	56.1
Ethnicity	137	
Dutch	130	94.9
Western	4	2.9
Non-Western	3	2.2
SES (%) [1]	139	
Lowest tertile	23	16.5
Middle tertile	45	32.4
Highest tertile	71	51.1
HL	139	3.1 (0.447)
BMI z-score	139	-0.2 (0.891)
PA score	139	3.0 (0.684)
Fruit consumption	139	
Never	1	0.7
Almost never	2	1.4
Sometimes (1–3 times/week)	13	9.4
Often (4–6 times/week)	43	30.9
Every day	80	57.6
Vegetable consumption	139	
Never	1	0.7
Almost never	2	1.4
Sometimes (1–3 times/week)	23	16.5
Often (4–6 times/week)	70	50.4
Every day	43	30.9
Water consumption	139	
Never	0	0.0
Almost never	11	7.9
Sometimes (1-3 times/week)	34	24.5
Often (4-6 times/week)	45	32.4
Every day	49	35.3

Table 1. Continued.

Characteristic	*n*	% / M (± SD)
Soft drink consumption	139	
Never	6	4.3
Almost never	37	26.6
Sometimes (1–3 times/week)	62	44.6
Often (4–6 times/week)	17	12.2
Every day	17	12.2

[1] Due to clustering of SES scores around several scores, the tertile group sizes are unequal. Abbreviations: M, mean; SD, standard deviation; SES, socio-economic status; HL, health literacy; BMI, body mass index; PA, physical activity.

Table 2. Relationship between children's HL and BMI z-scores.

HL measure	B (95% CI)	*p*-value
Mean HL scores	0.121 (-0.232; 0.473)	0.500
HL quintiles	0.124 (-0.127; 0.375)	0.331

Note. Analysed by multiple linear regression analyses. All analyses were adjusted for sex, age, and SES. Abbreviations: HL, health literacy; BMI, body mass index; CI, confidence interval.

Children's HL and Their PA Score

A significant variance on class level (not on school level) was found for children's PA summary scores (intraclass correlation coefficient = 0.279; p = 0.000), which is why multilevel regression analyses were performed to examine the relationship between children's HL and their PA scores. These analyses revealed a significant relationship between children's mean HL score and their PA summary score (B = 0.356; p = 0.002) (Table 3). A significant relationship between HL quintiles and PA summary scores was also found, revealing that participants with the lowest HL had significantly lower PA summary scores than children with medium HL (B = -0.499; p = 0.000).

Table 3. Relationship between children's HL and PA summary scores.

HL measure	B (95% CI)	*p*-value
Mean HL scores	0.356 (0.127; 0.585)	0.002 *
HL quintiles		
Lowest HL	-0.499 (-0.772; -0.225)	0.000 *
Highest HL	-0.019 (-0.267; 0.228)	0.879

Note. Analysed by linear mixed model analyses. All analyses were adjusted for sex, age, and SES. Abbreviations: HL, health literacy; PA, physical activity; CI, confidence interval. * Significant relationship ($p \leq 0.05$).

Children's HL and Their Dietary Behaviour

No significant variance on class and/or school level was found for any of the children's dietary outcomes, which is why multiple regression analyses were performed to predict children's dietary outcomes from HL (mean HL or HL quintiles), sex, age, and SES. Before conducting the analyses for fruit and vegetable consumption, three outliers were excluded from the dataset. In the regression analyses, including mean HL scores, these variables did not significantly predict fruit consumption, $F(4, 131) = 0.612$, $p = 0.654$, adjusted $R^2 = -0.012$; vegetable consumption, $F(4, 131) = 0.911$, $p = 0.459$, adjusted $R^2 = -0.003$; water consumption, $F(4, 134) = 1.18$, $p = 0.322$, adjusted $R^2 = -0.005$; or soft drink consumption, $F(4, 134) = 1.69$, $p = 0.157$, adjusted $R^2 = -0.019$. None of the four variables added statistically significantly to the predictions, $p > 0.05$. In the regression analyses including HL quintiles, these variables did not significantly predict fruit consumption, $F(4, 131) = 0.323$, $p = 0.862$, adjusted $R^2 = -0.020$; vegetable consumption, $F(4, 131) = 0.997$, $p = 0.412$, adjusted $R^2 = 0.000$; water consumption, $F(4, 134) = 1.10$, $p = 0.361$, adjusted $R^2 = 0.003$; or soft drink consumption, $F(4, 134) = 1.46$, $p = 0.218$, adjusted $R^2 = -0.013$. None of the four variables added statistically significantly to the prediction, $p > 0.05$ (Table 4).

Table 4. Relationship between children's HL and fruit, vegetable, water, and soft drink consumption.

Outcome	HL measure	B (95% CI)	*p*-value
Fruit consumption [1]	Mean HL scores	0.151 (-0.119; 0.421)	0.271
	HL quintiles	-0.026 (-0.220; 0.167)	0.790
Vegetable consumption [1]	Mean HL scores	0.167 (-0.104; 0.439)	0.225
	HL quintiles	0.132 (-0.061; 0.326)	0.179
Water consumption	Mean HL scores	0.242 (-0.132; 0.617)	0.203
	HL quintiles	0.155 (-0.113; 0.423)	0.254
Soft drink consumption	Mean HL scores	-0.202 (-0.601; 0.197)	0.319
	HL quintiles	-0.052 (-0.338; 0.234)	0.719

Note. Analysed by multiple linear regression analyses. All analyses were adjusted for sex, age, and SES. [1] For the outcomes fruit consumption and vegetable consumption, three participants were excluded from the analyses due to outliers. Abbreviations: HL, health literacy; CI, confidence interval.

Discussion

In the present study, we aimed to assess the association of Dutch children's own HL with (1) their BMI z-score, (2) dietary behaviour, and (3) amount of PA they engage in. The children in our study were 8–11 years old. Our hypothesis was that children's HL is negatively correlated with their weight and positively with their health-related behaviours. The first part of our hypothesis was not confirmed. This finding is contrary to two of the three other studies that studied the association between HL and their BMI scores. In total, we identified three studies that focused on primary school children [20–22]. Two studies, one in a New York sample of overweight children and adolescents (age 6–19 years) and one in a population-based study of Taiwanese children (age 11–12 years), demonstrated an inverse relation between children's HL and their BMI—the higher their HL, the less likely children were to be overweight or obese [20,21]. A study in Turkey, however, did not find a significant correlation between children's HL and their BMI [22]. Unlike the studies in New York and Taiwan [20,21], no significant association between children's HL and their BMI z-score was found in the present study. This might be due to the fact that in our sample, the variation in BMI z-score was limited: values ranged between 14 and 19 (mean 16.8). This means that the BMI of most participants in our sample was within the normal range for children in this age group [30,31]. Since 15.5% of the Dutch children in primary school are overweight, our sample is not representative in this respect [2].

Concerning the second part of our hypothesis, the results were different for dietary intake and PA. With regard to dietary behaviour, there was no significant association between children's HL and their vegetable intake, fruit intake, water consumption, or soft drink consumption. With respect to fruit intake, there was little variation in the sample, since almost six out of ten participants reportedly consume fruit every day. Given the fact that in the overall population of 9–12-year-old children, only one in five eats a daily portion of 200 grams of fruit, our sample seems to be eating healthier in this respect [6].

Children's HL, however, did show an evident association with the amount of PA they engage in. The present study showed a significant positive association between children's HL score and their PA score—the higher the HL, the higher the participants' PA score. Participants with HL scores in the medium or highest quintile had significantly higher PA scores than participants with HL scores in the lowest quintile.

Whilst the association between Dutch children's HL and their BMI z-score and dietary behaviour in this study was non-significant, possibly due to the homogeneity of the sample, the relationship between their HL and amount of PA was evident. Supposedly, children in this age range (8–11 years) have more autonomy over their PA behaviour than they have over their diet. Whilst their parents or caretakers are most often responsible for shopping, filling their lunch boxes, and dinner preparation, children themselves are able to choose whether they want to take part in active play and physical games, both during and after school time. A systematic review by Buja et al. also consistently found a positive association between HL and PA in different age groups [33]. They conclude that ‘individuals with a better-developed HL have skills and capabilities that enable them to engage in various forms of personal health-enhancing behaviour, such as regular PA’ [33]. We already know from other research that there is also a relationship between low parental HL, SES, and some child health behaviours likely to negatively impact their health and well-being, including unhealthy dietary intake [34]. If children in this age group are still heavily dependent on their parents regarding their food and beverage intake, a relevant topic for further research would be to study older children’s lifestyle behaviours in relation to HL level since the autonomy of children and adolescents is likely to increase with age. Furthermore, as HL is hypothesised to develop already at an early age and parents are important role models for young children, it would be interesting to investigate a potential association between parents and children’s level of HL. This has not yet been a subject of investigation.

PA is an important aspect of a healthy lifestyle. However, PA alone is not enough to counter overweight and obesity. Most intervention programmes aimed at reducing childhood overweight and obesity use combined strategies to improve both PA levels and food intake [35]. Considering the significant association between children’s HL and their PA level that was demonstrated in the present study, efforts aiming to improve children’s HL might be a valuable addition to interventions aiming to reduce childhood overweight and obesity.

The present study has several strengths and limitations. An important strength of this study is that it is one of the few studies worldwide and the first study in the Netherlands to assess the relation between children’s HL with aspects of their health and lifestyle. The study was conducted using an HL measurement instrument specifically designed for and tested in this age group. It is the first (and only) Dutch-language instrument to measure HL in children.

The most important limitation of the study is the homogeneity of the included sample. All children came from one area in the Netherlands (the province of Limburg), and more than half of the children came from the highest SES tertile. Information about the non-response group is generally lacking, which limits the results’ generalisability. It is likely that the relatively large group of parents who did not consent to their children participating in this research project (50.7%) had a lower SES, thus leading to a sample bias. Further ways to increase the participation of both adults with a lower SES and their children in research should be explored, leading to more inclusive studies and more generalisable study outcomes. The lack of variation in some outcome measures (e.g., BMI z-scores, fruit and vegetable consumption) and the relatively low number of participating children (n = 139) might have limited the ability to detect significant differences. Furthermore, the outcome measures with respect to dietary behaviour and PA were subjectively measured (with a questionnaire), which may have led to social desirability bias [36]. However, children were encouraged to give honest answers and confidentiality was stressed during questionnaire administration to minimise this risk of bias. Furthermore, the questions with respect to dietary behaviour were relatively global (e.g., questions regarding consumption frequency instead of consumed amount) and did not cover all possible unhealthy behaviours (e.g., intake of candy and sweets, consumption of crisps, fast food, and sugar). More objective and sensitive ways of determining the intake of food and beverages could generate more precise insights into children's dietary behaviours. Furthermore, the HLS-Child Q-15 questionnaire has only been used once (in this sample), and analyses have shown that the instrument needs further validation and tailoring to the target group. More research is needed to decrease comprehension problems and to investigate and retest reliability and construct validity [29].

Conclusions

On the basis of the present study's findings, it can be concluded that children's HL has an impact on some aspects of their lifestyle. A positive association between children's HL and their PA behaviour was observed, whilst no significant association was found between children's HL and their BMI z-score, vegetable, fruit, water, and soft drink consumption. The instrument used to measure children's HL in the present study should be subjected to further refinement to increase its suitability for the target group (children). Additionally, comparable research in a larger, more diverse sample using more objective and sensitive data instruments to measure lifestyle behaviours and/or research investigating the association between children's and parental HL is necessary to further advance the field of children's HL and its relationship with their lifestyle.

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CHAPTER 4

The Effects of a Multi-Component School-Based Nutrition Education Intervention on Children's Determinants of Fruit and Vegetable Intake

Hahnraths MTH, Jansen JPM, Winkens B, van Schayck CP. The Effects of a Multi-Component School-Based Nutrition Education Intervention on Children's Determinants of Fruit and Vegetable Intake.

Nutrients. 2022;14(20):4259.

Abstract

Evidence suggests that multi-component school-based health-promoting interventions have great potential to improve children's fruit and vegetable intake. However, interventions that combine classroom-based curricula with experiential learning strategies (e.g., cooking) are relatively seldom described. This study investigates the short-term and longer-term effects of a multi-component school-based nutrition education intervention combining classroom-based and experiential learning strategies on children's determinants of their fruit and vegetable intake (knowledge, taste preferences, attitudes, and intention). Using a comparative quasi-experimental study design, data were collected, through child-reported questionnaires, at the baseline, directly after the intervention, and three months after the intervention from four control and 15 intervention classes from Dutch primary schools. A total of 192 children in grades three and four (aged 8–10 years) constituted the participants. After correction for the baseline, sex, age, and the fruit or vegetable product assessed in the questionnaire; the intervention group showed a significant increase in knowledge (p = 0.001; standardised effect size (ES = 0.60), taste preferences (p = 0.002; ES = 0.52), attitude towards the assessed fruit or vegetable product (p = 0.004; ES = 0.48), and general attitude towards healthy products (p = 0.01; ES = 0.39) over the short term, when compared to the control group. The effects of the intervention did not continue to be significant over the longer term. The findings implicate short-term intervention success, although more research and intervention adaptations are recommended to increase the impact of such programmes, especially over the long term.

Introduction

Fruit and vegetables (FVs) are crucial parts of a healthy eating pattern, and insufficient FV intake is related to a wide variety of health problems such as obesity, hypertension, cancer, and coronary heart disease [1,2]. Lifestyle behaviours formed during childhood are often maintained throughout the life course and promoting sufficient and varied FV consumption from a young age is, therefore, likely to result in both short-term and long-term health benefits [3–6]. Nevertheless, Dutch children's FV consumption habits are suboptimal. Between 2014 and 2016, roughly 40% of 4–9-year-olds consumed at least 150 grams of fruit (42%) or vegetables (41%) per day. For 9–12-year-olds, these percentages dropped even further to 20% for fruit and 25% for vegetables [7] per day. These numbers show significant room for improvement, underpinning the importance of efforts to promote children's FV consumption.

There are various factors influencing children's FV intake, and according to social cognitive theory (SCT) they can be categorised into personal determinants and environmental determinants [8]. Important personal factors include children's taste preference and knowledge (e.g., concerning intake recommendations or different types of FV). Additionally, FV-related attitudes and self-efficacy are found to be associated with children's FV intake [9–12]. With regard to environmental determinants, the availability and accessibility of FVs are positively related to consumption [10]. Additionally, (parental) modelling and peer influences play an important role, and the nutrition-related habits and behaviours of parents and peers shape children's (perceived) social norms related to FV consumption [9]. Furthermore, nutrition-related rules and practices in, for example, the home and school setting influence children's intake.

The school is a key environment when it comes to shaping children's eating patterns. As children from different backgrounds come together regularly at school for several of their critical developmental years under the guidance of teachers who can serve as role models, schools can play an important role in the promotion of children's FV intake [13–15]. Over the years, various school-based interventions have been developed and implemented to increase children's FV consumption. Research has shown that interventions using either traditional educational strategies (e.g., explaining the health benefits of FV or tasting food products in school settings) or experiential learning strategies (e.g., garden- or cooking-related activities) have moderately positive effects on the determinants of FV intake among children [16–20]. Although evidence suggests that multi-component school-based interventions have the greatest potential to improve children's FV intake, interventions combining a classroom-based curriculum with experiential learning strategies (e.g., cooking) are still relatively seldom described [16,21,22].

The Dutch ‘Kokkerelli learning street’ programme, developed by Kids University for Cooking, is a school-based nutrition education programme that combines traditional education and experiential learning. The curriculum is developed for children in study years 5–8 in primary school (8–12 years old) and aims to improve children’s FV-related knowledge, taste preferences, attitudes, and intention. It comprises nine different ‘learning streets’: separate three-week programmes which each focus on one specific FV product. All learning streets include classroom-based lessons, a visit to a grower’s farm, and a cooking workshop. Although the programme is already being implemented in the Netherlands, its effectiveness has not yet been evaluated. The aim of the present study is, therefore, to investigate the effects of children’s participation in a learning street programme on the various behavioural determinants of FV consumption. More specifically, the study aims to answer the following research questions: In comparison with children who did not participate in a learning street, what are the short-term (directly after the learning street) and longer-term (three months after the learning street) effects of participation in a learning street programme on children’s:

- FV-related knowledge;
- FV-related taste preferences;
- FV-related attitudes;
- Attitudes related to healthy dietary habits in general;
- Intention to consume FV.

Materials and Methods

Intervention

Kids University for Cooking developed a school-based nutrition education curriculum specifically for children in study years 5–8 in primary school (internationally comparable to grades 3–6). A conceptual framework (Figure 1) based on SCT [8] and the environmental research framework for weight gain prevention (EnRG) [23] served as the theoretical foundation for the curriculum, which employs concepts from self-determination theory, experiential learning, and imagineering (e.g., self-experience in an interactive environment, rather than conventional education) [24–26]. The aim of the curriculum is to teach children where FVs come from, how they are processed, how they can be used for the preparation of healthy meals, and to let children experience different aspects of FVs in a positive context.

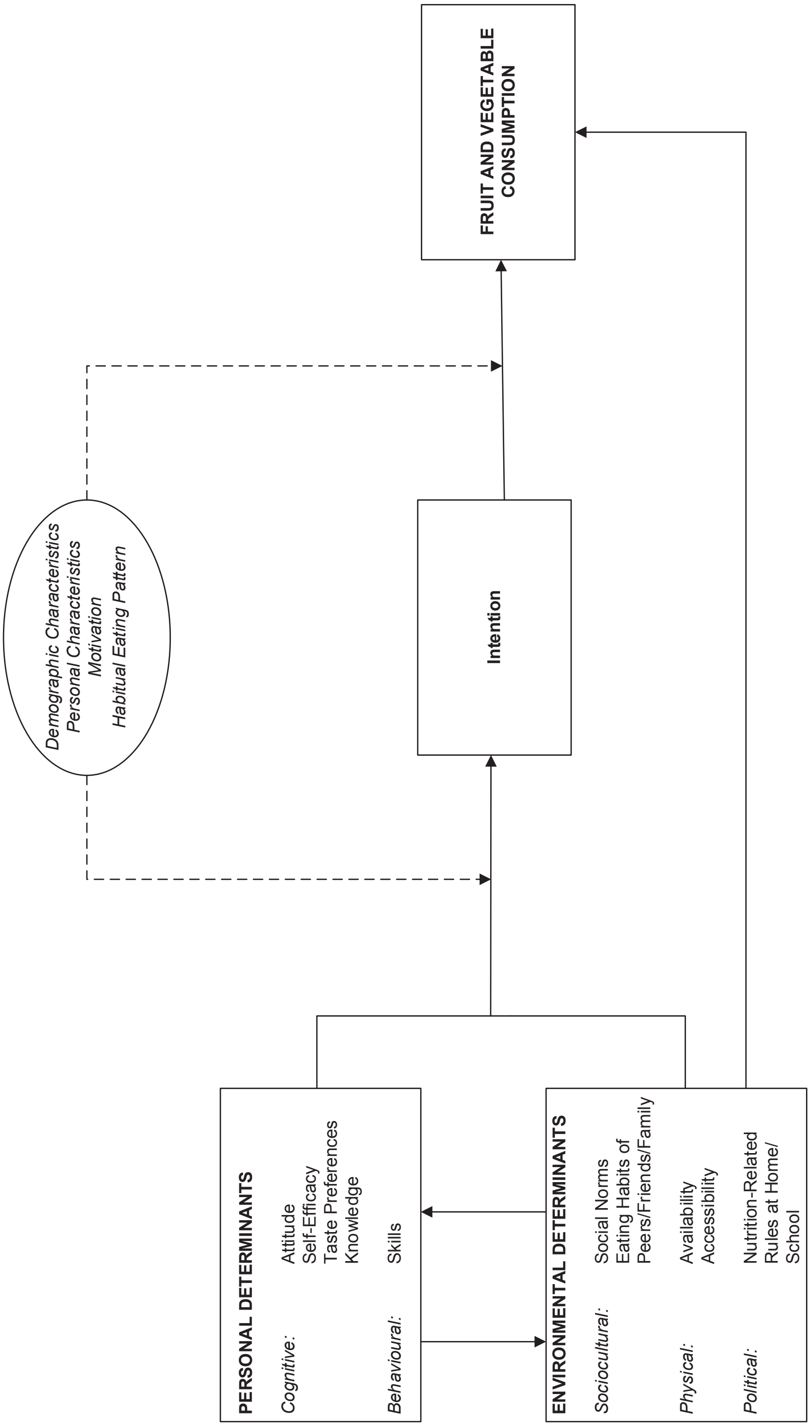

Figure 1. Conceptual framework of the determinants of children's FV consumption (adapted from [8,23]).

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The curriculum consists of various so-called learning streets (nine in total), which all focus on one specific FV product: cauliflower, tomato, asparagus, pepper, strawberry, blueberry, mushroom, carrot, or leek. A school class can participate in a learning street as a one-time activity, but schools are encouraged to implement at least one learning street each study year to create a continuous curriculum for children from study years 5–8. Each learning street consists of multiple components, which schools can plan in a way that suits their schedule (although all activities should be planned in a specific order and within a three-week period). The programme starts with an introduction lesson at school, during which the teacher introduces children to the taste of the specific product. Next, children visit a grower's farm, where they receive information about the planting, growing, and harvesting processes. After visiting the grower's farm, children prepare a dish containing the specific FV product at the cooking facilities of Kids University for Cooking with the help of a professional chef and volunteers. Afterward, they eat the self-prepared meal together with their peers. The last component is an evaluation lesson, which, again, takes place at school under the guidance of a teacher. A detailed overview of the different components of the programme and its theoretical foundations are presented in Supplementary Tables S1 and S2.

Study Design

A quasi-experimental study was conducted. The need for ethical approval for the study has been waived by the FHML-REC in Maastricht, the Netherlands (FHML-REC/2019/062). The study was registered in the ClinicalTrials.gov database on 6 December 2019 (NCT04190680). The participants in the intervention group participated in a learning street, whilst the control group received no intervention and continued with their regular curriculum. The trial was non-randomised; primary school classes that registered to participate in a learning street for the first time during school years 2019–2020 or 2020–2021 were included in the intervention group. The school classes included in the control group were chosen from a pool of primary schools already participating in another research project on the effects of school-based health-promoting initiatives on children's health and well-being (no publications on this study are available as the study is still ongoing). From this pool, classes from schools that were not (planning on) implementing nutrition-related and/or physical activity (PA)-related health-promoting initiatives in the context of this project were eligible to be included in the control group of the present study. Prior to the study's start, an effect calculation was performed using the following assumptions: (a) children are nested within school classes, with 25 participants per class (as is common in the Netherlands), and seven intervention classes and seven control classes were included in the study; (b) an intraclass correlation coefficient of 0.04, a dropout rate of 10%, a standard deviation of 0.2, a power of 80%, and a significance level (alpha) of 0.05 were present in accordance with comparable research [27,28]. On the basis of these numbers, an effect size of 0.104 can be detected with sufficient power. This effect corresponds to a standardised effect size (Cohen's d) of 0.52, indicating a medium effect size [29].

Participants and Recruitment

Participants were children in study years five and six (internationally comparable to grades three and four; aged 8–10 years) from primary schools located in Northern Limburg, the Netherlands. Researchers and employees of Kids University for Cooking informed the children and parents about the study both orally and through information brochures (containing information about the study's purpose, procedures, and data handling). Informed consent was obtained from all parents of the participating children.

Data Collection Procedures

Data collection in the intervention group took place before the start of the introduction lesson (T0), directly after finishing the evaluation lesson (T1), and three months after the evaluation lesson (T2). For the control group, the same data collection timing was used, meaning there were three weeks between T0 and T1 data collection and three months between T1 and T2 data collection. Initially, data collection was to be completed in the school year 2019–2020, but due to the COVID-19 outbreak and the resulting closure of primary schools in the Netherlands, this was not feasible. Measurements in the intervention classes started before the COVID-19 outbreak in the school year 2019–2020 (September 2019). It was originally planned to include more intervention classes throughout the rest of the school year 2019–2020 and to also collect data in the control classes later during the school year 2019–2020. However, due to the mandatory primary school closure and the focus on minimising the educational delay after reopening, data collection in both intervention and control classes was suspended from March 2020 until the end of the school year (July 2020). Measurements in the control classes were therefore conducted in the school year 2020–2021. However, as the learning streets were still suspended due to the ongoing COVID-19 outbreak, it was not possible to include more intervention classes during this school year. During all of the time points, children were asked to fill out the same short questionnaire in writing, assessing the various psychosocial determinants related to the FV product they encountered during their participation in the learning street. In the control group, participants received questionnaires concerning the same FV products that were addressed in the intervention group. For some of the classes from the control group, this was not possible, as COVID-19-related changes were made during planning. As a consequence of these changes, data collection in these classes was executed before it was known that no other intervention classes would be included in the study. Participants filled out the questionnaires during class hours, which took about 10 minutes. Due to the COVID-19-related restrictions, the participants filled out the questionnaires under the supervision of the responsible teacher only, who received written and verbal instructions from the researchers prior to data collection.

Covariates

At baseline, participants' demographic characteristics (age in years, sex (male/female), and (parental) birth country) were collected through the questionnaire. The children's ethnicity was determined by parental birth country and categorised into (1) Western background (i.e., the Netherlands and all other European countries (excluding Turkey), and North America, Japan, Indonesia, and Oceania) and (2) non-Western background [30]. If at least one of the parents was born in a non-Western country, the child's ethnicity was assigned to non-Western.

Outcomes

Changes in the various psychosocial determinants of FV intake were selected as outcome measures. On the basis of the conceptual framework used to develop the learning street curriculum, five relevant determinants were selected: (1) knowledge; (2) taste preferences; (3) intention; (4) attitude towards the FV item addressed in the learning street; and (5) attitude towards healthy food products in general [9,10,23]. Mean scores per participant on the various determinants of FV intake at each time point were calculated. At least two-thirds (67%) of the questions concerning a determinant had to be answered before a mean score for that determinant was calculated. The children's knowledge was assessed by six true/false questions based on the information provided in the learning street. A correct answer was scored as 1; an incorrect answer was scored as 0. A mean summary score of the number of correct answers was computed by dividing the number of correct answers by the total number of items that were answered (mean summary score could range from 0 (low knowledge) to 6 (high knowledge)). Three questions were developed regarding taste preferences (e.g., 'What do you think about the taste of the FV product?') (five-point Likert scale from 1 = 'I do not like it' to 5 = 'I like it very much', with an additional answer option 'never tried'). Mean taste preferences were calculated by adding the scores of the questions that were answered and dividing them by the amount of answered questions (mean summary score could range from 1 (low taste preferences) to 5 (high taste preferences)). Two questions were used to assess intention, concerning participants' plans to consume or cook a meal containing the FV product, and were assessed on a five-point Likert scale from 1 = 'no, I do not want to' to 5 = 'yes I want to' with an additional answer option 'I do not know'. Mean intention was calculated by adding the scores of the questions that were answered and dividing them by the amount of answered questions (mean summary score could range from 1 (low intention) to 5 (high intention)). The two questions and scales for attitude ('How much do you think the target behaviours are clever, interesting, nice, cool, and tasty?') were used as described by Ajzen and Fishbein and as previously used in comparable research [16,27,31]. From these questions, a mean summary score for (1) attitude towards the FV product assessed in the questionnaire and (2) general attitude towards healthy products were calculated by adding the scores of the questions that were answered and dividing them by the amount of answered questions. For both attitude scores, the mean summary score could range from 1 (negative attitude) to 5 (positive attitude). The questionnaires were previously used in a pilot study regarding the learning street curriculum (not published) and appeared appropriate after small adaptations to the formulation of the questions.

Data Analysis

All analyses were performed using IBM SPSS Statistics for Windows (version 27.0, IBM Corp, Armonk, NY, USA). Only data from participants who completed at least 75% of the questionnaire were included in the present study. This percentage was based on comparable research, using the same cut-off point [27,32–34]. Baseline characteristics are presented as mean with standard deviation (SD) for numerical variables and as the number of participants with percentage (%) for categorical variables. The difference in these characteristics between the intervention and control group was investigated using independent-sample t-tests for the numerical variables and Pearson's chi-square or Fisher's exact tests, where appropriate, for the categorical variables. As for the main analyses, data were imputed for age, ethnicity, sex, and the different determinants of FV intake for each time point, using multiple imputations with 20 iterations and predictive mean matching. As the number of incomplete cases (at least one fixed variable missing and/or outcome variable missing at all time points) was 38%, at least 38 imputed datasets should be used according to the rule of thumb given by White et al. [35]. To be sure, 50 imputed datasets were created. A three-level linear mixed model analysis, with classes as the third level, participants as the second level, and measurements as the first level, was used to assess the longitudinal effect of the learning street on the various determinants assessed in the questionnaire. The fixed part of the model consisted of group (intervention versus control), time (T0, T1, T2), and the interaction term of group and time to assess the group effect at each time point, correcting for the outcome at baseline. Furthermore, sex (male/female), age (in years, at T0), the FV product addressed in the learning street, and the baseline scores for the other four determinants of FV intake were included in the fixed part of the model. As for the random part of the model, a random intercept (and slope) on the class level was included next to an unstructured covariance structure for the three repeated measurements. We did not include the nesting of classes within schools as an additional level in our analysis as (a) the children mainly influence each other within a class and less within a school; (b) the number of included classes per school is very small; (c) the inclusion of schools as another level would further increase the number of levels in the analyses (there would be four levels), potentially resulting in estimation problems. As a sensitivity analysis, the same linear mixed model analyses were applied to the original (non-imputed) data. Furthermore, post-hoc analyses were performed, where we only corrected for the baseline outcome and those covariates and/or baseline scores of determinants of FV intake that were significantly different between the intervention and control group at baseline. Standardised effect sizes were calculated for each determinant and expressed as Cohen's d, defined as the difference in observed mean change scores divided by the pooled standard deviation of the change scores. The Cohen's d was interpreted as small (d = 0.2), medium (d = 0.5), and large (d = 0.8) [29]. Two-sided p-values ≤ 0.05 were considered statistically significant.

Results

Demographic Characteristics

Of the 91 children from the four classes (study years five and six) participating in a learning street programme during the school year 2019–2020, 61 (67.0%) handed in a completed informed consent form so as to be included in the intervention group of the present study. Of these children, 60 met the additional inclusion criteria to be included in the present study's data analyses. Of the 312 children from the 30 school classes already participating in the other research project, 165 children (52.8%) from 17 classes (study years five and six) were suitable for inclusion in the present study's control group as they were from classes that were not (planning on) implementing nutrition-related and/or PA-related health-promoting initiatives in the context of the project. Of this group, 132 children from 15 classes were included as they met the additional criteria to be included in the present study's data analyses. A detailed overview of the inclusion process of the participants can be found in Supplementary Figure S1.

Table 1 provides an overview of the sample's baseline characteristics. The intervention and control group were comparable regarding sex and ethnicity. There were, however, significant baseline differences in age and intention to consume the FV item between the two groups. The mean age in the intervention group was significantly lower (8.3 years) compared to that of the control group (8.6 years) (p = 0.00). The baseline intention was significantly higher in the intervention group (3.9) compared to that of the control group (3.1) (p < 0.001).

Intervention Effects on the Psychosocial Determinants of FV Intake

The intervention's effects on the various psychosocial determinants were analysed after correction for baseline knowledge, intention, taste preferences, attitude towards addressed FV product, general attitude towards healthy products, sex, age, and the FV product addressed in the learning street programme. The analyses revealed significant positive intervention effects for the knowledge ($p = 0.001$; standardised effect size (ES = 0.60), taste preferences ($p = 0.002$; ES = 0.52), attitude towards addressed FV product ($p = 0.004$; ES = 0.48), and general attitude towards healthy products (p = 0.01; ES = 0.39) at T1 (directly after the intervention). No significant intervention effect for intention was found at T1. At T2 (three months after the intervention), the significant intervention effects for all outcomes had disappeared. Detailed information on the intervention effects for the various outcomes can be found in Table 2, Figure 2, Figure 3, Figure 4 and Figure 5, and Supplementary Figure S2. Descriptive data regarding the observed mean scores for the various determinants of FV intake from T0–T2 can be found in Supplementary Table S3. The estimated treatment effects based on the original (non-imputed) data can be found in Supplementary Table S4, showing similar effects. The post-hoc analyses, which were only corrected for the baseline outcome, age, and intention (as there were significant baseline differences between the intervention and control group for these two variables), also showed similar results (Supplementary Table S5).

Table 1. Baseline characteristics of participants from the present study's intervention and control group (*n* = 190).

Characteristic
Schools
Included classes per school
Included participants per class
Sex (% boys)
Age (years)
Ethnicity (%Western) [3]
Knowledge (mean correct) (0–6)
Intention (mean score) (1–5)
Taste preferences (mean score) (1–5)
Attitude towards addressed FV product (mean score) (1–5)
General attitude towards healthy food (mean score) (1–5)

Note. All children who filled in 75% of the questionnaire and 67% of the questions for each determinant at T0 were included in the baseline. Children who were not present at T0 were not included. For intention, a five-point Likert scale was used: 1: 'No, I do not want to', 2: 'I do not think so', 3: 'Maybe', 4: 'I think so', 5: 'Yes I want to'. For taste preferences, a comparable scale was used: 1: 'I do not like it', 2: 'I do not really like it', 3: 'It is okay', 4: 'I like it', 5: 'I like it very much'. For attitude, the following scale was used: 1: 'No, sure not', 2: 'I do not think so', 3: 'In between',

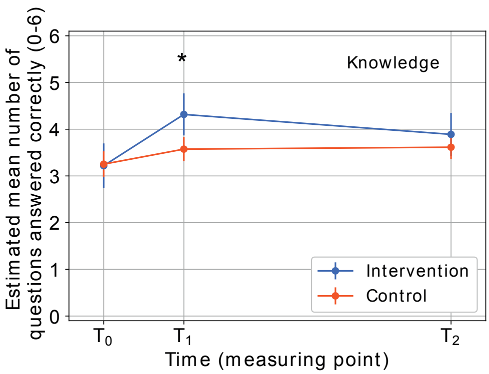

Figure 2. Estimated marginal means of the number of questions answered correctly from T0–T2.

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between the intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake.

Intervention Group				Control Group					
n	% Missing Values [1]	% / M	SD	*n*	% Missing Values [1]	% / M	SD	χ^2 / *t*-value	*p*-value
4	N/A	N/A	N/A	7	N/A	N/A	N/A	N/A	N/A
1	N/A	N/A	N/A	2–4 [2]	N/A	N/A	N/A	N/A	N/A
N/A	N/A	15.0	6.5	N/A	N/A	8.8	3.8	N/A	N/A
24	3.3	41.4		55	0.0	41.7		0.00	0.97
60	0.0	8.3	0.5	132	0.0	8.6	0.7	-3.81	< 0.001 *
52	6.7	92.9		127	0.8	97.0			0.24
60	0.0	3.0	1.6	132	0.0	3.2	1.2	-0.75	0.46
46	23.3	3.9	1.1	96	27.3	3.1	1.3	3.50	< 0.001 *
54	10.0	3.6	1.1	115	12.9	3.5	1.2	0.44	0.66
59	1.7	2.7	0.9	131	0.8	2.6	0.9	0.81	0.42
58	3.3	3.0	0.9	131	0.8	3.1	0.9	-1.01	0.31

4: 'Yes, I think so', 5: 'Yes, sure'. * Significant difference between intervention and control group ($p \leq 0.05$); [1] Missing values based on true missings and participants having selected the answer option 'I do not know'; [2] In five schools, two classes were included. In one school, three classes were included. In one school, four classes were included; [3] Fisher's exact test. Abbreviations: FV, fruit and vegetable; M, mean; SD, standard deviation; N/A, not applicable.

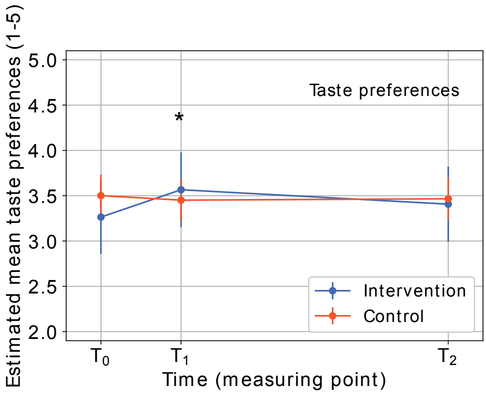

Figure 3. Estimated marginal means of taste preferences from T0–T2.

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between the intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake.

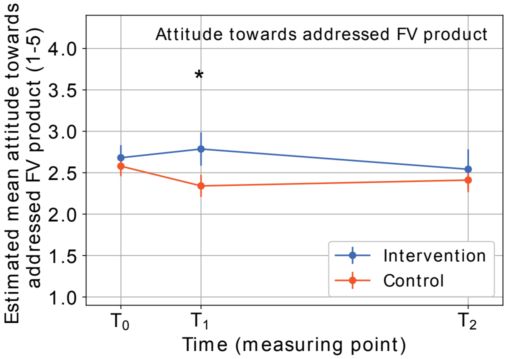

Figure 4. Estimated marginal means of attitude towards addressed FV product from T0–T2.

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between the intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake.

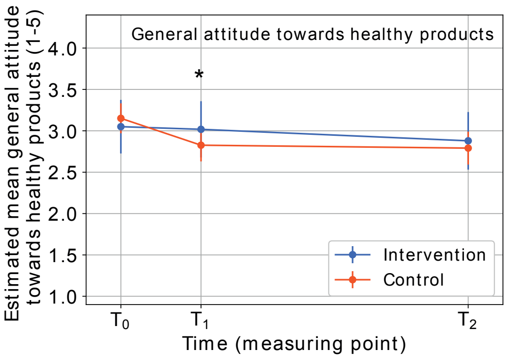

Figure 5. Estimated marginal means of general attitude towards healthy products from T0–T2.

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between the intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake.

Table 2. Estimated treatment effects after multiple imputation (*n* = 192).

Determinant		Intervention vs. Control		
		B (95% CI)	*p*-value	ES [1]
Knowledge	T1−T0	0.78 (0.32; 1.23)	0.001 *	0.60
	T2−T0	0.31 (-0.28; 0.90)	0.31	0.22
Intention	T1−T0	0.11 (-0.24; 0.45)	0.55	0.20
	T2−T0	-0.21 (-0.65; 0.22)	0.33	-0.09
Taste preferences	T1−T0	0.35 (0.13; 0.57)	0.002 *	0.52
	T2−T0	0.18 (-0.07; 0.42)	0.16	0.20
Attitude towards addressed FV product	T1−T0	0.32 (0.10; 0.55)	0.004 *	0.48
	T2−T0	0.03 (-0.25; 0.30)	0.84	0.00
General attitude towards healthy products	T1−T0	0.29 (0.06; 0.53)	0.01 *	0.39
	T2−T0	0.19 (-0.09; 0.47)	0.19	0.19

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between the intervention and control group ($p \leq 0.05$), analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake. [1] Effect size based on observed means and SD from original data, not imputed data. Abbreviations: CI, confidence interval; ES, effect size; FV, fruit and vegetable.

Discussion

This study aimed to investigate the short-term and longer-term effects of participation in the Kokkerelli learning street on the knowledge, taste preferences, intention, attitude towards FV products, and general attitude towards healthy food products of Dutch primary school pupils aged 8–10 years old. For all determinants except intention, significant positive intervention effects were found over the short term (directly after the intervention). These intervention effects decreased over time and were no longer significant three months after the intervention. These findings are partly in line with our hypothesis, which described an expected increase over the short and long term for knowledge, taste preferences, intention, attitude towards addressed FV product, and general attitude towards healthy products following pupils' participation in the learning street programme.

The fact that no significant longer-term intervention effects were found for any of the study's outcomes might be related to the intensity of the intervention. The learning street had a duration of approximately three weeks, during which children participated in various lessons and activities. However, after this period, schools continued with their regular curriculum. Additionally, all activities were organised within the school setting with limited efforts to include parents and the home setting in the learning street programme. Besides the school environment, the home setting has a large influence on children's dietary behaviours through factors such as FV availability at home and the dietary habits of family members [10,11,36]. The Dutch school-based intervention 'Taste Lessons' was successful in achieving short-term and long-term improvements in children's knowledge [16]. A possible explanation for the occurrence of long-term improvements in knowledge might be that Taste Lessons also stimulated parental involvement through homework assignments. Possibly, improvements in parental nutrition-related behaviours following the homework assignments positively influenced the children's knowledge, as it is known that caregivers' health-promoting behaviours are associated with higher nutrition-related knowledge and higher FV intake in children [37]. Another comparable intervention was the so-called 'High 5 project', although this intervention had a much higher intensity than the present intervention, including homework assignments, efforts to involve parents, and a food service component in the school cafeteria [38]. An evaluation of this intervention found long-term improvements in children's knowledge and FV intake, although the magnitude of the effects had decreased at two-year follow-up compared with one-year follow-up [38]. The findings from these other interventions support the hypothesis that the present intervention's intensity might not have been sufficient to achieve longer-term improvements in the various outcomes and that parental involvement might increase intervention impact. Indeed, a review by Contento et al. states that up to 50 classroom hours of exposure are needed to achieve stable improvements in various outcomes, which is considerably more than the (approximately) 4.5 hours of exposure that was achieved in the present intervention. It also showed that programmes with a duration of several years resulted in stable changes in dietary intake [39]. Repeating the present intervention several times a year and/or in various study years might therefore lead to more prominent effects. Despite the fact that Kids University for Cooking already recommends repeating the intervention over various study years, this is currently not a common practice due to various practical barriers mentioned by schools (e.g., limited space in the curriculum, limited financial resources, etc.).

The lack of observed intervention effects on intention could also potentially be linked to the intervention's limited intensity and parental involvement. According to the theory of planned behaviour, intention is the most important precedent for behaviour. Intention is, in turn, influenced by attitude, subjective norms, and perceived behavioural control [40]. Potentially, the present intervention was not powerful enough to influence these determinants sufficiently to also lead to improvements in intention. It should also be noted that children's FV intake and also, very likely, their intention to consume FV outside of school is largely regulated by parents and caregivers who purchase and prepare the food in the home setting. Possibly, children subconsciously took this large parental influence on their FV consumption behaviour into account when answering the questions regarding their intention to consume FV. If no changes in parental behaviour were expected, children might have reasoned that their own behaviour and intention could not be changed either.

The evaluation of the effectiveness of Taste Lessons furthermore revealed a significant short-term increase in the number of different foods tasted by the intervention group, with the effect disappearing after six months [16]. These findings are in line with the significant short-term effects on taste preference which were observed in the present study [41,42]. Furthermore, the present study found a significant short-term improvement in attitude, whilst Taste Lessons was not successful in improving attitude over the short or long term. A possible explanation for this discrepancy in the findings might be the difference in the ratio between experiential learning and traditional learning in the two programmes. Taste Lessons consisted of a large portion of traditional learning (in the form of classroom-based lessons combined with small experiments and activities), whilst the learning street programme comprises more elements focusing almost exclusively on experiential learning (e.g., a visit to a grower's farm and a cooking lesson) [43]. More experiential learning might lead to greater effects; research suggests it is a useful strategy to improve children's attitudes [26]. Other studies evaluating interventions consisting of a large portion of experiential learning also found positive intervention effects on children's attitudes over the short and/or long term [44–46].

Strengths and Limitations

The present study had several strengths and limitations. Various studies investigating the effects of school-based nutrition education programmes are available. However, the majority of these programmes focus on traditional education or experiential learning strategies in isolation. To our knowledge, the present study is one of the few studies that has investigated the effects of a school-based nutrition programme, deploying both traditional and experiential learning strategies [21], and has, therefore, contributed to the evidence base regarding this type of education programme. Furthermore, not only the short-term effects immediately after the intervention were investigated but also the longer-term effects three months after the intervention. Although no significant longer-term effects were found, the study provides valuable insights and suggestions for improving interventions to increase their effectiveness (e.g., through increasing its intensity and including a parental component). In this way, this study provides valuable information that can help intervention developers, researchers, schools, and other stakeholders in the field to maximise the impact of future school-based nutrition education programmes.

A limitation of the study is the restricted external validity of the study's results as the sample size is relatively small (especially in the intervention group), with a limited variety of ethnicity. It would, therefore, be beneficial to study the intervention's effects in a larger and more diverse population. Furthermore, the potential occurrence of selection bias in the intervention group could not be investigated, as the researchers had no access to the demographic characteristics of children for whom no informed consent for study participation was obtained. A second limitation is the fact that no randomisation took place when assigning schools to the intervention and control groups. This represented the real-world situation, as schools can enrol in the learning street programme on the basis of their willingness to participate. The fact that the control group consisted of classes already participating in another research project limited the external validity, although we made sure that these classes were not (planning on) implementing nutrition-related and/or PA-related health-promoting initiatives and were comparable with the classes from the intervention group. We tested for baseline differences between the intervention and control group and only found significant differences in age and intention. For age, it is debatable if this significant difference is relevant, as the mean difference between the intervention and control group was only approximately four months. For intention, the intervention group's baseline mean was significantly higher than that of the control group. Although we corrected for this baseline difference in the analyses, this still might have influenced the results, as there might have been limited room for improvement due to the already high intention at baseline.

All analyses were corrected for baseline knowledge, intention, taste preferences, attitude towards addressed FV product, general attitude towards healthy products, sex, age, and the FV product addressed in the learning street. Furthermore, post-hoc analyses, where we only corrected for baseline outcome, age, and intention (as there were significant baseline differences between the intervention and control group for these two variables), were performed (Supplementary Table S4). As the results from the main analyses and the post-hoc analyses were comparable, it was determined that no overfitting had occurred and that the results from the main analyses were acceptable.

For various determinants, especially the determinants 'intention' and 'taste preferences', the number of missing values at all time points was relatively high. This was due to the answer option 'I do not know', which was often selected and was recoded as a missing value. Many participants selected this answer option because they were not familiar with the FV product prior to it being addressed in the learning street programme. To compensate for the missing values, the data in the present study were imputed using multiple imputations.

Other important limitations are related to the measurement instrument that was used for the assessment of the various determinants of the children's FV intake. The danger in using subjective measurements like questionnaires is that they might lead to social desirability bias [47]. However, there is currently no objective way to measure constructs such as taste preferences, intention, and attitude. During the administration of the questionnaire, the teachers tried to limit the occurrence of social desirability bias by stressing confidentiality and by telling participants there were no wrong or right answers. The used questionnaire was based on questionnaires used in comparable research [16], was tested in a pilot study on the learning street curriculum (not published) and appeared appropriate after making small adaptations to the formulation of the questions. However, it should be noted that the reliability and validity of the questionnaire were not specifically tested and are, therefore, not known. Furthermore, differences in reading and comprehension skills might have had an influence on the capacity of participants to answer the questionnaire adequately.

The fact that each learning street covered a different FV product and that participants from different classes, therefore, completed questionnaires concerning various products might have had an influence on the outcomes evaluated in the present study. Fruit items, like strawberries, are sweeter than vegetables, such as cauliflowers. Studies show that children prefer sweet products above bitter products [48,49], which makes it more difficult to compare the different FV products concerning outcomes such as taste preference. To avoid these differences playing a role in future evaluations, it would be better to investigate the effects of one specific learning street at a time (e.g., only evaluating the effects of the learning street programme on cauliflower), which was not possible in the present study due to the relatively small sample size.

Another factor that had an impact on the present study was the outbreak of COVID-19 in early 2020. Due to this outbreak, Dutch schools were forced to close for several periods and could not participate in the learning street programme during these periods. This meant that only four intervention classes could be included in the present study instead of the seven classes that were anticipated prior to the start of the study. As a response to this, it was decided to include as many control classes as possible to increase the statistical power. This resulted in the inclusion of 15 control classes, meaning that the control group (n = 132) was approximately twice as big as the intervention group (n = 60). Despite this large difference in the number of participants between the intervention and control group, including this many participants in the control group was still beneficial, as it has been shown that statistical power improves until the largest group is approximately three times the smallest group [50]. Furthermore, performing an effect size calculation with the same assumptions as described earlier, but with four intervention classes and 15 control classes, resulted in a Cohen's d of 0.53 (was 0.52), indicating that the difference in the number of included classes did not have a large effect on the effect size. The COVID-19 outbreak and the subsequent school closures also meant that the timing of the questionnaire administration was different for the intervention and control groups. It is unknown what influence COVID-19 and the subsequent safety measures (e.g., school closures) had on the children's (determinants of) FV intake, as studies report mixed effects of the pandemic on children's FV consumption [51–53].

Implications for Research and Practice

Recommendations for future research include using a larger and/or more diverse population, exploring other measurement instruments to investigate children's (determinants of) FV intake, evaluating the intervention's effects on children's FV intake, and investigating the intervention's effects by evaluating a learning street that addresses one FV product at a time.

There are also various recommendations to further improve the learning street programme itself. To achieve more sustainable intervention effects, the intensity of the learning street programme should be increased. This can be achieved through a prolonged intervention duration, higher frequency of the provided lessons, and/or repeated participation in the learning street multiple times a year or for several school years in a row (as recommended by Kids University for Cooking). Furthermore, efforts to stimulate parental involvement could be a valuable addition to the learning street programme. Parents play an important role in the development of children's eating habits; therefore, it would be beneficial to target the home environment as well. This can be achieved by, e.g., expanding the learning street programme to include homework assignments and/or family activities. The above-mentioned recommendations are not only valuable for the learning street intervention, but they are also relevant for the developers of other school-based nutrition education programmes. Considering the potential impact of school-based nutrition education programmes on children's determinants of FV intake, we recommend including these programmes as a mandatory part of the curriculum, something that is currently not the case in the Netherlands. This should, however, be carried out in close consultation with intervention developers and researchers to ensure that schools implement adequate and evidence-based programmes. Furthermore, efforts should be made to reduce the various barriers that schools experience with regard to the implementation of nutrition education programmes (e.g., limited space in the curriculum, high workload, and limited financial resources).

Conclusions

The present study showed the significant positive short-term effects of participating in the Kokkerelli learning street intervention on children's knowledge, taste preferences, attitude towards the FV products addressed in the intervention, and their general attitude towards healthy food products. The results indicate that participation in the learning street programme can contribute to behavioural change. However, the observed effects were not sustained over the long term. This might be explained by the relatively small study sample, issues related to the used measurement instrument, and/or the limited intensity and parental involvement in the learning street programme. Longer-term effects might be achieved by repeating the programme more often (e.g., multiple times a year and/or multiple school years in a row) and/or by including additional components in the learning street programme (e.g., homework assignments to stimulate parental involvement). Further improving and investigating the learning street programme and comparable interventions is highly relevant to gain more insight into ways to sustainably improve children's determinants of FV intake and, subsequently, their overall health.

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Table S1. Overview of the Various Components of Each Learning Street.

Table S1. Overview of the various components of each learning street.

Intervention Component	Description
1. Introduction lesson	During the introduction lesson, children are introduced to (the taste of) the product. Children are familiarised with growing and harvesting processes, as well as with the importance of the product regarding health.
2. Visit to the grower's farm	During the visit to the grower's farm, children are introduced to the precise planting, growing and harvesting procedures of the product. Children are allowed to enter the facilities (e.g., the greenhouse) and to closely observe and experience the farming of the product.
3. Cooking	Children observe and listen to a professional chef while he/she explains each step that has to be taken for the preparation of the meal. Subsequently, children prepare their own portion of the meal with help of volunteers. After preparing the meal, children help to set the table and consume their self-prepared meal together.
4. Evaluation lesson	Children evaluate the learning street together and discuss what they have learned.

Duration and Location	Materials	Delivery Channel
45 minutes at school	• Preparation of the product (e.g., three types of mushrooms). • Poster of the food guide pyramid. • Poster with information on unnecessary food wastage. • PowerPoint presentation for assistance during the lesson.	Delivered by the responsible teacher, with help of guidelines and materials provided by Kids University for Cooking Foundation.
60 minutes at the grower's farm	No necessary material	Delivered by the farmer in cooperation with Kids University for Cooking Foundation.
60-90 minutes at the cooking facilities of Kids University for Cooking	• Cooking facilities such as a kitchen. • Cutting boards and knifes suitable for children. • Ingredients for the pre-chosen meals.	Delivered by a professional chef, assisted by volunteers.
45 minutes at school	No necessary material.	Delivered by the responsible teacher, with help of guidelines provided by Kids University for Cooking Foundation.

Table S2. Overview of the Theoretical Foundations of the Learning Street.

Table S2. Overview of the theoretical foundations of the learning street.

Determinant	Theoretical Method
Attitude	Participation
	Modelling
	Environmental re-evaluation
	Direct experience
Subjective norms	Participation
	Providing opportunity for social support
Self-efficacy	Active learning
	Tailoring
	Modelling
	Guided practice
	Enactive mastery experience

Practical Application / Hypothesised Effects	Intervention Components
High levels of engagement during all group activities lead to larger impact on the individual.	1. Introduction lesson 2. Visit at the grower's farm 3. Cooking 4. Evaluation lesson
Close observation of an appropriate model performing health related behaviour stimulates individuals' response.	2. Visit at the grower's farm 3. Cooking
Encouraging the positive effects of the healthy food within the individual's environment leads to larger impact on the individual.	2. Visit at the grower's farm 3. Cooking
Direct contact with FV increases positive attitudes; it offers the possibility to try new behaviours first-hand.	1. Introduction lesson 2. Visit at the grower's farm 3. Cooking
High levels of engagement during all group activities lead to larger impact on the individual.	2. Visit at the grower's farm 3. Cooking 4. Evaluation lesson
The surrounding of peers experiencing a stimulating learning environment stimulates the feeling of unity.	3. Cooking 4. Evaluation lesson
First-hand experience in a stimulating environment enhances learning processes and confidence in one's own ability.	2. Visit at the grower's farm 3. Cooking
Environment and intervention components suitable for children increase children's interest and abilities.	1. Introduction lesson 2. Visit at the grower's farm 3. Cooking
Close observation of an appropriate model performing health-related behaviour stimulates individuals' response.	2. Visit at the grower's farm 3. Cooking
Precise guidance of an expert increases children's beliefs in their own abilities.	1. Introduction lesson 2. Visit at the grower's farm 3. Cooking
Positive outcomes of newly learned behaviours enhance the beliefs in one's own ability.	3. Cooking 4. Evaluation lesson

Table S2. Continued.

Determinant	Theoretical Method
Knowledge	Active learning
	Tailoring
	Discussion
	Direct experience
	Guided practice
Intention	Active learning
	Environmental re-evaluation
	Direct experience
Taste preferences	Active learning
	Facilitation
Habitual eating patterns	Counter-conditioning
	Participation
	Active learning
	Tailoring
Motivational regulation	Modelling

Abbreviations: FV, fruit and vegetable.

	Practical Application / Hypothesised Effects	Intervention Components
	First-hand experience in a stimulating environment enhances learning processes.	2. Visit at the grower's farm 3. Cooking
	Environment and intervention components suitable for children increase children's knowledge.	2. Visit at the grower's farm 3. Cooking 4. Evaluation lesson
	Open discussion about health-related topics increases knowledge in an interactive manner.	1. Introduction lesson 3. Cooking 4. Evaluation lesson
	Direct contact with FV offers better learning experience.	1. Introduction lesson 2. Visit at the grower's farm 3. Cooking
	Precise guidance of an expert increases children's knowledge and skills.	3. Cooking
	First-hand experience in a stimulating environment enhances intentional beliefs.	2. Visit at the grower's farm 3. Cooking
	Encouraging the positive effects of the healthy food within the individual's environment leads to larger impact on the individual.	2. Visit at the grower's farm 3. Cooking
	Direct contact with FV leads to higher intentional beliefs.	1. Introduction lesson 3. Cooking
	First-hand experience in a stimulating environment enhances interest in new tastes.	1. Introduction lesson 3. Cooking
	More encounters with higher FV variety lead to higher taste preference.	3. Cooking
	Providing healthier choices to normal behaviours and reinforcing the healthy choices leads to the development of new habits.	3. Cooking
	High levels of engagement during all group activities lead to larger impact on the individual.	2. Visit at the grower's farm 3. Cooking
	First-hand experience in a stimulating environment enhances motivation among children.	2. Visit at the grower's farm 3 Cooking
	Offering a child-friendly learning environment enhances motivation among participants.	2. Visit at the grower's farm 3. Cooking
	Close observation of an appropriate model performing health-related behaviour stimulates individuals' response.	2. Visit at the grower's farm 3. Cooking

Figure S1. Flowchart Study Participation.

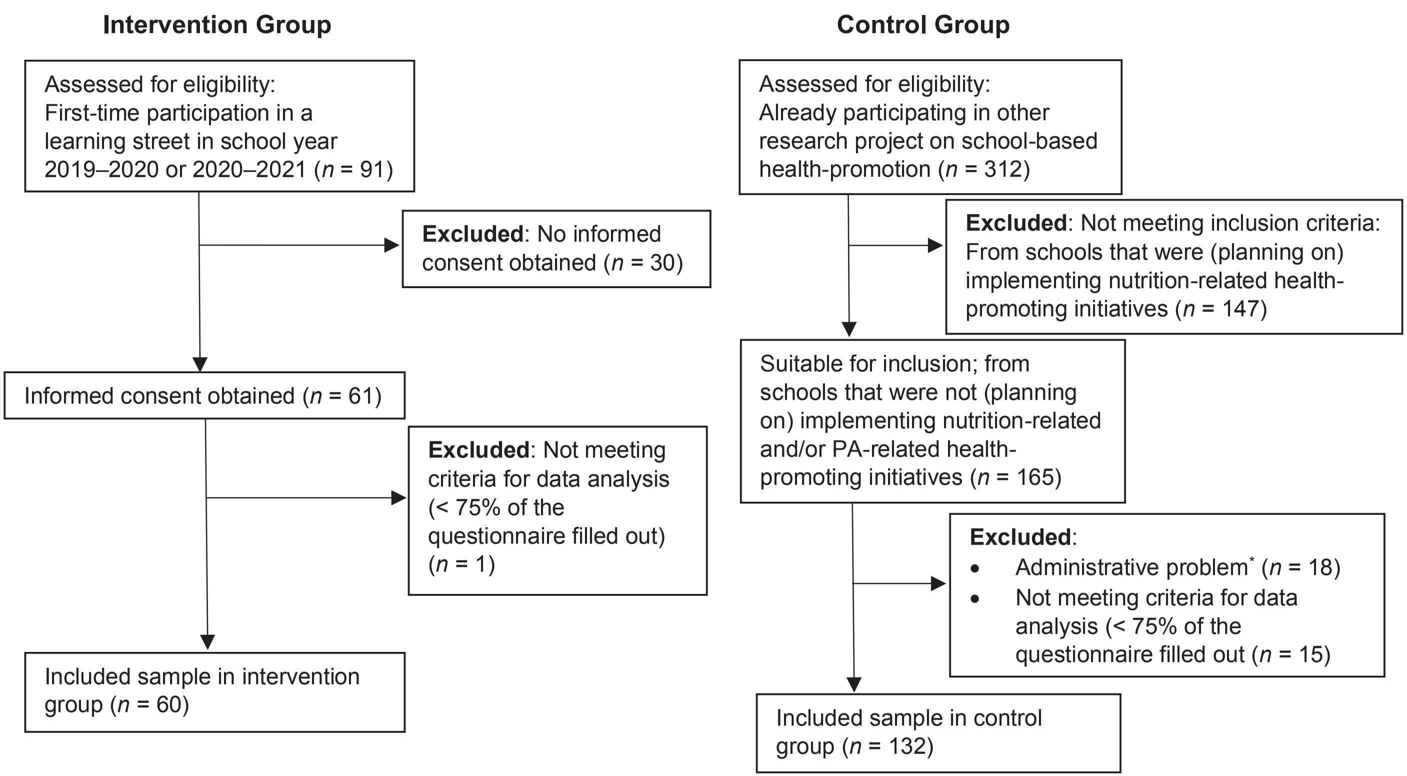

Figure S1. Flowchart study participation.

* Due to an administrative problem, the questionnaire for the wrong FV product was filled out by 18 participants at T1, which resulted in their exclusion from the study.

Figure S2. Estimated Marginal Means for Intention at T0–T2.

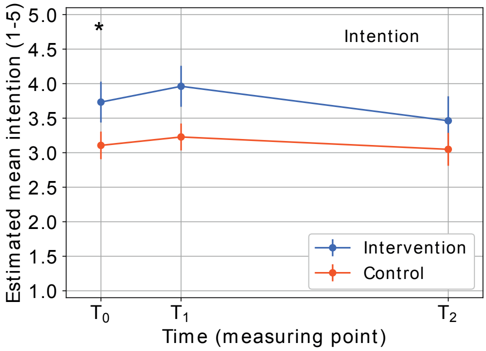

Figure S2. Estimated marginal means for intention at T0–T2.

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake.

Table S3. Observed Mean Scores for the Various Determinants of FV Intake at the Various Time Points (T0–T2).

Table S3. Observed mean scores for the various determinants of FV intake at the various time points (T0–T2).

Determinant	T0			
	Intervention Group		Control Group	
	n	**M (SD)**	***n***	**M (SD)**
Knowledge (mean correct) (0–6)	60	3.0 (1.58)	132	3.2 (1.21)
Intention (mean score) (1–5)	46	3.9 (1.08)	96	3.1 (1.27)
Taste preferences (mean score) (1–5)	54	3.6 (1.10)	115	3.5 (1.19)
Attitude towards addressed FV product (mean score) (1–5)	59	2.7 (0.93)	131	2.6 (0.90)
General attitude towards healthy products (mean score) (1–5)	58	3.0 (0.91)	131	3.1 (0.89)

Note. All children who filled in 75% of the questionnaire and 67% of the questions for each determinant at the different time points were included in the sample. For intention, a five-point Likert scale was used; 1: 'No, I do not want to', 2: 'I do not think so', 3: 'Maybe', 4: 'I think so', 5: 'Yes I want to'.For taste preferences, a comparable scale was used; 1: 'I do not like it', 2: 'I do not really like it',

Table S4. Estimated Treatment Effects Based on Original (Non-Imputed) Data.

Table S4. Estimated treatment effects based on original (non-imputed) data.

Determinant		Intervention vs. Control	
		B (95% CI)	***p*-value**
Knowledge (*n* = 119)	T1–T0	0.99 (0.41; 1.56)	0.001 *
	T2–T0	0.50 (-0.26; 1.26)	0.18
Intention (*n* = 154)	T1–T0	0.19 (-0.16; 0.53)	0.28
	T2–T0	-0.08 (-0.46; 0.29)	0.66
Taste preferences (*n* = 130)	T1–T0	0.38 (0.14; 0.62)	0.002 *
	T2–T0	0.22 (-0.04; 0.48)	0.10
Attitude towards addressed FV product (*n* = 122)	T1–T0	0.31 (0.06; 0.56)	0.02 *
	T2–T0	-0.01 (-0.43; 0.29)	0.70
General attitude towards healthy food (*n* = 123)	T1–T0	0.28 (0.02; 0.54)	0.04 *
	T2–T0	0.20 (-0.15; 0.54)	0.26

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, sex, age, FV product assessed in the questionnaire, and the baseline scores of the other four determinants of FV intake. Abbreviations: ES, Effect Size; FV, fruit and vegetable.

T1				T2			
Intervention Group		Control Group		Intervention Group		Control Group	
n	M (SD)	*n*	M (SD)	*n*	M (SD)	*n*	M (SD)
57	4.1 (1.09)	128	3.5 (1.33)	53	3.7 (1.31)	131	3.6 (1.24)
48	4.1 (0.91)	95	3.2 (1.25)	41	3.8 (1.28)	91	3.3 (1.44)
55	3.8 (1.08)	119	3.4 (1.18)	52	3.7 (1.06)	120	3.4 (1.21)
57	2.8 (0.97)	128	2.3 (0.89)	54	2.6 (0.96)	132	2.4 (0.93)
56	3.0 (0.93)	128	2.8 (0.97)	53	2.9 (1.05)	131	2.8 (0.89)

3: 'It is okay', 4: 'I like it', 5: 'I like it very much'. For attitude, the following scale was used; 1: 'No, sure not', 2: 'I do not think so', 3: 'In between', 4: 'Yes, I think so', 5: 'Yes, sure'. Abbreviations: M, mean; SD, standard deviation; FV, fruit and vegetable.

Table S5. Post-hoc analyses – Estimated Treatment Effects after Multiple Imputation.

Table S5. Estimated treatment effects after multiple imputation (*n* = 192).

		Intervention vs. Control	
Determinant		**B (95% CI)**	***p*-value**
Knowledge	T1–T0	0.77 (0.32; 1.23)	0.001 *
	T2–T0	0.30 (-0.29; 0.89)	0.32
Intention	T1–T0	0.11 (-0.24; 0.46)	0.53
	T2–T0	-0.14 (-0.67; 0.39)	0.60
Taste preferences	T1–T0	0.35 (0.13; 0.57)	0.002 *
	T2–T0	0.18 (-0.07; 0.42)	0.16
Attitude towards addressed FV product	T1–T0	0.32 (0.10; 0.55)	0.004 *
	T2–T0	0.03 (-0.25; 0.30)	0.84
General attitude towards healthy food	T1–T0	0.29 (0.06; 0.53)	0.01 *
	T2–T0	0.19 (-0.09; 0.47)	0.19

Note. Time span: T1–T0 = three weeks; T2–T0 = three months. * Significant difference between intervention and control group ($p \leq 0.05$). Analysed by linear mixed model analyses. All analyses were corrected for baseline outcome, age, and baseline intention. Abbreviations: ES, Effect Size; FV, fruit and vegetable.

CHAPTER 5

The Effects of the Healthy Primary School of the Future on Children's Fruit and Vegetable Preferences, Familiarity, and Intake

Hahnraths MTH, Willeboordse M, van Assema P, Winkens B, van Schayck, CP. The Effects of the Healthy Primary School of the Future on Children's Fruit and Vegetable Preferences, Familiarity, and Intake.

Nutrients. 2021;13(9):3241.

Abstract

Mere exposure is an often-described strategy to increase children's food familiarity, preferences, and intake. Research investigating this method in less controlled settings is scarce. This study investigates the effects of repeated fruit and vegetable (FV) exposure through the Healthy Primary School of the Future (HPSF) on children's FV familiarity, preferences, and intake. The study had a longitudinal quasi-experimental design comparing two full HPSFs (focus: nutrition and physical activity) with two partial HPSFs (focus: physical activity) in the Netherlands. Annual measurements (child-reported questionnaires) were conducted during 2015–2019 in 833 7–12-year-old children. The study was registered on ClinicalTrials.gov (NCT02800616). After correction for baseline, full HPSFs had, on average, a lower number of unfamiliar vegetable items after one (effect size (ES) = -0.28) and three years (ES = -0.35) and a higher number of disliked vegetable items after one year (ES = 0.24) than partial HPSFs. Unfavourable intervention effects were observed for fruit intake after one (odds ratio (OR) = 0.609) and four years (OR = 0.451). Repeated FV exposure had limited effects on children's FV familiarity, preferences, and intake, likely due to insufficient taste exposure. Considering the widespread implementation of school-based mere exposure efforts, it is highly relevant to further investigate under which circumstances mere exposure effectively contributes to improvements in (determinants of) FV intake.

Introduction

Despite the important health benefits of fruit and vegetable (FV) intake, insufficient FV consumption is a global issue related to multiple health problems, such as obesity, coronary heart disease, stroke, and cancer [1,2]. In 2017, globally, 3.9 million deaths could be attributed to inadequate FV consumption [2]. As lifestyle behaviours that are formed during childhood are likely to persist throughout adulthood, promoting FV consumption at a young age is expected to result in both immediate as well as long-term health benefits [3–5]. In the Netherlands, the current dietary habits of children show significant room for improvement as their FV intake is currently suboptimal. Over the period of 2014–2016, only 42% of children (aged 4–9 years) consumed at least recommended 150 grams of fruit per day in the Netherlands; this percentage dropped to 20% for 9–12-year-olds. The percentages for vegetable intake were comparable: 41% of 4–9-year-olds and 25% of 9–12-year-olds consumed at least 150 grams of vegetables per day [6].

Food preferences or the related concept of liking have been identified as strong predictors of food intake in children, and this relationship has also been described for FV specifically [7–12]. Food preferences are defined as learned dispositions that are the result of children's experience with a food [10,13]. One of the strongest determinants of children's food preferences is therefore their familiarity with a specific food [10,14,15]. An often-described strategy to increase liking of a food is mere exposure; various studies have shown that repeated exposure to and consumption of a food (i.a., FV) enhances familiarity and subsequently increase liking [14,16–19]. Exposure to the food in a positive social context where others are also consuming it is thought to amplify this process [20,21].

The number of exposures required to impact preferences for a food seems to increase with age. Whilst the preferences of 2–4-year-olds were often increased after five to 15 exposures [22–24], more exposures seem necessary to influence 5–12-year-olds' preferences, although the exact number of exposures varies across studies [25,26]. Mere exposure therefore seems to be a particularly powerful strategy to form and impact food preferences in very young children (0–4 years), but research focusing on its effects in older children (4–12 years) is relatively scarce [19].

The school environment is a promising setting to influence the dietary habits of children, as, at school, children from various backgrounds come together on a regular basis for several critical developmental years [27,28]. Various school-based interventions aiming to increase FV preferences through repeated exposure (e.g., by FV delivery schemes or tasting sessions) have been implemented and showed promising results. In studies by Lakkakula et al. and Schindler et al., repeated FV exposure through school-based interventions resulted in increases in vegetable liking and willingness to try fruit [29,30]. However, as these studies often tightly control children's exposure to FV or are of short duration, there is a need for large, long-term studies in less controlled settings [29,30].

The Dutch initiative 'Healthy Primary School of the Future' (HPSF) is a multicomponent programme that was implemented at several primary schools. The aim of HPSF was to sustainably integrate health promotion within the school system, thereby improving children's health and well-being over the long term. For a period of four years, two 'full HPSFs' implemented (1) various interventions aimed at increasing children's exposure to FV (provision of a daily healthy school lunch and mid-morning snack), and (2) structured physical activity (PA) sessions during lunch break time. Two 'partial HPSFs' implemented solely the structured PA sessions [31]. The current study is part of the overall HPSF research project executed by a large multidisciplinary research team. Previous studies reported on the study design [31], research approach [32], process evaluation [33], non-response, and external validity [34]. Furthermore, various reports of this project revealed positive intervention effects on various health-related outcomes in children (e.g., BMI z-score, waist circumference, PA, and dietary behaviours) [35–38].

The present study aims to answer the following research question: What are the effects of one- to four-year exposure to school-based FV exposure interventions on children's familiarity with and preferences for specific FV items, and on children's FV intake? It was hypothesised that children's regular, increased exposure to FV in the full HPSFs would lead to an increase in the number of familiar and liked FV items and subsequently to an increase in FV intake (Figure 1). Furthermore, it was hypothesised that longer exposure to the full HPSF intervention, and therefore a higher number of FV exposures, would lead to more prominent effects.

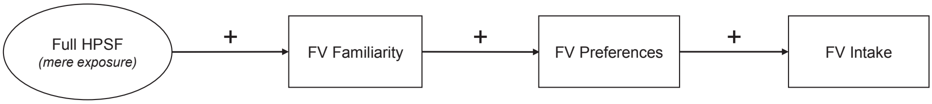

Figure 1. Hypothesised working mechanism of the full HPSF intervention.

+ Indicates a positive relationship between the concepts. Abbreviations: HPSF, Healthy Primary School of the Future; FV, fruit and vegetable.

Materials and Methods

Study Design

The overall project had a longitudinal quasi-experimental design with two full intervention schools (full HPSFs), two partial intervention schools (partial HPSFs), and four control schools (not discussed in the current paper), which were all recruited on the basis of voluntary participation [31]. All participating schools were members of the educational board MOVARE and located in the Parkstad region. Parkstad is a region located in the southern part of the Netherlands that consists of eight municipalities (Heerlen, Kerkrade, Landgraaf, Brunssum, Simpelveld, Voerendaal, Nuth, and Onderbanken). Compared to other areas in the Netherlands, Parkstad can be defined as a low to moderate socioeconomic area, characterised by a high prevalence of chronic diseases and a low life expectancy [34,39].

All HPSFs started implementation of the full or partial HPSF intervention in November 2015. Annual measurements were conducted in various ways by trained researchers in September–November of 2015 (T0), 2016 (T1), 2017 (T2), 2018 (T3), and 2019 (T4) during one week of measurements per school [31]. The study had a dynamic open cohort, meaning that enrolled students could participate at any moment during the study duration (between 2015 and 2019). This could be children who were already enrolled in one of the schools or children who had newly entered school at some point during the study duration (either at four years old or at a later age). Recruitment was done through information brochures and classroom visits. All participants were required to complete an informed consent form, signed by both parents/caregivers and by children if they were aged 12 years or older. Participants were excluded when they left school. If they switched to other participating schools during the study period, only data from the original school were included in the analyses. The study was registered in the ClinicalTrials.gov database in June 2016 (NCT02800616).

The Healthy Primary School of the Future

HPSF was developed by the regional educational board MOVARE, the regional public health services, and Maastricht University [31]. The intervention consisted of two main changes: (1) daily provision of a free healthy school lunch and mid-morning snack, and (2) daily structured PA sessions after lunch. Two schools implemented the complete HPSF intervention (full HPSFs), whilst two other schools implemented solely the structured PA sessions (partial HPSFs). Four control schools continuing with their regular curriculum that is common practice in the Netherlands were also included in the overall study. However, these schools were not discussed in the present study and a comparison was made between the full HPSFs and the partial HPSFs only. This made it possible to investigate the effects of the provided healthy school lunch and mid-morning snack without potentially contaminating the results with effects caused by the PA sessions.

In all intervention schools, lunch break time was prolonged with 45 to 75 minutes, thereby extending the school day. In full HPSFs, various nutrition-related changes were implemented. The most prominent change was the provision of a daily healthy school lunch. Normally, Dutch primary school pupils bring their lunch from home or go home to eat lunch. For the intervention, a bread-based lunch menu cycle was developed by a dietician and the lunch was provided by catering services. The menu cycle changed every ten weeks and at least 80% of the provided products met the dietary guidelines of the Dutch Health Council [40]. A wide variety of FV items was included in the lunch menu cycles (Table S1). The lunch was offered in a buffet style in the classroom or at a central location in school (depending on the available space within a school), and children were free to compose their own lunch out of the various available food products. Pedagogical staff and teachers encouraged children to include healthy products such as FV in their lunch. For this purpose, they used role modelling (e.g., tasting and consuming healthy products in the presence of children), nudging (e.g., visible placement of ready-to-eat healthy products), rewards for consumption of healthy foods (e.g., coins that could later be exchanged for fun activities), and giving positive attention to children consuming and enjoying healthy foods. These actions were not organised systematically but were largely bottom-up initiatives that occurred in both full HPSFs throughout the project. Additionally, children received a daily healthy mid-morning snack, which, most of the time, was a piece of fruit. After the first intervention year, additional weekly short 'educational lunches' were organised, where children learned about a specific food item that was provided during lunch that week (using educational materials inspired by the Taste Lessons programme [41] and adapted by the regional public health services to fit the FV items provided during lunch).

Children in both the full and partial HPSFs participated in structured PA and/or cultural sessions during lunch break time. Besides these top-down initiated changes, schools were encouraged to implement additional health-promoting initiatives. Especially towards the end of the project, this resulted in extra changes in the nutritional policies of all intervention schools (e.g., rules regarding healthy birthday treats, snacks, and drinks) [33].

Study Population

All children who were enrolled in full and partial HPSFs between 2015 and 2019 were invited to participate in the overall research project. Due to the study's dynamic character, recruitment of participants continued throughout the duration of the research project. To answer the current study's research questions, several inclusion criteria were applied. First, to be able to adequately assess the effects of HPSF's mere exposure component, only participants who were exposed to the school environment from T0 (baseline) onwards were included in the present study. This included children who enrolled in the study at T0 and children who started study participation at a later moment but were already enrolled in one of the HPSFs at baseline. In this way, exposure to FV items as part of HPSF was equal for all subjects.

Second, only children from study years four to eight (age range 7–12 years; internationally comparable to grades two to six) were included in the present study, due to age-related differences in questionnaire formulation for younger children (study years one to three). Third, only data of children who had a valid response for at least one outcome during at least one measurement from T1 to T4 were included.

The present study's inclusion criteria meant that baseline data were not available for all participants, as some subjects were only included at a later moment in the study (because they were not yet enrolled in the overall study or not yet in study years four to eight at previous time point(s)). An overview of the participants included at each time point can be found in Table 1.

Table 1. Participants included in the present study, specified for T0–T4.

	Number of Included Participants, Divided per Study Year *(Study Year at T0 in Brackets)*									
	Study Year 4		**Study Year 5**		**Study Year 6**		**Study Year 7**		**Study Year 8** [1]	
	Full HPSF	Partial HPSF	Full HPSF	Partial HPSF	Full HPSF	Partial HPSF	Full HPSF	Partial HPSF	Full HPSF	Partial HPSF
Time point										
T0 (2015)	48	53	53	61	51	45	58	67		
T1 (2016)	51 (3)	59 (3)	50 (4)	56 (4)	57 (5)	62 (5)	53 (6)	45 (6)	60 (7)	67 (7)
T2 (2017)	60 (2)	80 (2)	52 (3)	64 (3)	55 (4)	59 (4)	59 (5)	62 (5)	53 (6)	47 (6)
T3 (2018)	48 (1)	49 (1)	60 (2)	80 (2)	52 (3)	64 (3)	55 (4)	59 (4)	59 (5)	62 (5)
T4 (2019)	3 (1) [2]	6 (1) [2]	48 (1)	52 (1)	63 (2)	82 (2)	53 (3)	62 (3)	56 (4)	60 (4)

[1] At T0, no participants from study year eight were included as no data could be collected from these subjects at later measurement points (T1–T4) because they had left school. [2] Participants repeated study year one.

Data Collection Procedures and Measures

FV Familiarity and Preferences

Participants filled out a paper-based questionnaire during class hours under the guidance of at least one member of the research team. Filling out this questionnaire took approximately 30 minutes as other aspects such as PA, dietary behaviour, and general health were also assessed. FV familiarity and preferences were assessed by 12 fruit items and 16 vegetable items (Table 2), formulated in the following way: ‘Indicate how much you like the following type of fruit or vegetable’. Each item consisted of the FV item’s name accompanied by its picture. Between T0 and T1, the picture for pear was changed, as problems with the visibility of this picture were observed during questionnaire administration at T0. On a semantic differential rating scale, participants assessed each item as (1) ‘disliked’ (accompanied by a picture of a sad face), (2) ‘neutral’ (accompanied by a picture of a neutral face), or (3) ‘liked’ (accompanied by a picture of a smiley face). If children were unfamiliar with or had never tried an FV item, they could indicate this by checking a fourth response option accompanied by a question mark. This method of assessing FV familiarity and preferences resembled the visual cart-sorting technique that was previously tested and used to assess food and activity patterns in African American girls [42].

Table 2. Fruit and vegetable items assessed in the questionnaire.

Fruit	**Vegetables**
Apple	Cucumber
Banana	Tomato
Grapes	Carrot
Kiwi	Bell pepper
Mango	Lettuce
Tangerine	Zucchini
Pear	Spinach
Orange	Eggplant
Melon	Onion
Pineapple	Leek
Peach	Peas
Strawberries	Brussels sprouts
	Broccoli
	Green beans
	Cauliflower
	Kale

Separate familiarity scores (unfamiliar/familiar) and preference scores (disliked/neutral/liked) were composed for the 28 FV items. If a participant had checked one of the three preference response options (‘disliked’, ‘neutral’, ‘liked’), familiarity with the FV item was assumed. If the fourth response option (‘don’t know this FV item/never tried’) was checked, this indicated unfamiliarity with the FV item. When a participant indicated that they were unfamiliar with an FV item, preference for this item was set to missing. To facilitate data analysis, familiarity and preference summary scores were computed for fruit and vegetables. Familiarity summary scores were formed through computing the total number of unfamiliar fruit items and the total number of unfamiliar vegetable items. For preference summary scores, the total number of disliked items was calculated for fruit and vegetables. Summary scores could range from 0 to 12 for fruit and 0 to 16 for vegetables, and were calculated for children with ≤ 3 missing responses (fruit) and ≤ 4 missing responses (vegetables) (corresponding to a maximum missing rate of 25%). In case of missing responses, the average of the observed scores was multiplied by the number of items of the scale (12 for fruit and 16 for vegetables). This is equivalent to mean imputation, i.e., imputing the mean score of the items from the same scale (fruit or vegetables) and same child.

FV Intake

The child-reported questionnaire also contained questions regarding FV intake, which were used in the present study. The questions were formulated as: ‘Do you consume fruit?’ and ‘Do you consume vegetables?’ (response options ‘(almost) never’, ‘sometimes (1–3 days a week)’, ‘often (4–6 days a week)’, and ‘every day’). This method of assessing FV intake is comparable to methods previously used in similar studies, although questionnaire formulation was slightly changed [42,43].

Socio-Demographic Characteristics

Children’s age and sex were collected through the school database and checked for correctness with data from the regional Youth Health Department. A digital questionnaire was sent out to parents of all participating children to obtain information about the children’s socioeconomic status (SES) and ethnicity. Filling out the questionnaire took approximately 30 minutes. Other aspects such as PA, dietary behaviour, and general health were also assessed. SES was calculated on the basis of standardised scores for maternal and paternal education level and household income (adjusted for household size) [44]. The mean scores were categorised into low, middle, and high SES scores on the basis of tertiles. Children’s ethnicity was determined by the country of birth of both parents and divided into (1) Western background (including the Netherlands, all European countries (except Turkey), Japan, Indonesia, and Oceania), and (2) non-Western background (when at least one parent was born in a non-Western country) [45].

Data Processing and Statistical Analyses

Data were analysed using IBM SPSS Statistics for Windows (version 25.0, IBM Corp, Armonk, NY, USA). Participants were included in the analyses if they were exposed to the school environment at T0 and had a valid response for at least one outcome during at least one measurement from T1 to T4.

Pearson's chi-square tests and independent-samples t-tests were conducted to analyse the comparability of observed participant characteristics at T0, i.e., sex, age, SES, ethnicity, FV familiarity, FV preferences, and FV intake, among the full and partial HPSFs. Linear mixed model (LMM) analyses were used to analyse the intervention effects on participants' FV familiarity and preferences (using the computed summary scores). Ordinal logistic model analyses with exchangeable covariance structure were used for FV intake. For LMM, the best-fitting covariance structure was determined for each analysis, on the basis of the lowest Bayesian Information Criterion (BIC) value. As measurements were repeated within participants, a two-level model with repeated measurements as the first level and participants as the second level was used. The fixed part of the model consisted of condition (full HPSF, partial HPSF), time (T0–T4), and the interaction term of condition and time. All analyses were adjusted for the following covariates: sex (boy/girl), study year (at T0; one to eight), SES (low/middle/high), and ethnicity (Western/non-Western).

For all analyses, a two-sided *p*-value ≤ 0.05 was considered statistically significant. Standardised effect sizes (ES) were determined for continuous outcome variables (FV familiarity and preferences) and were computed as the estimated mean difference divided by the square root of the residual variance at baseline. According to the benchmarks suggested by Cohen et al., ES ≤ 0.2 were considered small, values between 0.2 and 0.5 were considered medium, and ES ≥ 0.5 were considered large [46]. Categorical outcomes (FV intake) resulted in odds ratios (OR).

Results

Demographic Characteristics

Of the 1243 students exposed to the school environment at T0, 998 (80.3%) handed in a completed informed consent form in 2015–2019. Of these students, 833 (83.5%) were included in the analyses as they met the additional inclusion criteria applied in the present study. Of the included subjects, 397 children (47.7%) started study participation at a later moment but were already enrolled in one of the HPSFs at baseline. A detailed overview of the subjects included at each time point can be found in Figure S1.

Table 3 provides an overview of the sample's baseline characteristics. There were no significant differences in baseline characteristics between full and partial HPSFs. At baseline, participants were familiar with and liked the majority of FV items. Fruit items were more often familiar and liked than vegetable items. A detailed overview of observed mean familiarity and preference scores at baseline for the different FV items can be found in Table S2. Approximately 40% of participants in both the full and partial HPSFs were indicated to consume FV on a daily basis.

Intervention Effects on FV Familiarity and Preferences

After correction for baseline, the mean number of unfamiliar vegetable items was significantly lower in full HPSFs compared with partial HPSFs at T1 and T3 (ES = -0.28 and ES = -0.35, respectively) (Table 4; Figure 2). FV preferences were largely similar in full HPSFs compared to partial HPSFs. Only at T1, a significant unfavourable intervention effect was observed, with a significant increase from baseline in the number of disliked vegetable items in full HPSFs compared to partial HPSFs (ES = 0.24) (Table 4; Figure 3). Descriptive data regarding the observed mean familiarity and preference scores for the separate FV items at T0–T4 can be found in Table S2.

Intervention Effects on FV Intake

After correction for baseline, the frequency of fruit intake was significantly lower in full HPSFs compared with partial HPSFs at T1 (OR = 0.609) and T4 (OR = 0.451). No significant intervention effects were observed for vegetable intake at any of the time points (Table 5). The effects for fruit intake could not be ascribed to a change in the percentage of participants selecting one specific response category, but were caused by a combination of changes in the various categories. Descriptive data regarding the observed mean FV intake at T0–T4 can be found in Table S3.

Table 3. Characteristics of participants at baseline (T0).

	Total (*n* = 833)		
Characteristic	***n***	**% Missing Values**	**% / M (SD)**
Sex (% boys) [1]	833	0	48
Age (years)	833	0	7.5 (2.2)
Ethnicity (% Western) [1]	599	28	96
SES (%) [1]	629		
Lowest tertile	189	25	30
Middle tertile	233		37
Highest tertile	207		33
Familiarity (mean *n* unfamiliar items) [2]			
Fruit (range 0–12)	418	50	0.9 (1.6)
Vegetables (range 0–16)	420	50	1.8 (2.2.)
Preference (mean *n* disliked items) [2]			
Fruit (range 0–12)	393	53	1.4 (1.8)
Vegetables (range 0–16)	376	55	4.1 (3.1)
Fruit intake (%) [1]	403	52	
(almost) Never	21		5
Sometimes (1–3 days per week)	82		20
Often (4–6 days per week)	125		31
Every day	175		43
Vegetable intake (%) [1]	380	54	
(almost) Never	15		4
Sometimes (1–3 days per week)	62		16
Often (4–6 days per week)	143		38
Every day	160		42

Note. All children who were exposed to the school environment at T0, participated in ≥ 1 measurement from T1 to T4 while in study years four to eight, and had a valid response for ≥ 1 outcome during these measurements are included in the present table. For participants who had not yet enrolled in the study at T0, demographic characteristics from the first available measurement are included (age at T0 was calculated using age at participants' first available measurement). Due to the dynamic open cohort and the fact that only data collected in study years four to eight are included in the current study, baseline FV familiarity, preference, and intake scores are not available for all included participants.

Full HPSF (n = 394) with exposure to FV			Partial HPSF (n = 439) without exposure to FV				
n	**% Missing Values**	**% / M (SD)**	***n***	**% Missing Values**	**% / M (SD)**	**X^2 / t- value**	***p*-value**
394	0	47	439	0	49	0.267	0.605
394	0	7.5 (2.1)	439	0	7.5 (2.2)	0.534	0.593
287	27	94	312	29	97	2.566	0.109
292			337			1.180	0.554
82	26	28	107	23	32		
109		37	124		37		
101		35	106		32		
198	50	1.0 (1.6)	220	50	0.9 (1.5)	0.155	0.877
199	50	1.8 (2.1)	221	50	1.7 (2.3)	0.231	0.818
184	53	1.5 (1.9)	209	52	1.3 (1.7)	0.982	0.327
177	55	4.1 (3.1)	199	55	4.1 (3.2)	-0.235	0.814
190	52		213	52		3.684	0.298
11		6	10		5		
31		16	51		24		
62		33	63		30		
86		45	89		42		
184	53		196	55		5.026	0.170
8		4	7		4		
22		12	40		20		
72		39	71		36		
82		45	78		40		

This is because some subjects were not yet enrolled in the study at T0, or participants were not yet in study years four to eight at T0, meaning that no baseline data were collected for these subjects. This can be observed in the table by the relatively high amount of missing values for these outcomes. Note. Due to the non-randomised nature of the study, baseline differences between the full and partial HPSF were investigated. [1] Analysed by X^2 test. [2] Calculated for participants with a maximum missing rate of 25% (corresponding to ≤ 3 missing fruit items or ≤ 4 missing vegetable items). Abbreviations: HPSF, Healthy Primary School of the Future; M, mean; SD, standard deviation; SES, socioeconomic status.

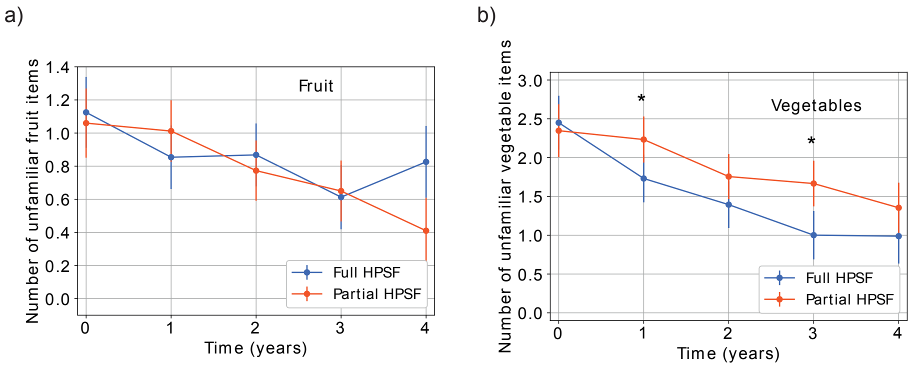

Figure 2. Estimated means of children's fruit and vegetable familiarity at T0–T4: (a) Number of unfamiliar fruit items; (b) Number of unfamiliar vegetable items.

Note. All analyses were adjusted for sex, study year at T0, SES, and ethnicity. * Significant difference between full and partial HPSF after correction for baseline ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future.

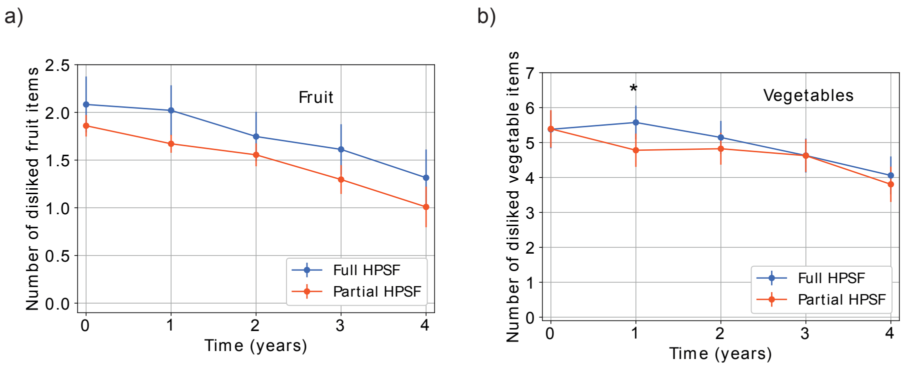

Figure 3. Estimated means of children's fruit and vegetable preferences at T0–T4: (a) Number of disliked fruit items; (b) Number of disliked vegetable items.

Note. All analyses were adjusted for sex, study year at T0, SES, and ethnicity. * Significant difference between full and partial HPSF after correction for baseline ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future.

Table 4. Estimated intervention effects on fruit and vegetable familiarity and preferences.

			Full HPSF vs. Partial HPSF		
			B (95% CI)	***p*-value**	**ES**
Familiarity	Number of unfamiliar fruit items	T0–T1	-0.222 (-0.487; -0.043)	0.101	-0.16
		T0–T2	0.031 (-0.271; 0.332)	0.841	0.02
		T0–T3	-0.102 (-0.426; 0.223)	0.538	-0.07
		T0–T4	0.351 (-0.005; 0.708)	0.053	0.25
	Number of unfamiliar vegetable items	T0–T1	-0.604 (-1.058; -0.150)	0.009 *	-0.28
		T0–T2	-0.465 (-0.990; 0.060)	0.083	-0.21
		T0–T3	-0.768 (-1.333; -0.203)	0.008 *	-0.35
		T0–T4	-0.469 (-1.083; 0.146)	0.135	-0.22
Preferences	Number of disliked fruit items	T0–T1	0.127 (-0.203; 0.457)	0.450	0.07
		T0–T2	-0.031 (-0.423; 0.361)	0.877	-0.02
		T0–T3	0.094 (-0.335; 0.523)	0.667	0.05
		T0–T4	0.083 (-0.391; 0.558)	0.730	0.04
	Number of disliked vegetable items	T0–T1	0.808 (0.151; 1.464)	0.016 *	0.24
		T0–T2	0.336 (-0.431; 1.103)	0.390	0.10
		T0–T3	0.016 (-0.821; 0.853)	0.970	0.00
		T0–T4	0.266 (-0.651; 1.184)	0.569	0.08

Note. Analysed by linear mixed model analyses. All analyses were adjusted for sex, study year at T0, SES, and ethnicity. * Significant difference between full and partial HPSF ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future; CI, confidence interval; ES, effect size.

Table 5. Estimated intervention effects on fruit and vegetable intake.

		Full HPSF vs. Partial HPSF	
		OR (95% CI)	***p*-value**
Fruit intake	T0–T1	0.609 (0.389; 0.952)	0.030 *
	T0–T2	0.626 (0.383; 1.021)	0.061
	T0–T3	0.798 (0.478; 1.334)	0.390
	T0–T4	0.451 (0.259; 0.786)	0.005 *
Vegetable intake	T0–T1	0.828 (0.490; 1.402)	0.483
	T0–T2	1.330 (0.750; 2.359)	0.329
	T0–T3	1.009 (0.548; 1.856)	0.978
	T0–T4	1.008 (0.538; 1.887)	0.981

Note. Fruit and vegetable intake was coded as follows: 1 = (almost) never, 2 = sometimes, 3 = often, 4 = every day. Analysed by ordinal logistic model analyses. All analyses were adjusted for sex, study year at T0, SES, and ethnicity. * Significant difference between full and partial HPSF ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future; OR, odds ratio; CI, confidence interval.

Discussion

The current study aimed to investigate the effects of repeated FV exposure through the full HPSF intervention on children's FV familiarity, preferences, and intake. Although some positive intervention effects were observed for FV familiarity (mainly for vegetables), effects on preferences and intake were (almost) absent. These findings are not in line with our initial hypothesis, which described increased FV familiarity, preferences, and ultimately intake with increased exposure to FV (Figure 1). Several previous studies describing repeated exposure interventions did report positive effects on children's familiarity, preferences, and intake [19], which raises the question of why these effects were not observed in the current study.

A possible explanation for the lack of effects on preferences and subsequently intake can be found in the form of exposure that took place. Previous research indicates that in order to be effective, exposure must take place in the same domain in which changes in preferences are desired [14]. Birch et al., for example, found that visual exposure increased visual preferences, but actual tasting was needed to increase taste preferences [23]. In the present study, FV were part of a buffet from which children composed their own lunch. This meant that children were visually exposed to FV, but taste exposure only happened after a child decided to consume FV as part of their lunch. It is likely that this increased visual exposure, together with the encouragement from teachers and educational staff, led to an increase in the number of familiar FV items, which was measured in the questionnaire. However, as FV tasting was not a standard or obligatory part of the lunch, and increased taste exposure therefore did not always happen, the increased familiarity might not have comprised an increase in taste familiarity, and an increase in taste preferences therefore remained absent. A more specific measurement of familiarity (e.g., measuring different aspects such as familiarity with the smell, texture, colour, or taste of a certain FV) could have provided more insight into this possible mechanism. If the above-described phenomenon occurred, it would mean that the naturalistic nature of the intervention resulted in suboptimal effects on preferences and intake, and better results might be achieved by including a tasting component as a standard intervention component.

Another factor that might have played a role in the limited effects is the relatively high age of the study sample. The ease of food acceptance and preference formation seems to decrease as a child matures, and more exposure over a longer time seems necessary to influence older children's dietary habits. Moreover, preferences that are formed early in life (i.e., during a child's first four years) tend to have a persistent long-term influence on food choices [14,47]. The current study involved children aged

7–12 years old, and the HPSF intervention might not have been powerful enough to influence the preferences already formed before this age. It would be interesting to investigate the intervention's effects in younger children—something that was not done in the present study as the measurement instrument used in participants from study years one to three was deemed less valid due to differences in questionnaire formulation. In addition, more research into the effects of mere exposure interventions in older children would be beneficial, as studies investigating the potential of mere exposure in older age groups are relatively scarce.

It should also be noted that baseline familiarity and preferences for the various FV items measured in the present study were already high, meaning that ceiling effects might have occurred. This was most apparent for fruit items, which might explain the fact that significant intervention effects on familiarity were mostly observed for vegetables. Besides relatively high baseline familiarity and preferences, the number of exposures was higher for FV items that are generally well known and often consumed in the Netherlands (e.g., apple, banana, tomato, cucumber). Less well-known fruit and especially vegetable items (e.g., eggplant, leek, and kale) were less frequently included in the lunch cycle (Table S1). Due to this, the number of exposures might not have been sufficient to increase liking for these specific items. Increasing the number of exposures to less familiar FV items in the lunch might therefore lead to more effects on familiarity and preferences.

From baseline to one year (T1), a significant decrease in vegetable preferences was observed in full HPSFs compared with partial HPSFs. Separate item analyses to investigate which vegetable item(s) caused this decrease in preferences were not possible due to the low variety in item responses, but experiences during the intervention might shed light on the possible causes of this negative intervention effect. In the first intervention year, several teachers and pedagogical staff reported negative experiences with the eggplant included in the lunch cycle. Children had been encouraged to try the (roasted) eggplant, but they did not like the taste of it. This could be attributed to the relatively bitter taste of eggplant, as humans and especially young children are known to have an innate aversion to bitter tastes [10]. Negative taste experiences can have a long-lasting unfavourable impact on liking of a specific food, even more so when the food has not been consumed on many other occasions [10,13]. It is therefore possible that the negative experience with eggplant during the first intervention year contributed to the decrease in vegetable preferences at T1. It could also be that teachers and pedagogical staff were too coercive in their enthusiasm to encourage children to consume FV, which negatively influenced preferences. Children might have felt forced to taste FV, whilst free choice with regard to FV intake is key in increasing FV preferences through repeated exposure [48]. Whilst it is recommended to include a tasting component in the intervention to increase taste exposure, it is important that this tasting is organised in a playful, relaxed setting to minimise the potential pressure that children might feel to taste the different FV items.

At baseline, roughly 40% of participants in both groups indicated that they consumed FV on a daily basis, which is higher than the national numbers discussed in the Introduction in the present paper. A potential explanation for this could be found in the current study's data collection procedures. As FV intake was measured using a self-report questionnaire, it is possible that children gave socially desirable responses instead of choosing responses that reflected their actual FV intake.

After correction for baseline, the frequency of fruit intake was significantly lower in full HPSFs compared with partial HPSFs after one (T1) and four years (T4). This is striking, as children in full HPSFs, as opposed to children in partial HPSFs, received a daily mid-morning snack, which was most often a fruit item. It is possible that the self-report nature of the questionnaire assessing participants' FV intake played a role in this inconsistent result. The unfavourable effects on fruit intake might also be explained by the occurrence of compensatory behaviour, which has previously been described in relation to various health behaviours such as dietary intake and PA [49–52]. Children might have consumed less fruit outside school hours to compensate for the extra fruit that they had already eaten while at school. The fact that negative effects were only observed for fruit intake and not for vegetable intake could be explained by cultural factors. In the Netherlands, fruit is often consumed as a snack, whilst vegetables are mostly consumed as part of the evening meal. It might therefore be easier to compensate for extra fruit intake by choosing another snack than to compensate for extra vegetable intake, as the evening meal is often consumed together as a family. Interview data from parents at full HPSFs revealed that some parents and children indeed engaged in compensatory behaviours at home following HPSF implementation—for example, by allowing their child to have a cookie instead of a healthy snack (parents) or by asking for candy instead of fruit after school because they had already eaten healthily at school (children). Inclusion of questions specifically measuring FV intake at school and at home could have provided more insight into the possible occurrence of compensatory behaviour.

Although the regular, increased exposure to FV as part of HPSF resulted in some positive effects on FV familiarity, it seems that HPSF was not successful in increasing children's FV preferences and intake. Nevertheless, in previous studies comparing full HPSFs with control schools, favourable intervention effects on BMI z-score, waist circumference, PA, and dietary behaviours (e.g., school water consumption, vegetable and dairy intake during lunch) were found [35,36]. Mere exposure efforts combined with other school health-promoting interventions can therefore be a powerful strategy to improve children's overall health and bring a halt to the childhood obesity epidemic. Considering the millions of children in primary schools across Europe who are currently exposed to mere exposure FV efforts by means of the freely available EU school fruit and vegetable scheme [53], it is highly relevant to further investigate under which circumstances mere exposure interventions can effectively contribute to changes in (determinants of) FV intake and eventually childhood obesity levels.

Post-Hoc Analyses

As previously described, ceiling effects might have played a role in the limited intervention effects that were observed for FV familiarity. To further investigate this potential explanation, a post-hoc analysis was performed using new summary scores for FV familiarity. Any FV item that was unfamiliar for < 5% of the population at T0 was excluded from the new summary scores, resulting in the inclusion of only those FV items that showed room for improvement in familiarity at T0. This led to the exclusion of apple, banana, tangerine, pear, strawberry, and grapes from the fruit summary score, and carrot, cucumber, broccoli, tomato, and lettuce from the vegetable summary score. The results of the post-hoc analysis indicate more positive intervention effects on vegetable familiarity (significant positive intervention effects at T1–T3) as compared with the primary analysis' results (significant positive intervention effects only at T1 and T3). For fruit familiarity, the results of the post-hoc analysis were comparable to the primary analysis' results. Detailed results from the post-hoc analysis can be found in Table S4. The results confirm the hypothesis that ceiling effects played a role in the limited effects that were observed for vegetable familiarity, but this influence was not clear for fruit familiarity. However, it should be noted that familiarity for fruit items was generally higher than for vegetable items (at T0, 81.8% of the fruit items were familiar for > 10% of participants, whilst 75% of the vegetable items were familiar for > 10% of participants at T0). Taking this into account, it seems that participants were already more familiar with fruit items in general, providing less room for improvement in this domain as opposed to vegetable familiarity.

As can be seen in Table S1, five of the 16 vegetable items that were included in the questionnaire assessing subjects' familiarity and preferences were not part of the intervention, meaning that participants were not exposed to these items between T0 and T4 as part of HPSF. It is therefore unclear whether HPSF would increase children's familiarity with and preferences for these items. Therefore, a second post-hoc analysis was performed in which the intervention's effects on vegetable familiarity and preferences were examined after excluding these five items (Brussels sprouts, broccoli, cauliflower, green beans, and kale) from the vegetable summary scores. This post-hoc analysis showed similar results for vegetable familiarity as compared with the primary analysis. However, for vegetable preferences, more positive intervention effects were observed in the post-hoc analysis (significantly positive intervention effects at T1–T2). Detailed results of this post-hoc analysis can be found in Table S5. The results indicate that the inclusion of the five vegetable items that were not part of HPSF in the primary analysis resulted in limited intervention effects on children's vegetable preferences, further validating the importance of actual (taste) exposure in order to improve children's food preferences.

Strengths and Limitations

Considering the study's strengths and limitations, there are a few issues that can be noted. First, generalisation of the study's results should be done carefully, despite the relatively large sample size. Although the study population was previously found to be a good representation of the region, comparability with a national sample was moderate [34]. This was due to the lower ethnic diversity, lower SES, and higher prevalence of overweight and obesity in the sample as compared with national numbers [54]. It would therefore be beneficial to study the intervention's effects in diverse populations. The non-randomised nature of the study can also be seen as a limitation. However, including schools on the basis of their willingness to implement the intervention is a better reflection of the real-world process of school-based health promotion. In addition, no significant baseline differences were observed between the full and partial HPSFs, and all analyses were controlled for outcome at baseline, sex, study year at baseline, SES, and ethnicity. Due to the study design, a relatively high number of missing values could be observed for the various outcome measures. Most of the missing data occurred due to participants' study year, as subjects were only included from study year four onwards and dropped out of the study when they left school after study year eight. This missing information was accounted for by including study year at T0 as a covariate in the analyses that were performed. Dropout due to other reasons was observed in three subjects only in the present study.

The fact that teachers and pedagogical staff encouraged FV consumption through nudging, rewards, and positive attention might have influenced the intervention's effects on children's FV preferences and intake. However, such small bottom-up initiatives fit with a real-world setting, and it is likely that their effects were limited compared with those of the systematically organised lunch.

The quality of the measurement instrument used to assess FV familiarity, preferences, and intake should also be discussed. Subjective measurements, such as the questionnaire used, might lead to socially desirable answers. However, at this moment, there is no objective way to measure constructs such as food familiarity and preferences. Although the child-reported nature of the questionnaire resulted in a high response rate, it limited the amount of detail in which questions could be asked. The three-point semantic differential rating scale might not have been sensitive enough to measure FV preferences accurately. Measuring FV familiarity and preferences as continuous dimensions would have made it possible to assess slight differences more accurately. Additionally, it was not possible to assess different aspects of FV familiarity (e.g., familiarity of smell, taste, texture) with the current questionnaire. Furthermore, the outcome measures used to assess FV intake might not have captured all potential effects. It was impossible to relate changes in the familiarity and preferences of specific FV items to changes in intake, as the outcome measures that were used only assessed general FV intake and did not make a distinction between specific FV items. Furthermore, the questions measured the frequency of FV intake (in days per week) and not the amount of FV consumed. It could be that the intervention resulted in children consuming more FV on days during which they normally already consumed FV—a positive effect that could not be measured with the current outcome measures. It should also be noted that children's FV intake outside of school is mostly regulated by parents/caregivers, who purchase and prepare the food at home. HPSF is therefore not the only factor having an impact on children's FV intake through increasing FV exposure at school, as FV availability at home also has a large influence on children's intake [7,55,56]. Including questions on FV availability at home and/or specifically measuring FV intake at home could have provided more insight into the influence that children's home environments had on their FV intake in the present study.

A limitation related to data analysis might be the fact that although multiple testing was performed, no correction was applied. However, it is unlikely that correction would have changed our overall conclusion that effects on preferences and intake were (almost) absent, as p-values for the various outcomes would remain largely non-significant. A final limitation is related to the HPSF intervention in general. As recommended by various researchers in the field, it seems that interventions aimed at improving children's lifestyle habits should target all environments in which the child is involved (e.g., school, home, sports associations) [57–59]. The main focus of HPSF was the school environment, but more positive results might be observed when parents and the home setting in general are more explicitly included in the intervention as well.

Conclusions

The HPSF intervention showed limited effects on FV familiarity, and effects on FV preferences and intake were (almost) absent. These findings are not in line with our initial hypothesis, which described increased FV familiarity, preferences, and ultimately intake with regular, increased exposure to FV as part of the HPSF intervention. The lack of effects might be explained by the presence of a ceiling effect, the relatively high age of the included sample, and the fact that actual taste exposure as part of the intervention was limited. Although the HPSF intervention was previously found to have positive effects on various health outcomes in children, it can be concluded that the intervention was not powerful enough to influence children's FV preferences and intake. Considering the widespread implementation of school-based mere exposure efforts (e.g., by means of the EU school fruit and vegetable scheme), it is highly relevant to further investigate under which circumstances these efforts can effectively contribute to changes in (determinants of) FV intake and eventually reduce childhood obesity levels.

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Table S1. Frequency of Exposure between T0 and T4 per Fruit and Vegetable Item.

Table S1. Frequency of exposure between T0 and T4 per fruit and vegetable item.

Fruit	Frequency of exposure †	Vegetables	Frequency of exposure †
Apple [1,‡]	476	Cucumber ‡	355
Banana ‡	263	Tomato [6,‡]	351
Grapes ‡	189	Carrot ‡	349
Kiwi [2,‡]	126	Bell pepper [7,‡]	226
Mango [3,‡]	115	Lettuce [8,‡]	193
Tangerine ‡	104	Mixed salad	122
Pear ‡	100	Baby corn	97
Orange ‡	90	Beet	68
Melon [4,‡]	84	Avocado	63
Pineapple ‡	65	Radish	58
Fruit salad	60	Celeriac	50
Nectarine	32	Cress	47
Mineola	21	Zucchini [9,‡]	44
Plums	20	Celery	44
Peach ‡	16	Spinach ‡	30
Apricot	11	Pickle	28
Strawberries ‡	9	Sweet potato	21
Grapefruit [5]	7	Seaweed	19
Pomegranate	7	Eggplant [10,‡]	10
Blackberries	7	Fennel	10
Blueberries	3	Cabbage [11]	8
Kaki fruit	3	Pumpkin	7
Dragon fruit	3	Onion ‡	6
Passion fruit	3	Leek ‡	6
Carambola	3	Rhubarb	3
Papaya	3	Peas ‡	1.5
		Asparagus	1.5
		Brussels sprouts ‡	0
		Broccoli ‡	0
		Green beans ‡	0
		Cauliflower ‡	0
		Kale ‡	0

[1] Including dried apple; [2] Including hardy kiwi; [3] Including dried mango; [4] Including watermelon, cantaloupe, honeydew; [5] Including pomelo; [6] Including snack tomatoes; [7] Including grilled bell pepper; [8] Including arugula, crop, lamb's lettuce, iceberg lettuce, little gem, winter purslane; [9] Including grilled zucchini; [10] Including grilled eggplant; [11] Including red cabbage, bok choy. † Amount of exposures corresponds to the number of times the FV items were included in the lunch cycle. Amount of exposures includes half portions (as the lunch cycle prescribed that the caterer could choose between two FV types, or a mix of both FV types was presented). ‡ Fruit and vegetable types evaluated in the current study.

5

Table S2. Observed Mean Fruit and Vegetable Familiarity and Preference Scores at the Various Time Points (T0–T4).

Table S2. Observed mean fruit and vegetable familiarity and preference scores at the various time points (T0–T4).

T0						
Item	**Full HPSF**					
	Familiarity		**Liking**			
	n	**% (*n*) Unfamiliar**	***n***	**% (*n*) Dislike**	**% (*n*) Neutral**	**% (*n*) Like**
Apple	198	1 (1)	197	2 (4)	21 (42)	77 (151)
Banana	198	0 (0)	198	16 (31)	31 (62)	53 (105)
Tangerine	198	4 (8)	190	15 (28)	34 (64)	52 (98)
Orange	197	7 (14)	183	19 (34)	28 (51)	54 (98)
Pineapple	197	18 (35) [1]	162	20 (32)	22 (35)	59 (95)
Pear	197	3 (6)	190	12 (22)	34 (64)	55 (104)
Melon	197	5 (10)	187	11 (21)	9 (16)	80 (150)
Kiwi	198	7 (13)	185	21 (38)	22 (40)	58 (107)
Strawberry	198	2 (4)	193	3 (6)	10 (20)	87 (167)
Mango	198	32 (64) [1]	133	21 (28)	23 (31)	56 (74)
Peach	198	15 (29) [1]	169	12 (20)	27 (45)	62 (104)
Grapes	198	2 (4)	194	6 (12)	18 (35)	76 (147)
Cauliflower	198	6 (12)	186	20 (37)	28 (52)	52 (97)
Zucchini	198	27 (53) [1]	144	56 (80)	22 (31)	23 (33) [2]
Carrot	198	0 (0)	198	11 (22)	24 (48)	65 (128)
Cucumber	199	1 (1)	198	4 (8)	11 (21)	85 (169)
Bell pepper	199	4 (7)	192	23 (44)	17 (32)	60 (116)
Broccoli	199	3 (5)	193	18 (35)	25 (48)	57 (110)
Green beans	198	7 (13)	185	21 (39)	28 (51)	51 (95)
Eggplant	198	54 (107) [1]	91	56 (51)	24 (22)	20 (18) [2]
Kale	197	25 (49) [1]	148	26 (38)	22 (32)	53 (78)
Brussels sprouts	199	9 (18)	181	54 (97)	17 (30)	30 (54) [2]
Leek	195	15 (29) [1]	166	36 (60)	33 (55)	31 (51) [2]
Tomato	199	2 (4)	195	28 (55)	16 (32)	55 (108)
Lettuce	198	3 (6)	192	10 (20)	16 (30)	74 (142)
Spinach	198	5 (10)	188	25 (46)	18 (34)	57 (108)
Onion	198	8 (15)	183	35 (64)	32 (59)	33 (60) [2]
Peas	199	13 (26) [1]	173	24 (42)	21 (37)	54 (94)

Partial HPSF					
Familiarity		Liking			
n	% (*n*) Unfamiliar	*n*	% (*n*) Dislike	% (*n*) Neutral	% (*n*) Like
219	0 (0)	219	3 (6)	16 (35)	81 (178)
219	2 (4)	215	9 (19)	18 (39)	73 (157)
220	2 (5)	215	14 (30)	28 (60)	58 (125)
219	5 (11)	208	17 (36)	25 (52)	58 (120)
220	15 (32) [1]	188	22 (42)	19 (36)	59 (110)
219	1 (2)	217	18 (39)	18 (40)	64 (138)
219	6 (13)	206	6 (13)	8 (16)	86 (177)
218	6 (13)	205	14 (28)	16 (33)	70 (144)
220	1 (3)	217	3 (6)	3 (6)	95 (205)
221	36 (79) [1]	142	21 (30)	18 (26)	61 (86)
221	16 (36) [1]	185	10 (18)	16 (29)	75 (138)
221	2 (5)	216	2 (4)	11 (24)	87 (188)
222	5 (10)	212	21 (44)	26 (55)	53 (113)
219	27 (59) [1]	160	50 (80)	16 (26)	34 (54) [2]
222	1 (2)	220	16 (35)	17 (37)	67 (148)
222	1 (3)	219	4 (9)	10 (22)	86 (188)
222	8 (17)	205	22 (44)	20 (41)	56 (120)
222	5 (11)	211	20 (42)	23 (48)	57 (121)
221	6 (13)	208	28 (59)	23 (48)	49 (101) [2]
221	46 (101) [1]	120	55 (66)	23 (27)	23 (27) [2]
222	19 (42) [1]	180	26 (47)	21 (38)	53 (95)
221	6 (13)	208	50 (103)	12 (25)	39 (80) [2]
216	17 (36) [1]	180	32 (58)	32 (58)	36 (64) [2]
219	3 (6)	213	24 (52)	13 (27)	63 (134)
220	5 (11)	209	10 (21)	17 (36)	73 (152)
220	7 (16)	204	25 (50)	19 (39)	56 (115)
216	6 (13)	203	44 (90)	25 (50)	31 (63) [2]
220	15 (33) [1]	187	25 (47)	24 (44)	51 (96)

Table S2. Continued.

T1						
Item	**Full HPSF**					
	Familiarity		**Liking**			
	n	**% (*n*) Unfamiliar**	***n***	**% (*n*) Dislike**	**% (*n*) Neutral**	**% (*n*) Like**
Apple	263	0 (0)	263	3 (9)	24 (64)	72 (190)
Banana	263	0 (0)	263	15 (39)	23 (60)	62 (164)
Tangerine	262	3 (7)	255	18 (46)	33 (84)	49 (125) [2]
Orange	261	8 (20)	241	21 (50)	34 (83)	45 (108) [2]
Pineapple	262	11 (29) [1]	232	21 (49)	17 (40)	62 (143)
Pear	261	0 (1)	260	15 (40)	31 (81)	54 (139)
Melon	263	1 (3)	260	14 (36)	12 (32)	74 (192)
Kiwi	263	4 (11)	252	20 (50)	26 (65)	54 (137)
Strawberry	263	2 (5)	258	5 (12)	7 (18)	88 (228)
Mango	261	25 (65) [1]	196	30 (58)	20 (40)	50 (98) [2]
Peach	263	15 (39) [1]	224	18 (40)	18 (41)	64 (143)
Grapes	263	2 (4)	259	4 (10)	18 (46)	78 (203)
Cauliflower	264	5 (12)	252	20 (50)	35 (87)	46 (115) [2]
Zucchini	264	14 (36) [1]	227	58 (131)	20 (45)	23 (51) [2]
Carrot	264	1 (2)	262	16 (41)	23 (60)	62 (161)
Cucumber	263	1 (2)	260	5 (13)	6 (16)	89 (231)
Bell pepper	263	3 (8)	255	23 (59)	18 (46)	59 (150)
Broccoli	264	1 (2)	261	21 (55)	23 (61)	56 (145)
Green beans	264	3 (8)	256	25 (63)	35 (89)	41 (104) [2]
Eggplant	262	34 (88) [1]	174	71 (123)	19 (33)	10 (18) [2]
Kale	263	24 (64) [1]	199	34 (67)	26 (51)	41 (81) [2]
Brussels sprouts	261	7 (19)	242	53 (128)	18 (44)	29 (70) [2]
Leek	261	12 (31) [1]	230	41 (94)	35 (81)	24 (55) [2]
Tomato	262	2 (4)	257	28 (71)	16 (41)	56 (145)
Lettuce	262	2 (4)	258	16 (42)	27 (69)	57 (147)
Spinach	262	5 (14)	247	25 (61)	19 (47)	56 (139)
Onion	262	6 (15)	247	40 (98)	36 (89)	24 (60) [2]
Peas	260	8 (20)	239	25 (60)	29 (70)	46 (109) [2]

Partial HPSF					
Familiarity		Liking			
n	% (*n*) Unfamiliar	*n*	% (*n*) Dislike	% (*n*) Neutral	% (*n*) Like
283	0 (1)	282	2 (6)	17 (48)	81 (228)
283	0 (1)	282	9 (25)	26 (73)	65 (184)
283	4 (11)	272	14 (37)	26 (71)	60 (164)
282	5 (14)	268	9 (25)	28 (74)	63 (169)
282	16 (45) [1]	236	20 (47)	19 (45)	61 (144)
282	2 (6)	276	14 (39)	20 (55)	66 (182)
282	4 (10)	271	7 (20)	7 (20)	85 (231)
281	8 (22)	259	13 (33)	22 (57)	65 (169)
283	1 (4)	279	3 (9)	5 (13)	92 (257)
283	36 (102) [1]	181	18 (32)	19 (34)	64 (115)
282	14 (39) [1]	243	12 (29)	16 (38)	72 (176)
282	1 (4)	278	4 (11)	11 (31)	85 (236)
283	4 (10)	273	20 (54)	30 (81)	51 (138)
282	23 (64) [1]	217	48 (105)	25 (55)	26 (57) [2]
282	1 (3)	279	13 (37)	20 (56)	67 (186)
283	1 (4)	279	4 (12)	8 (21)	88 (246)
283	5 (13)	270	16 (44)	16 (44)	67 (182)
282	5 (13)	269	20 (55)	18 (49)	61 (165)
280	8 (21)	259	25 (65)	27 (71)	48 (123) [2]
280	50 (139) [1]	141	53 (75)	23 (32)	24 (34) [2]
282	22 (61) [1]	220	24 (52)	20 (44)	56 (124)
282	9 (25)	257	50 (129)	18 (45)	32 (83) [2]
279	18 (50) [1]	229	28 (65)	31 (70)	41 (94) [2]
282	3 (9)	273	25 (67)	15 (42)	60 (164)
281	5 (13)	268	8 (21)	18 (47)	75 (200)
282	9 (24)	258	21 (53)	17 (43)	63 (162)
282	8 (23)	259	32 (83)	35 (90)	33 (86) [2]
282	10 (28) [1]	254	21 (52)	29 (73)	51 (129)

Table S2. Continued.

T2						
Item	**Full HPSF**					
	Familiarity		**Liking**			
	n	**% (*n*) Unfamiliar**	***n***	**% (*n*) Dislike**	**% (*n*) Neutral**	**% (*n*) Like**
Apple	254	0 (0)	254	2 (6)	25 (63)	73 (185)
Banana	254	0 (0)	254	13 (33)	23 (59)	64 (162)
Tangerine	252	4 (10)	242	17 (40)	31 (76)	52 (126)
Orange	252	9 (23)	229	21 (47)	31 (71)	49 (111) [2]
Pineapple	250	14 (34) [1]	216	20 (44)	22 (48)	57 (124)
Pear	253	0 (1)	252	12 (31)	29 (73)	59 (148)
Melon	253	3 (7)	246	11 (26)	12 (29)	78 (191)
Kiwi	252	5 (12)	240	21 (51)	28 (66)	51 (123)
Strawberry	254	1 (2)	252	5 (12)	9 (23)	86 (217)
Mango	254	22 (56) [1]	198	35 (70)	21 (41)	44 (87) [2]
Peach	253	14 (36) [1]	217	21 (45)	21 (45)	59 (127)
Grapes	253	1 (3)	250	8 (19)	17 (43)	75 (188)
Cauliflower	254	3 (7)	247	23 (57)	31 (76)	46 (114) [2]
Zucchini	254	10 (25) [1]	229	66 (150)	21 (49)	13 (30) [2]
Carrot	253	0 (1)	252	14 (36)	27 (69)	58 (147)
Cucumber	252	1 (2)	250	7 (18)	10 (24)	83 (208)
Bell pepper	254	2 (6)	248	29 (71)	19 (48)	52 (129)
Broccoli	254	2 (5)	249	21 (53)	27 (67)	52 (129)
Green beans	253	6 (15)	238	26 (61)	29 (68)	46 (109) [2]
Eggplant	253	39 (98) [1]	155	74 (114)	18 (28)	8 (13) [2]
Kale	251	20 (50) [1]	201	35 (70)	25 (50)	40 (81) [2]
Brussels sprouts	251	6 (15)	236	51 (121)	18 (43)	31 (72) [2]
Leek	249	12 (29) [1]	220	40 (87)	32 (70)	29 (63) [2]
Tomato	253	2 (5)	248	32 (79)	11 (27)	57 (142)
Lettuce	253	4 (9)	244	15 (36)	25 (62)	60 (146)
Spinach	253	5 (13)	240	28 (67)	19 (45)	53 (128)
Onion	252	6 (16)	236	43 (102)	31 (72)	26 (62) [2]
Peas	252	8 (19)	233	26 (60)	23 (54)	51 (119)

Partial HPSF					
Familiarity		Liking			
n	% (*n*) Unfamiliar	*n*	% (*n*) Dislike	% (*n*) Neutral	% (*n*) Like
286	1 (2)	284	4 (12)	19 (53)	77 (219)
286	1 (2)	284	11 (32)	23 (65)	66 (187)
286	2 (5)	281	17 (47)	29 (80)	55 (154)
284	6 (18)	265	14 (37)	31 (82)	55 (146)
285	18 (51) [1]	234	21 (48)	21 (48)	59 (138)
285	3 (7)	278	17 (46)	23 (65)	60 (167)
285	3 (8)	277	8 (23)	8 (22)	84 (232)
285	7 (20)	265	18 (47)	22 (59)	60 (159)
286	1 (4)	282	4 (12)	5 (15)	90 (255)
286	38 (108) [1]	178	22 (39)	15 (27)	63 (112)
286	19 (54) [1]	232	19 (44)	20 (46)	61 (142)
285	2 (5)	280	4 (11)	15 (43)	81 (226)
285	5 (13)	272	28 (77)	27 (72)	45 (123) [2]
284	25 (70) [1]	214	52 (111)	25 (54)	23 (49) [2]
283	1 (2)	281	18 (50)	23 (65)	59 (166)
284	1 (2)	282	4 (12)	8 (22)	88 (248)
284	5 (15)	269	19 (52)	16 (44)	64 (173)
286	3 (9)	277	23 (63)	23 (63)	55 (151)
281	6 (16)	265	29 (77)	25 (65)	46 (123) [2]
284	56 (160) [1]	124	67 (83)	20 (25)	13 (16) [2]
286	24 (69) [1]	217	29 (63)	26 (57)	45 (97) [2]
285	7 (21)	264	55 (145)	15 (39)	30 (80) [2]
282	21 (60) [1]	222	38 (84)	30 (66)	32 (72) [2]
284	3 (9)	275	28 (77)	15 (42)	57 (156)
285	4 (12)	273	12 (33)	22 (61)	66 (179)
285	7 (21)	264	30 (78)	17 (45)	53 (141)
284	7 (21)	263	43 (112)	27 (72)	30 (79) [2]
285	11 (32) [1]	253	31 (78)	26 (65)	44 (110) [2]

Table S2. Continued.

T3						
Item	**Full HPSF**					
	Familiarity		**Liking**			
	n	**% (*n*) Unfamiliar**	***n***	**% (*n*) Dislike**	**% (*n*) Neutral**	**% (*n*) Like**
Apple	246	0 (0)	246	1 (3)	23 (57)	76 (186)
Banana	246	0 (0)	246	12 (29)	24 (60)	64 (157)
Tangerine	245	2 (5)	240	14 (33)	31 (74)	55 (133)
Orange	246	5 (12)	233	23 (54)	27 (63)	50 (116) [2]
Pineapple	246	12 (29) [1]	217	26 (56)	20 (44)	54 (117)
Pear	246	1 (2)	244	16 (39)	28 (67)	57 (138)
Melon	246	4 (9)	237	13 (30)	6 (15)	81 (192)
Kiwi	246	4 (9)	236	21 (49)	22 (52)	57 (135)
Strawberry	245	1 (3)	242	3 (7)	8 (19)	89 (216)
Mango	245	21 (52) [1]	193	33 (64)	25 (49)	42 (80) [2]
Peach	247	13 (33) [1]	214	23 (50)	25 (53)	52 (111)
Grapes	246	0 (1)	245	7 (17)	17 (42)	76 (186)
Cauliflower	247	5 (11)	236	23 (55)	24 (56)	53 (125)
Zucchini	245	11 (27) [1]	218	65 (142)	18 (40)	17 (36) [2]
Carrot	247	0 (1)	246	17 (41)	22 (54)	61 (151)
Cucumber	247	1 (2)	245	7 (16)	12 (29)	82 (200)
Bell pepper	246	4 (9)	237	25 (60)	13 (30)	62 (147)
Broccoli	246	2 (5)	241	25 (61)	21 (51)	54 (129)
Green beans	245	5 (13)	232	27 (62)	27 (62)	47 (108) [2]
Eggplant	244	39 (96) [1]	148	72 (107)	17 (25)	11 (16) [2]
Kale	247	22 (54) [1]	193	33 (64)	27 (52)	40 (77) [2]
Brussels sprouts	241	6 (14)	227	52 (117)	18 (40)	31 (70) [2]
Leek	241	16 (38) [1]	203	41 (84)	29 (59)	30 (60) [2]
Tomato	241	2 (4)	237	27 (65)	16 (37)	57 (135)
Lettuce	242	2 (4)	238	18 (43)	24 (56)	58 (139)
Spinach	242	5 (12)	230	25 (58)	17 (40)	57 (132)
Onion	242	4 (9)	232	44 (101)	32 (73)	25 (58) [2]
Peas	241	10 (23) [1]	218	27 (59)	24 (52)	49 (107) [2]

	Partial HPSF					
	Familiarity		Liking			
	n	% (*n*) Unfamiliar	*n*	% (*n*) Dislike	% (*n*) Neutral	% (*n*) Like
	289	0 (0)	289	5 (13)	16 (47)	79 (229)
	289	0 (0)	289	10 (30)	18 (52)	72 (207)
	289	1 (4)	285	12 (35)	25 (72)	63 (178)
	289	4 (10)	278	10 (29)	27 (75)	63 (174)
	289	10 (28) [1]	261	22 (56)	14 (37)	64 (168)
	288	1 (3)	285	17 (48)	25 (72)	58 (165)
	286	1 (4)	282	9 (24)	9 (24)	83 (234)
	288	6 (18)	270	15 (41)	21 (56)	64 (173)
	289	1 (2)	287	6 (18)	4 (12)	90 (257)
	287	30 (87) [1]	200	19 (38)	19 (37)	63 (125)
	287	20 (56) [1]	231	15 (35)	20 (45)	65 (151)
	287	2 (5)	282	4 (12)	14 (39)	82 (231)
	287	5 (14)	273	26 (71)	29 (79)	45 (123) [2]
	287	25 (71) [1]	216	51 (111)	27 (59)	21 (46) [2]
	286	2 (7)	279	17 (48)	23 (64)	60 (167)
	285	1 (2)	283	6 (16)	6 (17)	88 (250)
	287	4 (12)	275	22 (61)	18 (49)	60 (165)
	285	3 (8)	276	21 (59)	26 (72)	53 (145)
	286	7 (19)	267	29 (76)	29 (77)	43 (114) [2]
	286	53 (152) [1]	134	67 (90)	18 (24)	15 (20) [2]
	287	23 (67) [1]	220	33 (72)	27 (60)	40 (88) [2]
	290	9 (27)	263	54 (141)	14 (37)	32 (85) [2]
	290	25 (71) [1]	219	42 (92)	29 (64)	29 (63) [2]
	289	4 (10)	279	28 (78)	13 (37)	59 (164)
	289	4 (11)	278	16 (43)	23 (63)	62 (172)
	290	11 (31) [1]	259	29 (75)	19 (50)	52 (134)
	290	9 (27)	263	41 (108)	25 (65)	34 (90) [2]
	290	14 (41) [1]	249	32 (80)	25 (63)	43 (106) [2]

Table S2. Continued.

T4						
Item	**Full HPSF**					
	Familiarity		**Liking**			
	n	**% (*n*) Unfamiliar**	***n***	**% (*n*) Dislike**	**% (*n*) Neutral**	**% (*n*) Like**
Apple	192	0 (0)	192	2 (3)	21 (40)	78 (149)
Banana	192	0 (0)	192	14 (27)	26 (49)	60 (116)
Tangerine	94	5 (5)	187	13 (24)	35 (65)	52 (98)
Orange	192	7 (14)	178	15 (27)	35 (62)	50 (89) [2]
Pineapple	191	16 (31) [1]	160	26 (41)	17 (27)	58 (92)
Pear	191	1 (1)	190	17 (33)	32 (60)	51 (97)
Melon	192	4 (8)	184	11 (20)	7 (13)	82 (151)
Kiwi	192	4 (8)	184	18 (33)	26 (48)	56 (103)
Strawberry	192	1 (2)	190	1 (2)	4 (8)	95 (180)
Mango	193	21 (41) [1]	152	32 (49)	16 (25)	51 (78)
Peach	193	18 (35) [1]	157	12 (19)	27 (42)	61 (96)
Grapes	193	1 (2)	191	4 (7)	17 (33)	79 (151)
Cauliflower	192	4 (7)	185	23 (43)	20 (36)	57 (106)
Zucchini	192	14 (27) [1]	165	58 (95)	22 (36)	21 (34) [2]
Carrot	191	1 (2)	189	16 (30)	24 (45)	60 (114)
Cucumber	191	1 (1)	190	6 (11)	11 (20)	84 (159)
Bell pepper	192	4 (7)	184	21 (38)	15 (28)	64 (118)
Broccoli	192	2 (3)	189	21 (39)	25 (48)	54 (102)
Green beans	192	6 (11)	181	25 (45)	31 (56)	44 (80) [2]
Eggplant	192	43 (82) [1]	110	72 (79)	11 (12)	17 (19) [2]
Kale	192	20 (38) [1]	154	34 (52)	25 (39)	41 (63) [2]
Brussels sprouts	193	9 (17)	176	52 (91)	14 (24)	35 (61) [2]
Leek	191	16 (30) [1]	161	37 (59)	30 (48)	34 (54) [2]
Tomato	193	2 (3)	190	33 (62)	12 (22)	56 (106)
Lettuce	193	1 (2)	191	16 (30)	26 (50)	58 (111)
Spinach	193	4 (7)	186	25 (46)	20 (38)	55 (102)
Onion	193	7 (13)	180	39 (70)	32 (57)	29 (53) [2]
Peas	193	11 (22) [1]	171	26 (45)	27 (46)	47 (80) [2]

Note. Preference values were handled as missing values for participants who indicated to be unfamiliar with the specific FV item and for participants who selected > 1 answer option.

Partial HPSF					
Familiarity		Liking			
n	% (*n*) Unfamiliar	*n*	% (*n*) Dislike	% (*n*) Neutral	% (*n*) Like
239	0 (0)	239	4 (10)	18 (44)	77 (185)
239	0 (0)	239	9 (22)	22 (52)	69 (165)
98	2 (2)	236	10 (23)	31 (72)	60 (141)
237	2 (5)	232	11 (25)	24 (56)	65 (151)
238	5 (12)	226	19 (43)	20 (44)	62 (139)
239	0 (0)	239	16 (37)	26 (62)	59 (140)
239	0 (1)	238	7 (16)	8 (19)	85 (203)
239	4 (9)	230	19 (44)	20 (46)	61 (140)
239	0 (1)	238	4 (10)	6 (13)	90 (215)
241	25 (59) [1]	182	20 (37)	18 (33)	62 (112)
241	15 (35) [1]	206	15 (31)	22 (46)	63 (129)
241	1 (2)	239	6 (15)	14 (34)	80 (190)
240	5 (12)	228	26 (59)	27 (61)	47 (108) [2]
240	25 (61) [1]	179	54 (97)	27 (48)	19 (34) [2]
241	0 (1)	239	16 (38)	27 (65)	57 (136)
240	0 (1)	239	6 (14)	9 (22)	85 (203)
239	2 (5)	234	20 (47)	12 (27)	68 (160)
241	3 (6)	235	20 (48)	22 (52)	57 (135)
241	6 (15)	226	29 (65)	26 (59)	45 (102) [2]
241	52 (124) [1]	116	64 (74)	26 (30)	10 (12) [2]
241	24 (58) [1]	183	34 (62)	26 (48)	40 (73) [2]
240	9 (21)	219	53 (116)	18 (39)	29 (64) [2]
239	18 (43) [1]	196	35 (68)	34 (67)	31 (61) [2]
240	4 (9)	231	27 (63)	10 (23)	63 (145)
240	3 (6)	234	16 (38)	19 (44)	65 (152)
238	7 (17)	221	29 (63)	19 (41)	53 (117)
238	8 (18)	220	35 (77)	31 (67)	35 (76) [2]
239	14 (33) [1]	206	28 (57)	23 (47)	50 (102) [2]

[1] ≥ 10% participants indicated to be unfamiliar with the FV item. [2] ≤ 50% participants indicated to like the FV item. Abbreviations: HPSF, Healthy Primary School of the Future.

Table S3. Observed Mean Fruit and Vegetable Intake at the Various Time Points (T0–T4).

Table S3. Observed mean fruit and vegetable intake at the various time points (T0–T4).

	T0				
Outcome	**Full HPSF**		**Partial HPSF**		
	n	**% (*n*)**	***n***	**% (*n*)**	***p*-value †**
Fruit intake	190		213		0.298
(almost) Never		6 (11)		5 (10)	
Sometimes (1–3 days/week)		16 (31)		24 (51)	
Often (4–6 days/week)		33 (62)		30 (63)	
Every day		45 (86)		42 (89)	
Vegetable intake	184		196		0.170
(almost) Never		4 (8)		4 (7)	
Sometimes (1–3 days/week)		12 (22)		21 (40)	
Often (4–6 days/week)		39 (72)		36 (71)	
Every day		45 (82)		40 (78)	
	T3				
Outcome	**Full HPSF**		**Partial HPSF**		
	n	**% (*n*)**	***n***	**% (*n*)**	***p*-value †**
Fruit intake	241		281		0.259
(almost) Never		5 (12)		3 (7)	
Sometimes (1–3 days/week)		20 (47)		25 (69)	
Often (4–6 days/week)		32 (77)		29 (82)	
Every day		44 (105)		44 (123)	
Vegetable intake	220		277		0.674
(almost) Never		4 (9)		7 (18)	
Sometimes (1–3 days/week)		14 (31)		13 (35)	
Often (4–6 days/week)		42 (92)		42 (116)	
Every day		40 (88)		39 (108)	

† Analysed by X^2 test. * Significant difference between full and partial HPSF without correction for baseline ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future.

	T1					T2				
	Full HPSF		**Partial HPSF**			**Full HPSF**		**Partial HPSF**		
	n	**% (*n*)**	***n***	**% (*n*)**	***p*-value †**	***n***	**% (*n*)**	***n***	**% (*n*)**	***p*-value †**
	256		277		0.586	246		282		0.315
		4 (9)		4 (12)			5 (11)		6 (17)	
		22 (57)		21 (57)			24 (59)		23 (66)	
		36 (93)		32 (89)			39 (96)		32 (91)	
		38 (97)		43 (119)			33 (80)		38 (108)	
	230		270		0.656	230		268		0.006 *
		7 (15)		4 (11)			5 (11)		8 (20)	
		14 (31)		13 (35)			10 (23)		18 (48)	
		40 (93)		43 (115)			40 (91)		42 (112)	
		40 (91)		40 (109)			46 (105)		33 (87)	

	T4				
	Full HPSF		**Partial HPSF**		
	n	**% (*n*)**	***n***	**% (*n*)**	***p*-value †**
	184		234		0.268
		7 (12)		3 (8)	
		20 (37)		18 (41)	
		36 (67)		35 (81)	
		37 (68)		44 (104)	
	173		223		0.364
		4 (7)		3 (6)	
		11 (19)		13 (29)	
		42 (73)		49 (109)	
		43 (74)		35 (79)	

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Figure S1. Trial Profile.

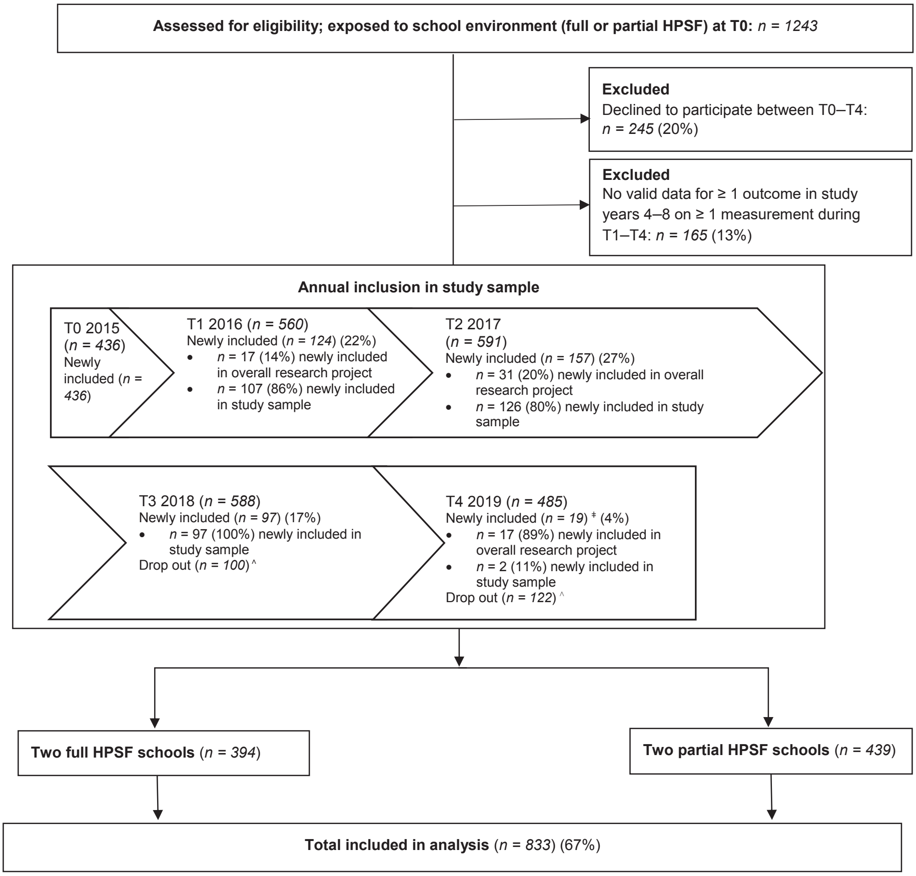

Figure S1. Trial profile.

Note. Between T0–T1, no drop out was observed as subjects were only included in the present study if they had ≥ 1 valid measurement between T1–T4. Reported drop out numbers only include subjects dropping out of the current study, not the overall research project. ^ Reasons for drop out over the four years include graduation (*n* = 345), or other (*n* = 3) including migration, actively stopping participation or switching to other included schools. ‡ Newly included participants include subjects who started participation in the overall research project after T0 and subjects who already participated in the research project while in study years 1–3, but are included in the present study's sample from the moment they are in study years 4–8. Abbreviations: HPSF, Healthy Primary School of the Future.

Table S4. Post-Hoc Analysis – Estimated intervention effects on fruit and vegetable familiarity using new summary scores.

Table S4. Post-hoc analysis – Estimated intervention effects on fruit and vegetable familiarity using new summary scores.

		Full HPSF vs. Partial HPSF		
		B (95% CI)	***p*-value**	**ES**
Number of unfamiliar fruit items	T0–T1	-0.183 (-0.418; 0.051)	0.126	-0.15
	T0–T2	0.040 (-0.226; 0.307)	0.766	0.03
	T0–T3	-0.058 (-0.344; 0.229)	0.692	-0.05
	T0–T4	0.349 (0.035; 0.663)	0.030 *	0.29
Number of unfamiliar vegetable items	T0–T1	-0.554 (-0.957; -0.151)	0.007 *	-0.29
	T0–T2	-0.512 (-0.970; -0.054)	0.028 *	-0.27
	T0–T3	-0.733 (-1.224; -0.243)	0.003 *	-0.38
	T0–T4	-0.459 (-0.992; 0.075)	0.092	-0.24

Note. In the present post-hoc analysis, any fruit or vegetable item which was unfamiliar for < 5% of the population at T0 was excluded from the new summary scores, resulting in the exclusion of apple, banana, tangerine, pear, strawberry, and grapes from the fruit summary score, and carrot, cucumber, broccoli, tomato, and lettuce from the vegetable summary score. Analysed by linear mixed model analyses. All analyses were adjusted for sex, study year at T0, SES and ethnicity. * Significant difference between full and partial HPSF without correction for baseline ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future; CI, confidence interval; ES, effect size.

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Table S5. Post-Hoc Analysis – Estimated Intervention Effects on Vegetable Familiarity and Preferences.

Table S5. Post-hoc analysis – Estimated intervention effects on vegetable familiarity and preferences.

			Full HPSF vs. Partial HPSF		
			B (95% CI)	***p*-value**	**ES**
Familiarity	Number of unfamiliar vegetable items	T0–T1	-0.497 (-0.841; -0.153)	0.005 *	-0.31
		T0–T2	-0.321 (-0.716; -0.073)	0.110	-0.20
		T0–T3	-0.530 (-0.953; -0.108)	0.014 *	-0.33
		T0–T4	-0.249 (-0.707; 0.210)	0.288	-0.16
Preferences	Number of disliked vegetable items	T0–T1	-1.684 (-2.558; -0.810)	0.000 *	-0.36
		T0–T2	-1.043 (-2.068; -0.017)	0.046 *	-0.23
		T0–T3	-0.059 (-1.177; 1.060)	0.918	-0.01
		T0–T4	-0.687 (-1.915; 0.541)	0.273	-0.15

Note. In the present post-hoc analysis, vegetable items were excluded if children were not exposed to them between T0–T4 as part of the HPSF intervention. This resulted in the exclusion of Brussels sprouts, broccoli, cauliflower, green beans, and kale from the vegetable familiarity and preferences summary score. Analysed by linear mixed model analyses. All analyses were adjusted for sex, study year at T0, SES and ethnicity. * Significant difference between full and partial HPSF ($p \leq 0.05$). Abbreviations: HPSF, Healthy Primary School of the Future; CI, confidence interval; ES, effect size.

CHAPTER 6

'Mummy, Can I Join a Sports Club?' A Qualitative Study on the Impact of Health-Promoting Schools on Health Behaviours in the Home Setting

Hahnraths MTH, Willeboordse M, Jungbauer ADHM, de Gier C, Schouten C, van Schayck CP. 'Mummy, Can I Join a Sports Club?' A Qualitative Study on the Impact of Health-Promoting Schools on Health Behaviours in the Home Setting.

Int. J. of Environ. Res. and Public Health. 2021;18(22):12219.

Abstract

Information regarding school-based health-promoting interventions' potential effects in the home environment is scarce. Gaining more insight into this is vital to optimise interventions' potential. The Healthy Primary School of the Future (HPSF) is a Dutch initiative aiming to improve children's health and well-being by providing daily physical activity sessions and healthy school lunches. This qualitative study examines if and how HPSF influenced children's and parents' physical activity and dietary behaviours at home. Between 2018 and 2019, 27 semi-structured interviews were conducted with parents from two HPSFs. Interviews were recorded and transcribed, and data were coded and interpreted through thematic analysis. HPSF resulted in various behavioural changes at home, initiated by both children and parents. Parents reported improvements in healthy behaviours, as well as compensatory, unhealthy behaviours. Reasons for behavioural change included increased awareness, perceived support to adopt healthy behaviours, and children asking for the same healthy products at home. Barriers to change included no perceived necessity for change, lack of HPSF-related information provision, and time and financial constraints. Both child-to-adult intergenerational learning and parent-initiated changes play an important role in the transfer of health behaviours from school to home and are therefore key mechanisms to maximise school-based health-promoting interventions' impact.

Introduction

Childhood is an important period in life for the development of lifestyle habits (e.g., physical activity (PA) and dietary habits), many of which are known to persist throughout adult life [1]. Unhealthy habits during childhood increase the risk of developing overweight and obesity, which has immediate negative consequences for children's physical, mental and social health. Furthermore, childhood overweight and obesity is often maintained during adult life and increases the risk of non-communicable diseases such as coronary heart disease and type 2 diabetes [2]. Considering this, the formation of healthy lifestyle habits early in life is vital to obtain long-lasting health benefits.

The ecological systems theory (ETS) states that behaviour is influenced by the various ecological and social contexts in which a person resides [3–6]. Children spend a considerable amount of time in the home and school environment, making them both important settings when it comes to influencing behaviour. According to the ETS, the various environments not only affect behaviour directly but also influence each other [3–6]. This means that lifestyle habits learned at home influence children's behaviour at school, and vice versa. As a result, school-based interventions promoting healthy lifestyle habits can also influence children's behaviours at home. The healthy habits learned at school can be transferred to the home context through children, leading to healthy behavioural changes at home. Alternatively, children (or parents) might feel that the healthy changes at school can compensate unhealthy behaviours at home, resulting in a justification of unhealthy changes in the home context [7].

Over the years, many school-based health-promoting interventions have been developed and implemented. Despite various effect evaluations, the impact these school-based interventions can have on health behaviour in the home context is seldom specifically investigated [8,9]. Gaining more insight into how changes in the school context might affect the home setting is therefore vital to optimise the potential of lifestyle interventions targeting children.

The Healthy Primary School of the Future (HPSF) is a Dutch initiative that aimed to improve the health and well-being of primary school-aged children by sustainably integrating health promotion within the whole school system [10]. As part of a comprehensive research project, two 'full HPSFs' implemented a daily healthy school lunch and structured PA sessions during the extended lunch break time [10]. Earlier reports of this study revealed favourable effects of HPSF on children's BMI z-score, waist circumference, and PA and dietary behaviours (e.g., school water consumption and vegetable and dairy intake during lunch) [11,12]. Additional quantitative analyses revealed no statistically significant favourable or adverse intervention effects on children's PA or dietary behaviours in the home context [13]. However, in informal conversations with several stakeholders (e.g., teachers and parents), various behavioural changes in the home setting were mentioned. Possibly, the HPSF-related changes at home were more extensive than could be captured using quantitative research methods, which makes additional qualitative research desirable. The present study therefore aims to identify and further investigate if there are patterns of behaviour change in the home environment that resulted from exposure to the HPSF intervention. For this purpose, qualitative research methods are used to answer the following research question: 'Does the Healthy Primary School of the Future lead to changes in health behaviours (especially physical activity and dietary behaviours) of children and parents in the home environment, and if so, what are the processes behind these changes?'

Materials and Methods

Setting and Study Design

The present study is part of a comprehensive quasi-experimental research project that investigates the effects of HPSF. For this purpose, data were gathered in eight primary schools (two full intervention schools (full HPSFs), two partial intervention schools (partial HPSFs), and four control schools) on various outcomes such as children's PA and dietary behaviours and anthropometrics. The current study consists of a qualitative analysis focussed on the two full HPSFs. Aim is to investigate if HPSF resulted in changes in PA and/or dietary behaviours of children and parents in the home environment and to further understand the processes behind any changes that might have occurred. For this purpose, semi-structured interviews were conducted with parents/caregivers of pupils from the two full HPSFs. The need for ethical approval for the overall study was waived by the Medical Ethics Committee Zuyderland in Heerlen (14N-142). Additionally, permission was given by the Medical Ethics Committee Zuyderland to actively approach all parents/caregivers of pupils from the two full HPSFs for participation in an interview, including parents who did not sign an informed consent for their child(ren) to participate in the overall HPSF study. This was performed to minimise selection bias, as parents already participating in the overall research project might have had a more positive opinion regarding HPSF, possibly resulting in an incomplete representation of the situation. In accordance with the Medical Research Human Subjects Act, parents who did not yet give permission for participation in the overall research project were asked to fill in an informed consent before participating in an interview.

The Healthy Primary School of the Future

HPSF is an innovative whole-school approach to health. Aim of the project was to improve children's health, lifestyle, and overall well-being through an innovative school day [10]. Implementation of HPSF started in the fall of 2015 in various primary schools in Parkstad, a region in the southern part of the Netherlands. This region is characterised by a low social economic status (SES) and substantially higher obesity rates than the national average [14,15]. Parents were actively involved in the development of HPSF, and a parental vote took place in all participating schools prior to implementation of HPSF.

Four control schools and four intervention schools (two full HPSFs and two partial HPSFs) were enrolled in the HPSF research project [10]. The two full HPSFs implemented changes in both nutrition and PA by offering a free healthy school lunch each day, combined with daily structured PA and cultural activities of at least 60 minutes during the prolonged lunch break [10]. This prolonged lunch break was realised through extending the regular school hours with on average 30 minutes. All changes were supervised by pedagogical staff. All intervention components were child oriented, and there were no components targeting parents. Parents were informed regularly about the intervention at school through newsletters and occasional information sessions. In addition, they were asked to volunteer during the various activities at school. A detailed description of study design, intervention, and recruitment is described elsewhere [10].

Participants

Interview participants were recruited between November 2018 and February 2019 among parents/caregivers of children who were enrolled in one of the two full HPSFs (n = 677 children; corresponding to ± 509 families). Parents/caregivers were excluded from participation if they themselves or their partner worked as a teacher or pedagogical staff member at one of the full HPSFs.

Participants were recruited using an advertisement in the school's (digital) newspaper and through active recruitment by researchers in the schoolyard after school hours and during two school events. Parents/caregivers were asked to participate in an interview to give their opinion about HPSF. The underlying research question (i.e., investigating any HPSF-related processes of change in the home environment) was not explained during recruitment. After initial recruitment, two different sampling strategies were applied. First, convenience sampling was applied, where participants were selected on the basis of their availability and willingness to participate, resulting in the inclusion of 18 participants. Second, extreme case sampling was applied to increase heterogeneity and to reach data saturation. Through this method, ten additional participants were included (Figure 1). Extreme cases were those parents/caregivers with an extreme or divergent opinion regarding HPSF, both positive and negative. To select extreme cases among the actively recruited parents/caregivers, school project leaders served as an important information source as they had a good overview of all extreme cases within their school.

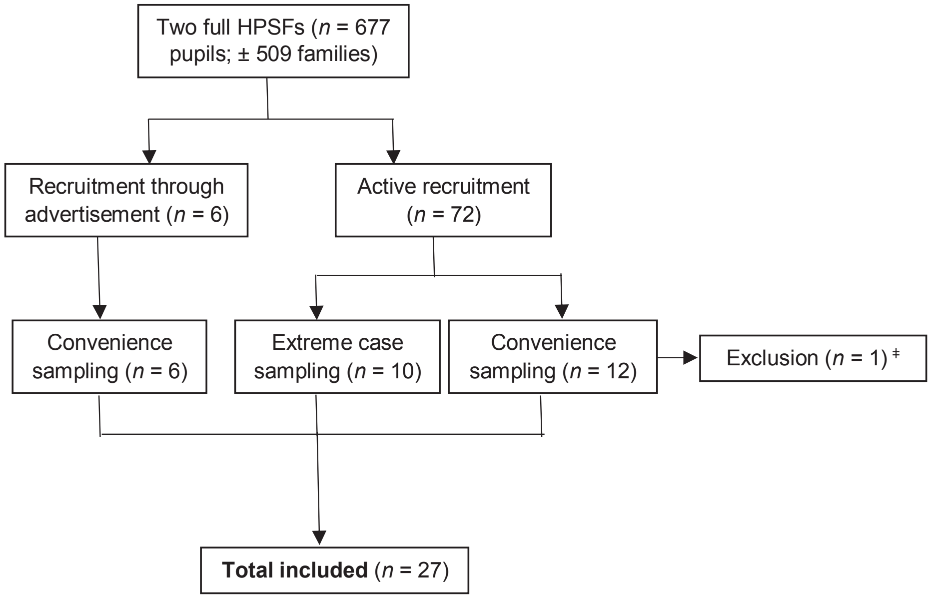

Figure 1. Flow chart of participant recruitment.

ǂ Excluded because the participant was a pedagogical staff member at one of the full HPSFs.

Abbreviations: HPSFs, Healthy Primary Schools of the Future.

Interviews

Three researchers involved in the HPSF research project (R.v.G., male; C.d.G., female; and C.S., female) carried out the interviews using a semi-structured interview guide (Supplementary File S1). This interview guide was developed in consultation with various stakeholders (e.g., parents, teachers, and pedagogical staff members). Using their observations and experiences with HPSF, various important themes (e.g., HPSF appreciation, influences on PA, and dietary behaviours) were identified and incorporated in the guide, which was subsequently pilot tested on parents among university staff. Open and nonsuggestive questions were used to prevent socially desirable answers and to ensure participants were not steered in a certain direction by question formulation. During the process of data collection, the interview guide was continuously revised and adapted on the basis of temporary analyses. In addition to the interview guide, interviewers used additional questions and follow-ups in response to the issues discussed during the interviews.

In consultation with the participants, a date and place for the interview was selected. Most interviews were conducted at home, although some participants preferred to be interviewed at school or at the university. Before the interview started, the interviewer briefly introduced him-/herself, and participants were verbally encouraged to express their true opinion, both positive and negative. After each interview, the interviewers reflected on the atmosphere and context, which helped to understand the family dynamics during the coding and analysis process.

Data Analysis

As there is little theory available regarding behavioural changes in the home context resulting from school-based interventions, data analysis followed a deductive grounded theory approach [16]. Interviews were recorded using a digital voice recorder and transcribed verbatim. Transcripts were not returned to participants for comments and/or corrections. After transcribing, NVivo 12 software (QSR International Pty Ltd., Doncaster, Australia) was used to structure, analyse, and interpret the interviews. Through thematic analysis, a structured framework of nodes was developed and tested by three researchers (A.D.H.M.J., C.S., and M.W.) using two rich interviews. One researcher (A.D.H.M.J.) systematically coded the remaining interviews by placing corresponding quotes under the different nodes in the framework, revising the framework when necessary. The coding process, which mainly involved open and axial coding, was continuously documented using memos. Ambiguities were discussed with two other researchers (C.S. and M.W.), and annotations were kept regarding socially desirable answers to reflect on the researcher’s objectivity. Answers that were perceived as socially desirable were included but were considered less significant than answers that were perceived as more sincere. The final coding framework consisted of various nodes (e.g., health behaviours in the home context and at school, participants’ opinion regarding HPSF, and factors of influence on health behaviours at home). Data saturation was defined by three pillars: (1) there are enough data to replicate the study, (2) the ability to obtain new data is reached, and (3) further coding is no longer practicable [17]. After coding all interviews, a structured overview of the data was generated [18]. Each node was then individually analysed, and themes were distracted to answer the research question. Interview participants did not provide feedback on the findings.

Results

Background

In total, 28 in-depth interviews involving 32 parents/caregivers were conducted between December 2018 and March 2019 before data saturation was reached. One interview was excluded because after the interview it became clear that the participant was a pedagogical staff member at one of the full HPSFs (Figure 1). The average duration of the interviews was 47 min, with a minimum duration of 23 minutes and a maximum of 70 minutes. Of the 27 interviews included, 16 were with parents/caregivers of children from HPSF1, and the remaining 11 involved parents/caregivers of children from HPSF2. Participants were predominantly positive about the HPSF concept. In 21 of the 27 (77.8%) interviews, participants indicated they voted in favour of HPSF implementation at the start of the project or took it into account when choosing a primary school for their children (Table 1). This was in the same order of magnitude as the percentage of the total parental population that voted in favour of HPSF before the implementation started in 2016 (86% in HPSF1 and 91% in HPSF2). Despite the overall positive opinion regarding HPSF, participants were critical about the execution of the project, in particular concerning food waste, communication, and supervision. Participants reported that their children were generally positive about HPSF; they liked the communal lunch and exercising together.

Processes of Change

Participants were not always aware of changes in their own and/or their children's behaviour following the start of HPSF. Most participants reported various behavioural changes in the home setting since the start of HPSF, both healthy and unhealthy. The interviews revealed two main processes behind behavioural changes in the home environment. First, children played a central role in transferring the intervention's content from school to the home environment, influencing the rest of their families. Furthermore, parents were directly influenced by HPSF and subsequently initiated behavioural changes in the home context themselves. In short, HPSF had a direct influence on the behaviour of both children and parents, and children and parents influenced each other's behaviours.

Table 1. Characteristics of interview participants.

Characteristic	***n***	**%**
School	27	
HPSF1	16	59.3
HPSF2	11	40.7
Caregiver interviewed	27	
Mother	20	75.0
Father	2	7.1
Both	4	14.3
Other [a]	1	3.6
Location of the interview	27	
Home	14	51.9
School	12	44.4
University	1	3.7
Voted in favour of HPSF implementation (% yes)	21	77.8
Participation in regular HPSF measurements (% yes)	21	77.8
Familiarity with traditional primary school system (% yes) [b]	21	77.8
Number of children in the family	27	
One	2	7.4
Two	20	74.1
Three	4	14.8
Four	1	3.7
Sex children [c]	48	
Male	22	45.8
Female	26	54.2
Study group children [c, d]	48	
Lower (1–2)	9	18.8
Middle (3–5)	21	43.8
Higher (6–8)	18	37.5

[a] Grandmother and mother. [b] This could be because their child(ren) were already enrolled in one of the full HPSFs before implementation of HPSF or because their child(ren) were enrolled in another primary school. [c] Interview participants were recruited through these children, who were enrolled in the full HPSFs. [d] In the Dutch primary school structure, children successively follow eight ‘groups’, starting in group one at the age of four years and typically proceeding to secondary school at the age of 11 or 12 years. Internationally, the first two groups are comparable to preschool, and the last six groups are comparable to grades one to six. Abbreviations: HPSF, Healthy Primary School of the Future.

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Children as Change Agents

Children had an influential role in the transfer of HPSF's contents to the home environment. At school, children were exposed to new food products and engaged in different forms of PA. Children reacted to this by initiating both healthy and unhealthy changes in dietary and PA behaviours at home. Many participants reported that their children asked for healthy products that they had come to know in school, recognised them in the supermarket, or asked questions about their family's dietary behaviours, *'Yes, I think, she [daughter] is actually quite aware of it. Because when I grab something that is less healthy, she says: "Mum that is not really healthy". So she is really aware of that. So it is kind of in her system already.'* (HPSF2.10). Children not only introduced new products in the home environment, they also transferred dietary behaviours learned at school to the home setting. Several participants reported that their children tasted new products more easily or learned to drink water as their main source of fluid, *'It was pretty quickly that we noticed it at home when we introduced a new food product. Especially during the evening meal or with new sandwich spreads, that they [the children] were less hesitant, less disgusted, less: "I do not want to taste that". They tasted it and they just ate it. You notice that very quickly.'* (HPSF2.9). On the other hand, children also used the fact that they ate healthily and exercised at school as an excuse to compensate for these behaviours at home. *'…Like, "Mum, we can have some candy because at school we ate healthily the whole day!" You know…'* (HPSF1.6).

The extent to which parents reacted to their children's behavioural changes varied across participants and could lead to healthy and unhealthy changes in the home environment. When children asked for new food items or showed new dietary behaviours, some parents supported this by buying the requested items and serving new products. Often, parents were motivated by their children's enthusiasm and tried the new products as well, *'When we walked through the supermarket for groceries, for the weekend or something, for the week. And then she [daughter] said: "Oh we have those crackers at school too!".... Yeah, so actually our entire family was included. Not just the children, but because they were so enthusiastic and recognised things from what they got at school. If they showed that and I thought… Yes, then we would try that.'* (HPSF1.6). Participants did not report situations in which their children showed healthy behavioural changes which they did not want to facilitate. However, most participants did indicate that it was not always possible to provide healthier products or more opportunities to be physically active, for example due to practical and financial constraints. Some participants mentioned that the price and shelf life of food products played an important role in their consideration to buy new products. If the requested food products had a short shelf life and/or children did not eat them at home causing food waste, participants were less likely to buy these items again. Additionally, one participant said her children asked for blueberries, which she could not afford. Alternatively, she offered her children less expensive fruit items. For PA, logistics were often a limiting factor. One participant mentioned that her daughter would love to join a sports club, but because all sport activities were in the evening and there was only one bus drive at night, she could not let her daughter join, *'She [daughter] would love to join a sport. But it is not possible for me to arrange that, because everything is during the evening, around 6–6:30pm. And yeah, by the time I get home it is 9–9:30pm. So, that is not possible on a school night.'* (HPSF2.10).

Some participants facilitated unhealthy behaviour through allowing their children to eat more snacks, drink soft drinks, or have more screen time at home than before HPSF. Most participants justified this behaviour by stating that it is important to have a balance between healthy and unhealthy behaviours, *'At home she [daughter] likes to drink something like juice. So it is… She can discuss about it like: "I had to drink water all day already, and now you tell me to drink water as well!" Well and then I think, when she is home… It is not that big of… She can have juice.'* (HPSF1.11).

On the other hand, there were also various participants who did not facilitate unhealthy behaviour. They did not answer to their children's wish for unhealthy snacks or screen time, and they sometimes even stimulated healthy behaviour instead, *'When he [son] comes home, and he uses the same excuse if he wants cookies, he says: "But I already ran so much outside today. Can I not just play video games?" So that it even goes in the wrong direction. And then I say "Look, the weather is nice! There is snow; you go get your ski suit!"'* (HPSF1.10).

Parents Initiate Behavioural Change

Next to behaviour changes initiated by children, parents also introduced healthy and/or unhealthy changes in family dietary and PA behaviours.

Because the school employed certain rules surrounding the school lunches and PA activities, parents could adopt these rules and habits more easily at home. Many participants indicated that they felt stimulated to reflect on their dietary and PA behaviours and that they intentionally implemented changes, *'My husband and I talked about it. I thought the mornings were very messy, and they [the children] would eat in front of the television. It just did not feel right. So we talked about it the next morning and now we all eat at the table. Statement made. So now, eh, we have this insight.'* (HPSF1.6). These participants said they were stimulated and even felt supported to introduce new rules or maintain existing rules more strictly, *'I know that I can be indulgent, like: "You* *have to eat a sandwich and it cannot be a sandwich with just butter". But why not? So I actually started thinking about it consciously. Where, for example, before I would say: "Grab a sandwich with chocolate sprinkles". Now they [the children] just have to eat a bare sandwich. That is the same at school.'* (HPSF1.6). Other participants indicated that their children were used to these rules at school, and, therefore, when they would apply them at home, the children seemed to adjust to them more easily, *'Interviewer: "And do they [the children] like it when they learn new things at school, regarding food?" Mother: "Yes very much, I also notice it at home sometimes, when there is something on the table. They say: "I do not like that!" We ask them: "Did you already taste it? First taste it!" And then they say: "Oh I do like it!"'* (HPSF1.3). An important reason for many parents to implement these changes in the home environment was that they wanted to be a role model for their children, *'Interviewer: "Why do you think you started to be more aware of your behaviour or look at it differently?" Mother: "Yeah, also because you want to set an example, also for the children of the healthy primary school of course."'* (HPSF1.3). Some participants mentioned they consciously chose to enrol their child in one of the HPSFs, and they wanted to continue the school's approach to health at home, *'The fact that it was a HPSF was a reason for us to choose this school and then I think you should not give him [son] unlimited access to candy at home. He spends many hours at school and most hours of the day, he is used to this structure. It does not work for our son to switch everything once he gets home. … It is of course nice that everything at school is healthy and it is a small effort to apply that at home as well.'* (HPSF1.2).

There were also some participants who initiated unhealthy behaviours. Most of these participants reported they felt less 'guilty' about their choices regarding diet and PA. They let the fact that their children already ate healthily or exercised at school influence their decisions at home, *'I do take it into account when it comes to them [the children] joining a sports club right now, because normally I think that is really important. My daughter had swimming lessons and I thought my sons would do soccer or something. But right now, I think: "I need to have a break". And I am very honest, at the moment with work and stuff it is very busy. At least they exercise at school. And yeah, indeed I think: "Okay, they did have their exercise today."'* (HPSF1.1).

Other Causes of Change

Not only did the school lunch and PA sessions trigger changes in the home setting, the prolonged school hours also influenced health behaviours at home. Because there was less time between the end of the school day and dinner, children were less likely to snack before the evening meal. One participant reported that her children had dinner earlier with their babysitter, because otherwise, they would start snacking. Contrarily, prolonged school hours resulted in less time for after school activities (e.g., playing with friends or sports activities) and/or tired children, which negatively affected PA behaviours at home for a small number of participants, *'Interviewer: "Is it possible, like you said, with the prolonged school hours, is there time for those after school activities?" Mother: "Yes, there is. [However] We did quit dance classes, because our child was very tired and I do notice the school days are very long. So if I could change one thing, I would say we would shorten school hours."'* (HPSF1.4).

Barriers to Change

Besides the reported healthy and unhealthy changes, many participants also indicated that their dietary and PA behaviours had not changed since the start of HPSF. Important barriers to change were participants' beliefs and habits regarding their dietary and PA behaviours. Participants who did not report major changes since the start of HPSF usually indicated that change was not deemed necessary. They perceived their diets as already healthy and balanced, their children as good eaters and/or were already satisfied with the amount of exercise they and their children engaged in. Some participants perceived HPSF as complementary to their already healthy diet at home. A minority of participants indicated that they considered the intervention unnecessary and sometimes even to be meddling, *'No, we did not start eating differently at home or deal with food differently. And it is not really that we have become much more aware of it. I think we were on the right track at home, even when they [the children] were small. So I do not think: "Oh, now I have suddenly seen the light" because things are different at school or something.'* (HPSF1.16).

Several participants noted the difficulty to change their current habits, even when they were aware of their behaviours and the things they wanted to change, *'I think that you kind of have a pattern. And those patterns are hard to break. We did adjust our habits slightly because of our family situation and by doing certain little things and not doing other little things.'* (HPSF2.11). Furthermore, even if children changed their behaviour at school, it did not always automatically lead to a change at home, *'Tasting new foods, yes, they [the children] do that at school of course, but that does not mean that it is easier at home, though. At home, they are just normal children who say: "I do not like the vegetables in the macaroni." I cannot really say that that has changed a lot because they have to taste at school. Because what is at school is at school. And at home is still just at home.'* (HPSF1.16).

As mentioned before, other barriers to change in dietary and PA behaviours at home were time management, logistics, and financial capability. Many parents worked during the day, children came home late from school, and in the evening, various sports and other activities were planned. Evening meals often had to be prepared quickly, and there was limited time for exercise, *'Look, if we both work and my sister has to pick up the children from school. Yeah, then it is often an easy meal, 20 minutes and it is ready to be served.'* (HPSF2.6). In addition, a few parents reported that the lack of information provision regarding HPSF's contents at school sometimes made it difficult to implement the same changes at home, *'With the PA activities, yeah what I miss is that I do not know between which activities they [the children] can choose at school. That would be a suggestion to also share that, because then you can also initiate that conversation at home. Like for example: "Good that you always do crafts, but maybe it would also be nice to play dodgeball sometimes". Or, "What do you find exciting about it?" That you can guide them a bit in that as well.'* (HPSF1.6).

Spectrum of Behavioural Change

The interviews displayed a wide spectrum in the extent to which changes in dietary and PA behaviours at school were transferred to the home context. Participants who were already satisfied with their family's dietary and PA behaviours prior to the implementation of HPSF generally reported less change in the home setting since the start of the intervention. Other participants reported that they had become aware of their behaviour and subsequently implemented changes at home. In addition, the extent to which changes were implemented differed for dietary and PA behaviours. In general, changes in dietary behaviours were most often mentioned and discussed in more detail by participants than changes in PA behaviours. In addition, participants often reported healthy changes in dietary behaviours whilst they did not change or even mentioned unhealthy changes related to PA, and vice versa. This resulted in a spectrum of stages in behavioural changes that was not only observed between families but also within a family. When healthy changes occurred, participants most often reported that the child initiated these changes, for example, through asking for specific food products or wanting to join a specific sports club, *'At a certain moment he [son] mentioned basketball. I asked him: "Where did you come to know basketball?" and he said: "Yeah I did that at school". So regarding that, he sees multiple sports.'* (HPSF1.7). In Figure 2, an overview of the main processes of behavioural change in the home environment following introduction of HPSF at school is presented.

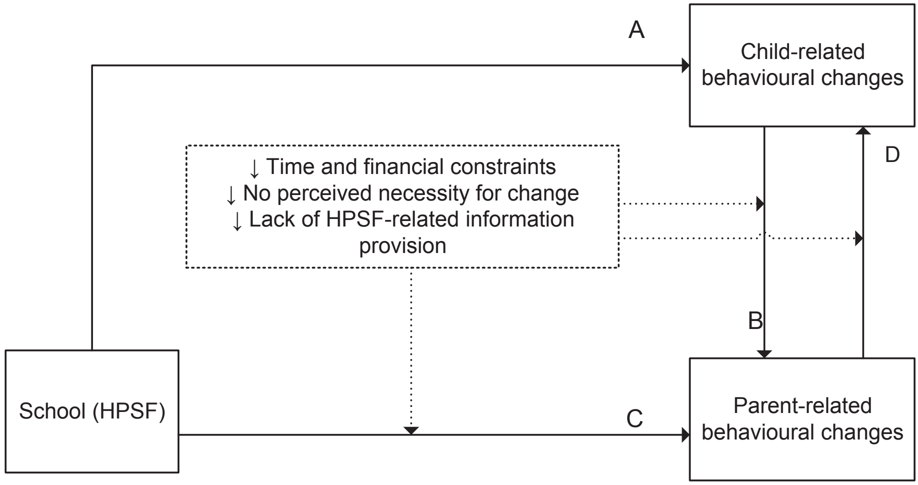

Figure 2. Schematic representation of the main processes behind behavioural change in the home environment.

A. HPSF leads to behavioural changes in children through exposure to new food products and new forms of physical activity at school. Children react to this by, e.g., wanting the same healthy food products at home (healthy change) or by asking for snacks or more screen time (unhealthy change). B. Parents react to their children's behavioural changes by, e.g., facilitating their children's healthy dietary wishes and becoming enthusiastic about the new products as well (healthy changes) or by allowing their children to eat more snacks or have more screen time (unhealthy changes). C. HPSF directly leads to behavioural changes in parents. Parents feel stimulated to reflect on their dietary and PA behaviours, and they feel supported to introduce new rules or maintain existing rules more strictly. Additionally, many parents want to be a role model for their children, which is an important reason for them to implement healthy changes at home. Contrarily, parents can initiate unhealthy changes at home, as they feel that it is important to have a balance between healthy and unhealthy behaviours. D. Children react to their parents' behavioural changes by e.g., adjusting to newly implemented dietary rules more easily (healthy change). Time and financial constraints, no perceived necessity for change, and lack of HPSF-related information provision can have a negative influence on the extent to which parents initiate behavioural changes at home following introduction of HPSF at school, indicated with the dashed arrows. Abbreviations: HPSF, Healthy Primary School of the Future.

Discussion

To maximise an intervention's effectiveness, the acquired behavioural changes should be continued outside the controlled setting of the intervention. Insight into the processes of this transfer of intervention effects to new settings is therefore vital to improve an intervention's impact. The present study aimed to explore the processes behind changes in dietary and PA behaviours of children and parents in the home context since the start of HPSF. The results illustrate that behavioural changes at home were initiated by both children and parents and led to healthy and unhealthy changes. Children proved to be important change agents in the transfer of HPSF's contents to the home context. Following the intervention at school, children changed their behaviour at home, and parents responded by facilitating this to a greater or lesser extent. These findings expand on previous research suggesting that children can promote healthy dietary behaviours by influencing their parents during food shopping [19]. Parents might be more open for behavioural changes when they are proposed by their children instead of other information sources. This so-called child-to-adult intergenerational learning (IGL) has previously been described as a promising strategy to influence parents' views and behaviours in relation to various topics (e.g., sustainability and the use of modern technology) [20–24]. As the present study illustrated the important role child-to-parent IGL plays in the transfer of health behaviours, this process could be stimulated more extensively in future health-promoting interventions (e.g., through homework assignments or family activities to stimulate parental involvement).

Besides the changes introduced by children, parents were also directly influenced by HPSF. As a result, they brought about change mainly by adjusting the rules regarding dietary and PA behaviours at home. Parents felt stimulated and supported to consciously reflect on their family's behaviour and subsequently adopt new rules or uphold existing ones more strictly. Although HPSF's primary target group was the children and the intervention did not specifically focus on parental involvement, these results suggest that the implemented changes also directly affected parents. However, several parents indicated they found it difficult to identify (un)healthy foods or could not comply with their child's healthy requests because they were not familiar with the specific products that were served at school. In addition, various parents mentioned the lack of information provision regarding the PA activities that were organised at school, which might explain the fact that during the interviews, nutrition-related changes were discussed in more detail than PA-related changes. Better information provision regarding the different intervention components (e.g., the various food products and PA activities provided at school) might increase parental involvement and support, which could lead to an increased impact of HPSF in the home setting. Another way to increase parental involvement could be to organise activities for children and parents together (e.g., cooking workshops), which might also stimulate child-to-parent IGL as previously discussed.

Various parents reported that their children or they themselves engaged in unhealthy behaviours at home because they felt it was being compensated by the healthy changes implemented at school. These observations can be linked to the concept of compensatory health beliefs (the belief that one can compensate the negative effects of unhealthy behaviours with the positive effects of healthy behaviours) that has previously been described in relation to various health behaviours such as dietary intake and PA [7,25–28]. In the present study, no clear pattern in the occurrence of unhealthy behaviours at home could be observed. Rather, these behaviours were present across participants, were initiated by both children and parents, and occurred in relation to dietary as well as PA behaviours. These observations indicate that the implementation of HPSF at school might have led to a new decisional process at home when it comes to PA and dietary behaviours. Offering support and guidance to parents on how to deal with this might aid them in the decision-making process at home.

Besides the two main processes of change that were discussed above, the present study also revealed a broad spectrum of behavioural changes, both between and within families. For instance, many participants reported healthy changes in one domain (e.g., dietary behaviours) whilst they did not change or even mentioned unhealthy changes related to the other domain (e.g., PA). Furthermore, several barriers that limited the transfer of behavioural changes to the home context were observed. Parents who did not report major changes often deemed change unnecessary for their family. They were satisfied with their current behaviour or found it too difficult to change their habits (e.g., due to financial or logistic challenges or a lack of knowledge). These motivational, financial, and practical barriers have previously been described in other research on parental perceptions regarding children's dietary and PA behaviours [29–32]. Globally, three key factors necessary for behavioural change initiated by parents could be identified: (1) awareness of one's behaviour, (2) willingness to change, and (3) ability to change (including e.g., financial and practical abilities and parental food literacy). These three prerequisites for behavioural change have previously been discussed under various names in other behaviour change research (e.g., the behaviour change wheel and the I-Change Model) [33,34].

The differences in the extent of change within and between families can be linked to the transtheoretical model (TTM). This model identifies five different stages of behavioural change through which people progress. On the basis of their degree of motivational readiness for change, people move from pre-contemplation (no intention to change) through contemplation, preparation, action, and ultimately maintenance (sustained change and resistance to relapse) [35]. The present study revealed a large variation in the degree of motivational readiness for change across participants. For example, there were participants who did not deem change necessary, which can be linked to being in the pre-contemplation phase. These participants reported little to no behavioural changes in their home context. Other participants mentioned that they had already formed new habits following HPSF implementation, which corresponds to being in the action or maintenance phase. In general, most behavioural changes in the home context were reported by participants who expressed an intention to change and were therefore in the contemplation, preparation, action, or maintenance phase according to the TTM.

The present study's findings seem to contradict the results of a previous quantitative study on HPSF's two-year effectiveness in the home context, where no statistically significant healthy or unhealthy changes in children's dietary and/or PA behaviours were found [13]. However, it is debatable whether subtle behavioural changes can adequately be measured through quantitative instruments alone. Since behavioural change is often hard to identify, comes about slowly, and consists of various aspects, qualitative instruments might be more suitable to disclose all changes that may occur. Furthermore, a combination of quantitative and qualitative instruments is likely to result in a more in-depth picture of the phenomenon under investigation, as in this way, both explorative and explanatory information can be obtained [36–38]. The quantitatively observed four-year effects of HPSF seem to further support this idea [39]. After four years, significant positive intervention effects were observed for several objective outcome measures (e.g., children's BMI z-score and waist circumference), whilst significant effects on quantitative outcome measures collected through self-report questionnaires (e.g., dietary behaviours) remained mostly absent after four years [39]. In the present qualitative study, however, participants reported to have experienced various behavioural changes in the home context, and it appeared that the concepts to measure these changes were addressed differently in the interviews than in the previously used quantitative self-report questionnaires. Due to the complexity of behavioural changes, it is often difficult for people to be aware of the changes that might have occurred. The qualitative nature of the interviews might have facilitated this as opposed to the self-report questionnaires. These observations underpin the value of taking a mixed-methods approach to investigate all potential intervention effects that may occur.

Several strengths and limitations of the present study should be discussed. Most of the qualitative literature on behavioural change focusses on the effectiveness of lifestyle interventions as perceived by participants or discusses the theoretical basis of change.

To the best of our knowledge, this is one of the first qualitative studies examining the process of behavioural change in the home context after the implementation of a school-based lifestyle intervention. The study was executed in a region characterised by a low SES and a high incidence of overweight and obesity, which increased the relevance of investigating ways to maximise HPSF's impact. However, it is not known if and how the intervention would have led to behavioural changes in the home context in other regions (e.g., regions characterised by a higher SES), which calls for the need to perform comparable research in more diverse regions and populations. Another limitation of the present study is that it was impossible to achieve investigator triangulation due to only one researcher coding the data [40]. However, notes were kept to reflect on the researcher's objectivity, the ambiguities during coding were discussed with colleagues, and the interpretation of the data was conducted in close consultation with two other researchers. In addition, the risk of participants having provided socially desirable answers should be mentioned. Some participants only realised changes had occurred in the home setting once they started reflecting in response to the interviewer's questions. Respondents might have engaged in impression management in an effort to cover up their true attitudes and behaviours. The researchers tried to minimise this risk by stressing confidentiality and the fact that participants could not give any wrong answers, and by carefully formulating the questions during the interviews. Another limitation is that HPSF's role with regard to the perceived behavioural changes was not always clear, as other factors (e.g., ageing of children) might have also played a role in the observed changes. Interview participants were not always aware of behavioural changes that had occurred, and they were often not able to identify reasons for these changes. In addition, participants often indicated that behavioural changes, especially with regard to PA behaviours, occurred because their child grew older. Conducting interviews in the control schools could therefore have shed some more light on the degree of correlation between HPSF and the observed behavioural changes.

Recommendations for Future Research

As quantitative data collection instruments might not be suitable to detect all changes that may occur following implementation of health-promoting interventions, future studies investigating the effects of these interventions in various settings should adopt a mixed-methods approach and also include qualitative instruments. Furthermore, more research on the ways to stimulate child-to-parent IGL and improve parental involvement in school-based health-promoting interventions such as HPSF (e.g., through information provision regarding the intervention's contents, organising parent–child activities such as cooking workshops, or providing information on how to deal with the justification of unhealthy compensatory behaviours that might occur at home) could lead to increased intervention effects in the home setting.

Conclusions

The present study is one of the first to provide insight into the processes, facilitators, and barriers of the transfer of behavioural changes acquired at school to the home context. On the basis of the observations presented in this paper, it can be concluded that school-based lifestyle interventions can lead to both healthy and unhealthy behavioural changes at home by influencing both children and parents. Both child-to-adult intergenerational learning and parent-initiated changes play an important role in the transfer of health behaviours from school to home. Further stimulating these mechanisms (e.g., by increasing parental involvement and support through family cooking workshops, homework assignments, or better information provision regarding the intervention components) can therefore lead to an increased impact of school-based health-promoting interventions' impact in the home setting.

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Supplementary File S1: Interview Guide (translated from Dutch)

Opening

Introduction of the interviewer: Good morning/afternoon, my name is … I am affiliated with the Healthy Primary School of the Future as a research assistant at Maastricht University. I will conduct this interview with you.

General points before the start of the interview:

- First of all, thank you for participating in this interview.
- A quiet environment ensures I can conduct this interview optimally.
- It would be preferred if we can both switch of our phones, so that we will not be interrupted.
- I would like to know about your experiences with the Healthy Primary School of the Future. Please be honest about your experiences. I am interested in positive as well as negative experiences. There are no right or wrong answers. We also like to hear negative points.
- Is it okay if I record this interview?
- Some questions are very personal. You do not have to answer them if you are not comfortable answering them.
- Everything you say during this interview will remain anonymous and confidential. Your name or your children’s names will never be linked to this interview.
- What does your family situation look like? How many children attend the HPSF and are they participating in the research?

Introduction of HPSF

- What was your opinion about HPSF when it was introduced?
- A parental vote regarding the implementation of HPSF took place at your child’s primary school. Can you still remember what your vote was and why?
- What were your children’s opinions regarding HPSF when it was introduced?
- Did you take your children’s opinions in consideration when voting?

Current situation

- What information did/do you receive about HPSF?
- Are you actively involved in HPSF? E.g., helping during the lunches, participating in parent feedback groups etc.
- How important is a healthy lifestyle for you and your family?
- What is your current opinion regarding HPSF? Did your opinion change over time?
- What are your children’s current opinions regarding HPSF?

- Do your children talk about HPSF at home? Do they talk predominately about the positive or negative aspects of HPSF? Was there a change in the last few years in the way your children talk about HPSF?
- What are in your opinion positive aspects of HPSF and why?
- What are in your opinion negative aspects of HPSF and why?
- Do you notice an effect of HPSF on your children, yourself and/or the rest of the family (in general)?

Dietary behaviour

- Does HPSF have an influence on your family's dietary behaviour? If so, in what way (both positively and negatively)?
- What do your children tell you about the food/lunches at school?
- Did the dietary behaviour of your children change since the start of HPSF, both at school and in the home environment?
    - Ask specifically about breakfast, lunch, dinner, snacks, and drinks.
- Do your children eat or drink different products since the start of HPSF? Who introduced these new products?
- Did the dietary behaviour of the rest of the family (siblings/parents/grandparents) change since the start of HPSF?
    - Ask specifically about breakfast, lunch, dinner, snacks, and drinks.
    - Do siblings affect each other's dietary behaviour? Both positively and/or negatively.
- How do you lunch during the weekend (since the children lunch 4-5 days a week at school)?
- Do you see unhealthy/compensatory behaviours, e.g., more snacks or soft drinks at home?
    - Who initiates this behaviour? Do the children ask for more snacks or do the parents initiate the unhealthy/compensatory behaviours?
- Did your opinion about nutrition/food/drinks/diet change since the start of HPSF?
- Are there any dietary restrictions in your family? E.g., allergies, religious restrictions, medical restrictions.

Physical activity

- Does HPSF have an influence on your family's physical activity behaviour? If so, in what way (both positively and negatively)?
- Is there a change in your children's physical activity behaviour since the start of HPSF?
- Is there a change in the physical activity behaviour of the rest of the family (siblings/parents/grandparents) since the start of HPSF?
- Did your opinion about physical activity change since the start of HPSF?

Other effects

- Do you notice an effect of HPSF on the overall well-being of your children?
- Do you notice other effects of HPSF on your children, yourself and/or your family?
- What is your opinion about screen time (e.g., TV, computer games, tablets etc.)?
- Are there any changes in dietary and/or physical activity behaviours you would like to see in your family, your children and/or yourself?
- What do you think about any possible long-term effects of HPSF, for example in 3-4 years, or when your children go to high school?

Concluding

- Do you have tips for other schools wanting to implement HPSF?
- Do you have tips to increase the effects of HPSF?
- Did we miss any topics you wanted to discuss?

CHAPTER 7

Challenges in Evaluating Implementation and Effectiveness in Real-World Settings: Evaluation Proposal for School-Based Health-Promoting Intervention

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Challenges in Evaluating Implementation and Effectiveness in Real-World Settings:
Evaluation Proposal for School-Based Health-Promoting Intervention.

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Abstract

There are various research designs and approaches to investigate how health-promoting activities are implemented in complex, real-world systems, and to identify potential health effects that might occur following implementation. Although literature describes guidelines to perform and report about implementation research and effect evaluations, no specific guidelines exist on analysing and reporting about the combination of effectiveness data and implementation data collected as part of intervention evaluation in complex and diverse settings. This paper describes the evaluation of primary school-based health-promoting activities in complex systems. Furthermore, an approach for data categorisation inspired by Rogers' Diffusion of Innovations theory is presented that can facilitate structuring the study's results and relating the degree of implementation to any impact on effectiveness outcomes that might be observed. Researchers interested in using this approach for data categorisation have to ensure that the following three conditions are met: (1) data on an intervention's efficacy in a controlled setting with optimal implementation is available, (2) key points that define an intervention's optimal implementation are available, and (3) an evaluation study is performed, collecting both effectiveness data and implementation data in a real-world context. This data categorisation approach can be useful to generate more insight into an intervention's effectiveness under varying circumstances, and optimal support and advice can be provided to stakeholders to achieve maximum impact of population-based health-promoting interventions in complex, real-world systems. However, the proposed approach is a first suggestion and further testing and adaptation is necessary to increase its usefulness. Knowledge and experience sharing among researchers performing comparable research can increase the knowledge base regarding this subject.

Background

For many decades, explanatory trials have generated an evidence base on the efficacy of numerous health-promoting interventions under controlled circumstances [1–3]. However, interventions' effectiveness in less controlled, complex, real-world systems often differs from their efficacy demonstrated in explanatory trials due to context- and implementation-related differences. Generating more knowledge on interventions' effectiveness in complex systems is therefore essential for successful dissemination. Health-promoting interventions are often implemented in complex systems consisting of multiple interacting components and characterised by adaptivity, non-linearity, feedback loops, and the difficulty to control or predict outcomes [4–6]. The complex-systems approach, which takes into account these characteristics, has been receiving increasing attention in the field of public health, with various researchers describing approaches and frameworks for the evaluation of interventions in complex systems [6–9]. Although taking a complex-systems approach [6] is one of the best ways to evaluate an intervention in a complex, real-world system, some of its characteristics (e.g., non-linearity) are not compatible with effectiveness and/or implementation evaluation. Furthermore, a complex-systems approach is a difficult and demanding approach, which is not always feasible to adopt. There is not always sufficient time, money, and/or resources to investigate a specific system in the amount of detail that a complex-systems approach calls for. Various researchers have proposed different research designs and approaches to shed more light on the evaluation of an intervention in a real-world context. Schwartz and Lellouch described pragmatic trials, of which the primary aim is to determine an intervention's effect under usual conditions rather than under ideal circumstances [10–12]. There are several pragmatic trials evaluating the effects of health-promoting interventions in real-world settings, but the description of results is often limited to their impact on health outcomes and little implementation-related information is presented [13,14]. Effectiveness–implementation hybrid research designs combine elements from effectiveness and implementation research and therefore allow for the linking of outcomes from effectiveness studies to general implementation strategies and/or factors [15]. Curran et al. previously proposed three types of hybrid approaches: (1) testing intervention effects while gathering implementation-related information; (2) dual testing of an intervention's effects and implementation strategies; and (3) testing an implementation strategy while gathering information regarding an intervention's effects on relevant outcomes [15]. Realist investigation is another often-described approach to evaluate an intervention's implementation and impact in complex settings. Using this approach, researchers aim to investigate what works for whom in which circumstances, instead of 'simply' investigating if a certain approach works [16]. Case studies are often mentioned as a suitable research design to answer realist investigations' research questions and to investigate an intervention's implementation and impact in complex and diverse settings, as they provide the opportunity to explore variance between different cases and to explain the circumstances under which certain outcomes are achieved [17,18].

In this paper, we describe a multiple-case study evaluating various primary school-based health-promoting activities in complex, real-world systems and we reflect on various choices that have been made so far in this project. To inform and support other researchers and stakeholders in this field, we illustrate an approach for evaluating the implementation and effectiveness of interventions in complex, real-world systems and relating these findings to the results of previously executed explanatory trials on the efficacy of these interventions. Although we recognise the importance and value of the various principles of the complex-systems approach, we propose a simplified approach that can be of use in practice, when taking a complex-systems approach is not always feasible.

Research Example: The Healthy Primary School of the Future

The research that we will discuss as an example throughout this paper comprises the Healthy Primary School of the Future (HPSF), a school-based health-promoting intervention that was evaluated using a quasi-experimental design involving eight Dutch primary schools (four intervention schools and four control schools) [19]. For four years, HPSF's efficacy on various outcomes was investigated, revealing significant positive intervention effects on outcomes such as children's body mass index z-score and dietary and physical activity (PA) behaviours [20–22]. Following HPSF's efficacy, the ambition rose to spread its principles to other schools. However, this 'scaling-up' of the activity comes with several challenges. Schools can be defined as complex and unique systems that consist of various interacting components (e.g., teachers, children, parents, the school environment, and the wider community) and have the ability to self-organise and adapt over time [23–25]. Applying the complex-systems approach to school-based health promotion means acknowledging that what works in certain schools might not work in other schools. This underpins the importance of taking a school's context, population, wishes, and needs into account when developing, implementing, and evaluating health-promoting activities, as evidence suggests a strong interaction between an intervention and the context in which it is being implemented [23–27]. To generate knowledge on how HPSF-related activities are implemented in various real-world school contexts, to identify influential factors, and to investigate the effectiveness on children's health and well-being, a follow-up research project of HPSF was initiated. In this project, 11 Dutch primary schools are followed between 2019 and 2023. The ambition at the start of the project was that all participating schools would eventually become full HPSFs. However, schools are free to decide whether, when, and to what degree they implement health-promoting activities in their setting, making the implementation process less controlled than in the HPSF efficacy trial, in which intervention schools implemented a pre-defined intervention. Schools are responsible for their own development and implementation process, but they are aided by a process coordinator who works independently of the research team and supports each school during the project. Researchers play an observing role and have limited influence on the implementation processes in the various schools. This approach stimulates bottom-up development and implementation of pragmatic and school-specific activities, which is hypothesised to facilitate sustainable integration of health within the schools.

The project's real-world nature provides several challenges when it comes to choosing a suitable research design that can account for the complexity of the setting. All schools are working on integrating health within their organisation, meaning that no control group is included in the project. Furthermore, instead of a pre-defined, standardised intervention, there is great variety in activities implemented in the schools, making often-utilised implementation outcomes such as fidelity (the degree to which an intervention is delivered as intended) less relevant in the present study. Rather, there is more emphasis on the actual implementation (what is implemented in the various schools?) and the reasons behind this implementation (why is implementation (not) successful?). Compared with the HPSF efficacy trial, which was mainly explanatory, the follow-up research project is therefore more pragmatic in nature and resembles a realist evaluation [10–12,28]. The aim of this research is to investigate the implementation of HPSF-related activities under complex, real-world circumstances and to explore the potential influence of differences in implementation on HPSF's effectiveness on various health outcomes. The lessons learned from this research can then be used to disseminate HPSF's principles to other schools. The schools' pre-existing contexts and the 'natural' implementation process of HPSF-related activities in a real-world context are investigated by observing relevant meetings with stakeholders (e.g., directors, managers, and teachers), gathering data through questionnaires, and performing semi-structured interviews with various stakeholders (directors, managers, and teachers). Besides data on actual implementation (what is implemented in the various schools?), information on reasons behind this implementation and potential implementation differences between schools (why is implementation in school A successful and why is implementation not successful in school B?) is gathered through these sources.

All implementation data are structured using the characteristics from the framework by Fleuren, Wiefferink, and Paulussen (characteristics of the socio-political context, organisation, person, innovation, and innovation strategy) [29]. For example, if one school is successful in implementing an extensive activity (e.g., the provision of a daily healthy school lunch) and interview participants from this school mention the positive influence of working on this implementation with the complete team, whilst another school is not successful in implementing a daily school lunch as the activity is only carried by the school director, these differences in implementation can (partly) be explained by differences in characteristics of the innovation strategy. Besides data on the implementation process, the same data on children's anthropometrics, dietary and PA behaviours, and well-being are gathered as in the HPSF efficacy trial to compare the impact on these outcomes in both settings. This will provide an estimate of the effectiveness of HPSF-related activities under real-world conditions compared with their efficacy following maximum implementation under controlled circumstances.

Challenges in Data Categorisation, Analysis, and Reporting

Although literature describes various guidelines to perform and report about implementation research and effect evaluations, no specific guidelines or practical approaches exist on how to analyse and report about the combination of effectiveness data and implementation data collected in real-world and complex settings [5,30]. To deal with this and to explore if differences in implementation lead to differences in HPSF's impact on children's health and well-being, a novel approach for data categorisation, analysis, and reporting is proposed. This approach is inspired by Rogers' Diffusion of Innovations theory, which states that a population can be divided into five adopter categories (innovators, early adopters, early majority, late majority, and laggards) on the basis of their degree of innovativeness regarding an introduced innovation. Subjects with a high degree of innovativeness (e.g., innovators or early adopters) will adopt an introduced innovation faster than those with a lower degree of innovativeness (e.g., late majority or laggards) [31]. In the present project, schools are not introduced to a standardised innovation. Rather, they have a shared ambition (integrating health within their organisation and—if realistic—becoming full HPSFs) and consequently shape activities fitting their context throughout the project. These activities can be composed of different components with varying intensity (e.g., changes in a school's policy, practices, and/or communication strategies) that evolve over time. To be able to compare participating schools with each other and with the efficacy trial's full HPSFs, they will be divided over Rogers' adopter categories on the basis of their degree of innovativeness. This degree of innovativeness is operationalised through the number of HPSF key points that schools adhere to three years after the start of the project. A period of three years was chosen as during the HPSF efficacy trial, it was observed that it took several years before project-specific plans and ambitions were formulated and implementation started. Additionally, the COVID-19 pandemic greatly restricted schools' ability to work on the present project, thereby delaying project development and implementation. Four HPSF key points defining optimal implementation of HPSF were formulated by stakeholders involved in the efficacy trial to facilitate further dissemination of HPSF. For optimal implementation, various stakeholders (e.g., school staff, children, and parents) should be actively involved (key point 1) and a school-wide approach should be taken, meaning that implemented activities should reach all children within a school (key point 2). In the HPSF efficacy trial, these two key points were perceived as vital to achieve successful implementation of HPSF. Furthermore, optimal implementation of HPSF means that children engage in at least one hour of PA every day (key point 3) and consume a daily healthy lunch at school (key point 4). For a detailed description of the HPSF key points, see Supplementary File 1. If a school participating in the present research project adheres to all four HPSF key points at the end of data collection (i.e., the school can be considered a full HPSF), this is defined as having the highest degree of innovativeness and the school will be categorised in the innovators/early adopters category (these two adopter categories are combined for clarity reasons). Alternatively, schools who do not adhere to any key points at the end of data collection will have the lowest degree of innovativeness and consequently fall in the laggards category. A further specification of the categorisation of schools on the basis of the HPSF key points can be found in Table 1.

Although the term degree of innovativeness might imply that we assume that differences in actual implementation between the various schools are simply the result of differences in degree of innovativeness, we acknowledge these differences can be caused by various factors that are much more diverse than differences in degree of innovativeness only. The term degree of innovativeness is solely used for clarity reasons and should not be used to explain implementation differences as it disregards the diversity and complexity of various real-world settings. Instead, the implementation processes of HPSF in the various schools are continuously investigated through various methods (e.g., observing relevant meetings with stakeholders, gathering data through questionnaires, and performing semi-structured interviews with various stakeholders) to obtain a more extensive impression of (reasons behind) implementation differences between the various schools, although this goes beyond the scope of the present paper and will therefore not be further discussed here. The described approach for categorisation will ease comparison between the various schools participating in the present study as it provides a potential framework to structure the study's results. When analysing and reporting about the study's implementation and/or impact on health outcomes, the data and an article's results section can be structured using the different adopter categories instead of the more traditional intervention and control group which are often used to describe an explanatory trial's results. The approach however is solely a first suggestion and further refinements and improvements are strongly advised to increase its usefulness and validity. For example, the categorisation of the schools in the different adopter categories is rather imprecise when using dichotomised key points as proposed in this paper (i.e., categorising schools on the basis of whether or not they adhere to the various key points). This limits the sensitivity with which the implementation degree of the activities can be related to any impact on children's health and well-being that might be observed, as not all differences in schools' implementation degrees will be captured and acknowledged using this approach. Rather than simply observing if schools do or do not adhere to the key points at the end of data collection, the key points could be addressed in a more continuous matter to obtain a more sensitive degree of implementation. For example, a school providing a healthy school lunch on a daily basis could be assigned a higher implementation degree than a school providing a healthy school lunch three times a week. By acknowledging these more subtle differences, the refined approach would provide a more nuanced and sensitive degree of implementation for the various schools, which can subsequently be linked to any impact on health outcomes that might be observed. Following this approach could make it possible to provide more general recommendations regarding HPSF implementation in complex systems. The intervention effects observed in the previously executed HPSF efficacy trial are assumed maximal due to the controlled conditions under which the complete intervention was implemented. By using the refined categorisation approach and comparing the results from the efficacy trial with the observations in various real-world settings, it would be possible to identify certain elements of HPSF that lead to more health-related impact than others do, and to recognise general implementation factors and/or strategies that would facilitate the implementation of these elements in various settings.

Besides the limitations related to the current impreciseness of data categorisation, it should be noted that categorisation with this approach happens at one moment in time, and categorisation at a different moment could therefore lead to different results. This is in line with the continuously changing complex and real-world conditions and settings in which the research is executed. Implementation is thought to be a continuous process that is never finished and to the best of our knowledge, there is currently no model or categorisation approach available that accounts for the continuously shifting degree of implementation over time.

Table 1. Specification of school categorisation on the basis of the HPSF key points.

Original efficacy trial (optimal implementation of HPSF)				
	HPSF key points			
	Actively involved stakeholders (e.g., parents, children, school staff)	School-wide approach	Children engage in at least one hour of PA per day	Children consume a daily heal thy lunch
Full HPSFs	X	X	X	X
Follow-up research project (scaled-up, real-world context)				
	HPSF key points			
Adopter categories	Actively involved stakeholders (e.g., parents, children school staff)	School-wide approach	Children engage in at least one hour of PA per day	Children consume a daily healthy lunch
Innovators/early adopters	X	X	X	X
Early majority	X	X	X [a]	X [a]
Late majority	X			
Laggards				

Note. A more elaborate description of the four HPSF key points can be found in Supplementary File 1. Key point 1 and 2 are assumed to be necessary for schools to achieve key point 3 and 4, which is why there is no categorisation for a combination of key point 1 or 2 with key point 3 and/or 4. In the follow-up research project, the categorisation of schools will be done at one moment in time, i.e., three years after the start of the project (at the end of data collection). This means that the categorisation will be based on a snapshot of a longitudinal, ongoing implementation process. Categorisation at a different moment in time could therefore lead to different results. [a] Schools have to adhere to one of these two indicated key points to fall in the early majority category. Abbreviations: HPSF, Healthy Primary School of the Future.

Implications

This novel approach for data categorisation can be useful to other scientists performing comparable research on the implementation and impact of general activities in a complex, real-world system following an efficacy trial with an observed promising impact on relevant outcomes. This research does not have to be limited to health promotion in the school setting but can span a wide range of research areas. The additional benefit of this approach is that an intervention's relative effectiveness on relevant outcomes following a certain degree of implementation can be established when compared with the effects observed in a previously performed efficacy trial. As a result, more insight into what works under which circumstances is generated and optimal support and advice can be provided to stakeholders to achieve maximum impact of population-based health-promoting interventions in complex, real-world systems. It should however be taken into account that categorisation with this approach is done at one specific moment in time, and categorisation at a different moment could lead to different results due to the complexity and adaptivity of the context and the implementation process that will continue to develop. Furthermore, categorisation as proposed in its current, dichotomous form is rather imprecise and further refinement is strongly recommended to increase the approach's usefulness and potential. The approach is not yet empirically tested and elaboration and adaptation are therefore necessary for further improvement and to increase its validity. As previously mentioned by Huiberts et al. [32], researchers sharing their experiences, insights, and approaches regarding evaluating interventions in complex, real-world systems can greatly facilitate the development of adequate and feasible evaluation approaches and should therefore be encouraged. Researchers interested in using the approach for data categorisation proposed in this paper have to ensure that the following three conditions are met: (1) data on an intervention's efficacy in a controlled setting with optimal implementation are available, (2) key points that define an intervention's optimal implementation are available, and (3) an evaluation study is performed, collecting both effectiveness data and implementation data in a real-world setting.

Conclusions

To advance research and to stimulate intervention dissemination and sustainability, it is vital to investigate how (preventive) activities are implemented in complex and real-world systems, and to identify potential health effects that might occur following this implementation. By combining elements from efficacy, effectiveness, and implementation research, outcomes can be related to general implementation strategies and/or factors. The approach for data categorisation described in this paper can be useful to relate an intervention's impact to specific implementation strategies and/or factors and thereby generating more insight into what works under which circumstances. This can subsequently lead to improved support and advice provision to stakeholders aiming to achieve maximum impact of population-based (health-promoting) interventions in complex, real-world systems. We acknowledge that the approach described in this paper describes a simplified version of reality and does not take into account all principles of a systems approach (e.g., non-linearity). Nonetheless, it could be of benefit in implementation science, where taking the complete complex-systems approach is not always feasible. However, further testing, adaptation, and refinement of the approach are necessary to increase its usefulness and validity. Knowledge and experience sharing among researchers working on comparable issues can increase the knowledge base regarding evaluating interventions in complex, real-world systems.

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Supplementary File 1: Healthy Primary School of the Future (HPSF) Key Points

The HPSF key points were formulated following the original HPSF efficacy trial to facilitate further dissemination of HPSF to other schools. In close collaboration with all involved stakeholders, the key points were developed to define optimal implementation of HPSF. In the follow-up research, they are used to sort the participating schools in the various adopter categories from Rogers' Diffusion of Innovations theory (1) to ease comparison between schools and with the full HPSFs from the efficacy trial. Three years after the start of the follow-up research, collected implementation data (observational data from e.g., relevant meetings, and interview and questionnaire data from various stakeholders (directors, managers, and teachers)) will be used to see to how many key points the participating schools adhere at that moment in time.

1. All stakeholders (parents, children, and school staff) are actively involved from the start of the project.
There is room for the wishes, needs, and ideas of all parties; stakeholders are actively involved in the development and implementation of HPSF. This involvement can be translated in e.g., the formation and/or involvement of project groups or student councils, and/or parents participating as volunteers during the various initiatives.

2. All HPSF-related steps follow a school-wide approach.
HPSF is a whole-school initiative; health and well-being are addressed in all study years and implemented initiatives reach all students within a school.

3. Children engage in at least one hour of physical activity each school day.
This physical activity can entail energisers, outdoor lessons, physical education lessons, and/or activities during lunch break time. All activities are guided by teachers, pedagogical employees, volunteers, and/or members from local sports clubs, who are supervised by physical activity experts from e.g., the municipality.

4. Every school day, children consume a healthy lunch.
On 3-5 school days per week, the school is responsible for the provision of a healthy lunch, potentially with the aid of a caterer. At least 80% of the products that are provided during the lunch meet the guidelines of the Dutch Health Council (2). If applicable, parents are given the opportunity to provide a healthy lunch for their child(ren) on the other 1-2 days. For this purpose, the school implements a food policy with clear guidelines.

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CHAPTER 8

Implementing Health-Promoting Activities in Diverse Primary School Contexts in the Netherlands: Practical Lessons Learnt

Hahnraths MTH, Willeboordse M, van Schayck CP. Implementing Health-Promoting Activities in Diverse Primary School Contexts in the Netherlands: Practical Lessons Learnt.

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Abstract

Purpose: To gain insight into factors enhancing or obstructing implementation in various school-settings, which is vital for widespread dissemination and sustainable integration of school-based health-promoting interventions.

Methodology: A mixed methods multisite comparative case study to investigate (factors influencing) the implementation of health-promoting activities in 12 Dutch primary schools. Data were collected during three school years (2019–2022) through observations, questionnaires, and interviews.

Findings: The project resulted in the implementation of small, incidental activities. Important reasons for the limited implementation were lack of commitment and bottom-up involvement. School directors and teachers were not involved early on in the project, which limited project support and commitment. On school level, directors largely carried project responsibility themselves, hindering project sustainability and integration. COVID-19 made that schools had difficulties forming long-term visions and plans. Other observed barriers included limited perceived necessity to change, high workload, and high staff turnover. Important facilitators were the presence of a process coordinator and sharing experiences from other schools.

Originality: This research provided valuable insights into (factors influencing) the implementation of health-promoting initiatives in diverse, real-world school contexts. More extensive support is needed to create commitment, bottom-up involvement, and a project vision. Furthermore, empowering in-school champions and/or school-wide project groups is desirable to decrease schools' dependence on long-term external support. The findings can be used by various stakeholders throughout development, adoption, and implementation and can facilitate widespread dissemination and sustainable integration of school-based health-promoting interventions.

Introduction

Schools have been identified as key environments for promoting healthy lifestyle behaviours [1,2], and over the years, many school-based health-promoting interventions have been implemented and found to effectively improve health outcomes (e.g., body mass index (BMI) and dietary and physical activity (PA) behaviours) [3–7]. Despite their effectiveness, long-term implementation and/or wide dissemination of these interventions is often not achieved [8]. This is partly due to a great diversity in school contexts. When implementing school-based health-promoting interventions, there is no "one size fits all" approach [8,9]. Schools can be defined as complex systems with a unique context and dynamics influenced by various interacting elements from within and beyond the school-setting [8–10]. Health-promoting activities that work in one school might therefore not work in another school. In addition, although there are many studies investigating school-based health-promoting interventions' effects [5,6,11], less research is available on factors influencing implementation, especially in a real-world setting [12,13]. This research gap contributes to a lack of hands-on, practical advice that can be used by schools and other stakeholders interested in implementing school-based health-promoting activities in their context. Gaining insight into factors enhancing or obstructing implementation can explain why an intervention does or does not work in a specific setting and is therefore vital to sustainably integrate health in more schools.

The 'Healthy Primary School of the Future' (HPSF) is a previously implemented and evaluated Dutch primary school-based intervention. In two intervention schools, two changes were initiated: (1) daily provision of a free healthy school lunch, and (2) daily structured PA sessions after lunch [14,15]. Effect evaluations showed significant positive intervention effects on various health outcomes (e.g., BMI z-score and dietary behaviours) [16–18]. Following these positive effects, other Dutch primary schools expressed their interest in implementing HPSF-related activities, which created the opportunity to 'scale-up' HPSF. Scale-up is 'the process by which health-promoting interventions shown to be efficacious on a small scale and/or under controlled conditions are expanded under real-world conditions into broader policy or practice' [19]. In HPSF's case, this scaling-up meant working with a significantly lower budget than during the HPSF trial and dealing with various schools with complex and unique contexts [8]. To evaluate the implementation and effectiveness of the HPSF initiative in a scaled-up, real-world setting, the present research project was initiated. Twelve Dutch primary schools aiming to sustainably implement HPSF-related activities participated in this project. To reflect the real-world situation, participating schools were mainly responsible for the selection and implementation of activities in their own context, in contrast to the schools participating in the HPSF trial that were subjected to a pre-defined intervention [14]. This approach stimulated schools to implement health-promoting activities fitting their context, resulting in the implementation of pragmatic, real-world, and school-specific activities.

The present study aimed to generate knowledge and experience on how health-promoting activities are implemented in complex and diverse school-contexts, and to identify factors influencing this process. This knowledge can subsequently be used to formulate practical advice for schools and other stakeholders involved in the development and implementation of school-based health-promoting activities. Using a mixed methods approach, the present paper aimed to answer the following research questions:

1. How and to what degree are activities promoting physical activity and healthy dietary habits implemented in 12 real-world school settings?
2. Which factors are of influence on the implementation of activities promoting physical activity and healthy dietary habits in 12 real-world school settings?

Materials and Methods

Study Design

This study is part of a research project investigating the scaling-up of the HPSF initiative in various school contexts using a non-randomised, non-controlled, observational study design. The project comprises 12 primary schools that are member of one educational board situated in the southern part of the Netherlands. In the present study, a mixed methods multisite comparative case study design was used to provide insight into project implementation in the various schools and to identify influential factors. Data were collected during three school years (2019–2022).

Setting

The educational board expressed its desire to implement HPSF-related activities in their schools. Their aim was that all schools would eventually implement a daily healthy school lunch and structured PA sessions after lunch, corresponding to the main intervention components allocated during the HPSF trial. However, there were various differences between the setup of the HPSF trial and the present project. In the HPSF trial, schools were subjected to a pre-defined intervention developed by a project team consisting of i.a., researchers, schools, and municipalities. Also, prior to the start of the HPSF trial, there was large commitment for HPSF across various stakeholders (e.g., schools, local sports clubs, and the Municipal Health Services), and extensive funding was provided by provincial authorities to aid implementation [14]. Although provincial authorities also provided funding for the present project, this was considerably less than in the HPSF trial and was mainly meant for research purposes and the appointment of a process coordinator. Furthermore, there was less widespread commitment across stakeholders prior to the project's start, and schools were free to decide whether, when, and to what degree they would implement health-promoting activities instead of having to implement a pre-defined intervention. Activities that schools could implement had to fall in at least one of the following categories, formulated by board members and researchers: (1) healthy and sustainable nutrition, (2) sufficient PA, (3) sufficient rest and relaxation, and (4) social involvement. The schools were mainly responsible for their own implementation process, but they were aided by a process coordinator. The process coordinator organised regular meetings with directors, managers, teachers, and other stakeholders to support implementation and to provide stakeholders with inspiration for possible activities. Researchers played an observing role to gain insight into these processes in a real-world setting.

Data Collection

Using a mixed methods approach, quantitative and qualitative data were simultaneously collected. To identify factors influencing implementation in the various schools, the framework by Fleuren, Wiefferink and Paulussen [20] was used, a framework previously used in dissemination research in the school setting [12,13]. According to the framework, an innovation process is influenced by characteristics of the socio-political context (e.g., existing rules and regulations), the organisation (e.g., staff capacity, available time and resources), the innovation strategy (e.g., coordination and communication), the innovation's user(s) (e.g., beliefs and perceived support), and the innovation itself (e.g., compatibility and complexity) [20]. This framework and the corresponding Measurement Instrument for Determinants of Innovations (MIDI) served as an inspiration during development of the present study's data collection instruments [20,21]. Figure 1 provides an overview of the key outcome domains and components addressed in the present study.

Questionnaires

Two questionnaires were administered yearly between 2019 and 2022: a school scan questionnaire for school directors and a teacher questionnaire.

School scan questionnaire: Directors of the 12 schools annually filled out a digital questionnaire containing several close-ended questions assessing the presence of health-promoting elements within their school. These elements were divided into four themes: routine (e.g., energisers and parental involvement), policy (e.g., rules on snacks, lunch, and sugar-sweetened beverages), education (e.g., amount and duration of physical education (PE) lessons, usage of classroom-based health-promoting programmes), and environment (e.g., presence of a school garden). Additionally, one open-ended question was included to identify other dominating organisational issues (e.g., the merging of two schools) potentially influencing a school's project focus.

Teacher questionnaire: All teachers of the 12 schools (n = 114 at T0) were annually invited to fill out a digital questionnaire containing several open-ended questions to gain insight into their health-related practices (focussed on nutrition, PA, and rest and relaxation). At T1 and T2, 14 additional statements based on the MIDI were included [21]. Statements assessing organisational characteristics (n = 9) included questions regarding staff capacity, available time, financial and material resources, accessibility of project-related information, and the presence of regular feedback moments regarding the project. Two statements assessing innovation characteristics were included to evaluate the project's compatibility with the school context and the observability of effects. Statements concerning personal characteristics (n = 3) assessed perceived professional obligation to work on the project, perceived project satisfaction of parents and children, and perceived support from colleagues and managers to work on the project. Response options for each statement ranged from 1 (totally disagree) to 5 (totally agree).

Interviews

Between 2020 and 2022, semi-structured interviews were conducted by one researcher (MH) with the process coordinator and a purposive sample of staff members from each school until data saturation was achieved. The sample consisted of two childcare managers involved in the project, the directors from all schools, and one teacher from each school. These teachers were selected on the basis of recommendations by school directors, as they were aware of the degree of project involvement of specific teachers. Due to COVID-19, all interviews were conducted online. The semi-structured interview guides were based on the MIDI [21]. The interviews were used to get an in-depth insight into the schools' project operationalisation and any factors (related to the socio-political context, organisation, innovation strategy, adopting person(s), and/or innovation) influencing implementation. All interviews were held in Dutch and were audiotaped and transcribed verbatim.

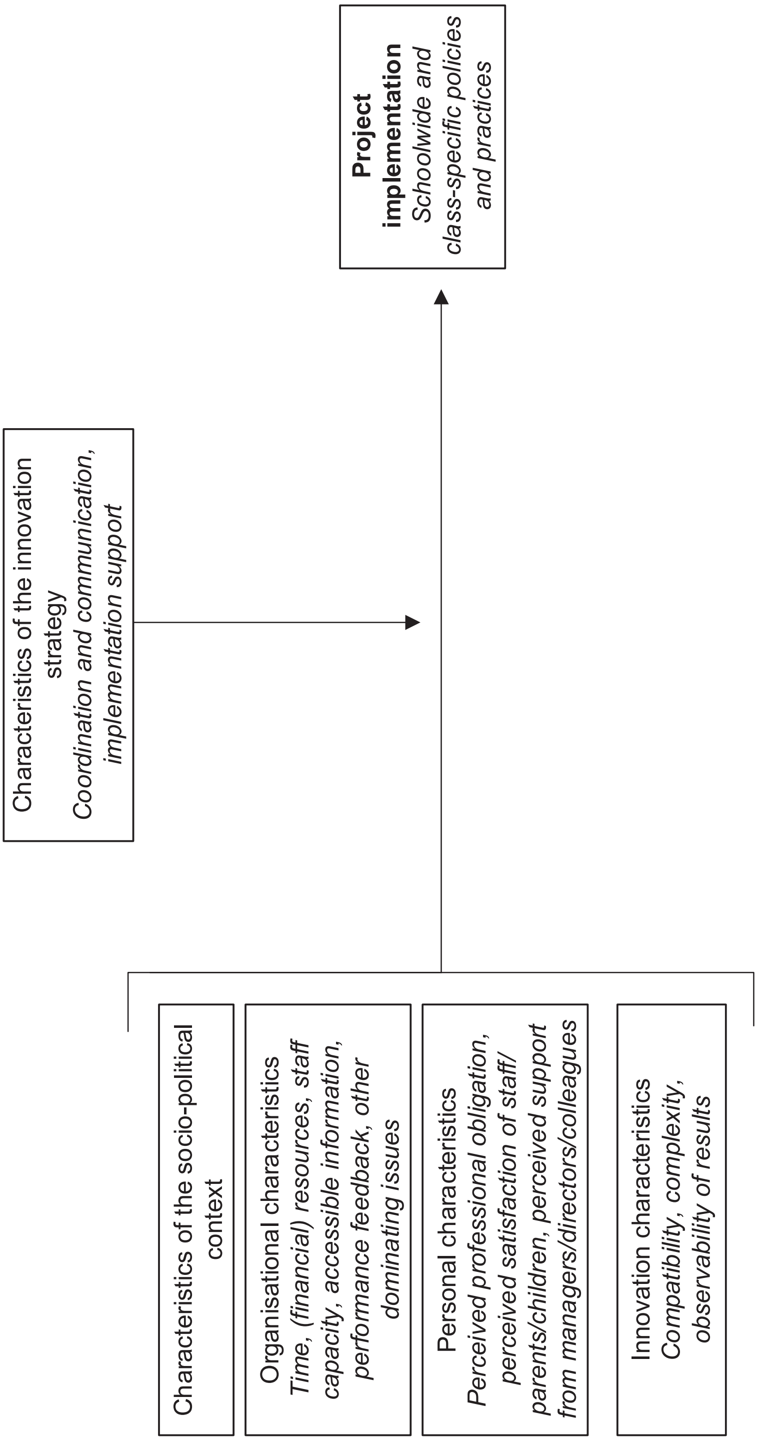

Figure 1. Key outcome domains and components of the present study (adapted from [21]).

Observations and Minutes of Meetings

MH observed and took notes during all project meetings with the educational board, school directors, working groups with parents and/or teachers, and children's voice groups. These meetings and observations were partly on site and partly online due to COVID-19. The observations' aim was to learn about each school's dynamics and implementation, and to see and hear factors influencing these processes. To create an open view, no observational checklist was used.

Analyses

Data from interviews, observations, and minutes were coded and analysed deductively by MH using NVivo (version 12.0) [22]. A second researcher (SJ) independently coded and analysed a sample of 12 interview transcripts. MH and SJ discussed their findings and consensus was easily reached. Coding was guided by the five categories from Fleuren et al.'s framework (socio-political context, organisation, innovation strategy, adopting person(s), and innovation), subcategories were created if necessary [20]. During analysis, categories were reviewed continuously and findings were discussed regularly within the research team. Quantitative questionnaire data were analysed using IBM SPSS Statistics for Windows (version 25, IBM Corp, Armonk, NY, USA). Baseline descriptives from both questionnaires, combined with data from observations and minutes, were used to describe the schools' pre-existing contexts. T1 and T2 questionnaire data were combined with data from interviews, observations, and minutes to describe the schools' implementation processes.

Results

Participants

Between 2020 and 2022, 24 digital interviews were conducted that lasted between 30–60 minutes (see Supplementary Table S1 for participants' characteristics). The school scan questionnaire was filled out by all directors at T0–T2. The teacher questionnaire was filled out by 84 teachers (response rate (RR) = 73.7%) at T0, 79 teachers (RR = 69.9%) at T1, and 63 teachers (RR = 61.8%) at T2.

Pre-Existing Context

All participating schools were member of one educational board and were located in a rural municipality in the southern part of the Netherlands. During the project preparation phase, the educational board's director was replaced by a new director, who mainly focussed on other dominating issues, thereby limiting project development. At T0, this director had recently been replaced by another director who was still director at the end of data collection.

The number of students enrolled in the schools at T0 varied from 31 to 263. At T0, there were seven directors responsible for 12 schools (some directors were responsible for two schools). Two managers were responsible for the various childcare locations within the schools. Two schools were in the process of merging at T0, two other schools were planning to move to different buildings, and a third school was designing a new school building. The T0 school scan questionnaire revealed that all schools had a nutrition policy, although not every school actively managed this policy. Usage of classroom-based health-promoting programmes was limited, and schools using specific programmes mostly worked with nutrition-related programmes. All schools implemented energisers during the day and all classes engaged in at least one PE lesson per week (although these lessons were not always supervised by a qualified PE teacher). All schools had access to a (more or less) active schoolyard, and one school used a school garden during the school day.

In the T0 teacher questionnaire, the majority of teachers reported to already pay attention to nutrition, PA, and/or rest and relaxation in class. These efforts were mainly unstructured; most teachers mentioned paying attention to the subject when it naturally came up during the day (e.g., by discussing students' lunches). Teachers who paid no attention to nutrition, PA, and/or rest and relaxation mentioned time constraints, other (education-related) priorities, and/or no perceived necessity as main reasons for this lack of attention.

Implementation

The educational board's ambition was that all schools would eventually implement a school lunch and structured PA sessions after lunch. However, due to frequent staff turnover in the board, this ambition was not communicated to school directors, managers, and teachers. They received general project information right before the project's start instead of being actively involved during project development. In the first meetings with the process coordinator, various stakeholders therefore felt overwhelmed and were hesitant to implement the school lunch and structured PA sessions. With the process coordinator's help, school-specific plans were formed in late 2019. Most schools wanted to integrate small activities (e.g., the provision of a daily fruit and/or vegetable (FV) item), although some schools had more extensive ambitions (e.g., incorporating cooking lessons in their regular curriculum). Project implementation had just started when the COVID-19 pandemic developed in early 2020. Schools had to deal with forced school closures, high absenteeism, and various health- and safety measures, making it impossible to implement all aspired plans and activities. Parents and other volunteers were not allowed within schools for the majority of project duration, which made it difficult to involve these stakeholders and to ensure enough capacity to implement the various plans. Several schools decided to postpone working on the project, whilst others continued implementing activities taking into account the various limitations. Towards the project's end, COVID-19's impact decreased and schools had more capacity to work on the project. Several schools started preparing 'bigger' plans and activities. Furthermore, the educational board initiated the formation of a 'PA team'. The ambition was that this team would be responsible for the provision of PE-lessons and for all other health-related activities in the schools, thereby taking over the process coordinator's role after external project funding ceased. Efforts to further shape the PA team's role were still ongoing at the end of data collection. Table 1 describes the implemented activities at the end of data collection (three years after the project's start).

Influencing Factors

In the remainder of the Results section, the most apparent influential factors across the categories from Fleuren et al.'s framework [21] are specified.

Characteristics of the Socio-Political Context

Within the socio-political context, national COVID-19-related restrictions influenced project implementation. Schools were repeatedly obliged to close, and after re-opening had to adhere to strict safety regulations (e.g., social distancing). The quickly changing situation often called for ad-hoc decision making, which made it difficult for schools to develop and adhere to a long-term project plan. Furthermore, schools had to deal with high staff absenteeism and parents and volunteers were not allowed to assist during activities in school, which greatly limited schools' capacity to implement activities. The national focus on minimising educational disadvantages following COVID-19 further complicated this matter.

Director 2,7: *'The closure of schools also had an impact. […] There is a different focus now. You now have to investigate which students have an educational disadvantage, how are the children, how did they pull through?" The focus is very much on that instead of on the project.'*

Organisational Characteristics

An important organisational barrier for project implementation was the educational board's lack of project vision. This made it difficult for schools to know what was expected from them and to start developing project plans. The reason for this lack of vision was twofold. First, the educational board was subjected to regular staff turnover at the project's start. These changes made it difficult to develop a long-term project vision. Furthermore, the board perceived it as very important to place project responsibility and ownership within the schools, ensuring that schools could make decisions fitting their context. Communicating a clear project vision whilst protecting schools' freedom was found to be difficult by the educational board.

A vision was also found to be influential on school level. In schools with a clear health-related vision, stakeholders found it easier to form project plans and motivate other staff members. The presence of a clear vision also made it easier to deal with the rapidly changing situation due to COVID-19, as the overall project objective remained clear and adaptations to the plans could be made relatively fast. If a school used their vision to guide implementation, the project was often not seen as an add-on, but as a part of the other ongoing processes within school, and it was less easily dismissed when the school was faced with other dominating issues. Lack of project vision was sometimes the result of time constraints or other priorities within a school. Multiple schools were dealing with high staff turnover and/or efforts to improve educational quality, which limited their ability to consistently focus on the project.

Teacher 7: *'There is a plan to improve educational results across all schools [of the educational board] because that is necessary. That plan currently has the highest priority within our school and probably also in other schools. […] So that is an important factor taking away time and capacity from this project.'*

In some schools, other dominating issues did not limit project attention, but created a window of opportunity facilitating implementation. A school designing a new school building had the opportunity to incorporate specific health-related concepts (e.g., a large kitchen and an active play yard) in their new building. Also, moving to a new building created the perception of 'starting fresh', which resulted in various stakeholders paying extra attention to the school's overall health-related vision and being more inclined to think about bigger activities.

Personal Characteristics

Across school directors, who were responsible for the project in most schools, there were differences in perceived project importance and appreciation. Although all directors acknowledged the project's importance, directors with high internal motivation and perceived necessity for change were more successful in involving other stakeholders and implementing activities than directors who felt less personal connection to the subject. These directors were more likely to focus on implementation barriers (e.g., high workload and other priorities), whilst enthusiastic directors looked for opportunities.

Table 1. Activities implemented in the various schools at the end of data collection.

School	Healthy and sustainable nutrition	Sufficient PA
1	Daily provision of FV item	(Limited) usage of PA floor for toddlers and preschoolers
2	N/A	• Various staff workshops and information evenings for parents related to PA integration in education • Adaptation schoolyard (more active elements)
3	• Daily provision of FV item • Pilot to investigate healthy lunch provision (not integrated yet)	• Various staff workshops related to PA integration in education • Increased amount of education provided outdoors • Adaptation schoolyard (more active elements) • Pilot to investigate structured PA sessions during lunch break time (not integrated yet)
4	Daily provision of FV item	• Integration of an additional 20 minutes of PA every day (using certified method) • Usage of specific game consoles for outside play
5	N/A	N/A
6	• Daily provision of FV item • Various activities focussed on healthy nutrition (e.g., Family Food Vlogs, classroom-based quiz, Family Food Experience) • Introduction new school-wide dietary policy	• Adaptation schoolyard (more active elements) • Integration of PA in curriculum
7	N/A	• Adaptation schoolyard (more active elements) • Staff workshop regarding reflex integration
8	Daily provision of FV item	N/A
9	• Daily provision of FV item • Daily provision of dairy serving • Expansion of school garden	Integration of an additional 20 minutes of PA every day (using certified method)
10	N/A	N/A
11	Daily provision of FV item	Integration of an additional 20 minutes of PA every day (using certified method)

Note. Due to the merging of two participating schools, 11 schools are included in Table 1 instead of the 12 schools that were originally participating in the project.

Sufficient rest and relaxation	Social involvement
Incidental yoga lessons provided by pedagogical employee	N/A
Provision of weekly yoga lessons in kindergarten	N/A
N/A	• Support from volunteers during lunch pilot and FV provision • Support from local companies to provide lunch during pilot
N/A	N/A
N/A	N/A
N/A	Active role for students' voice group and parents in nutrition-related plans
N/A	N/A
N/A	N/A
Development of relaxation spaces throughout the school	Active role for volunteers in maintaining school garden
Usage of certified method to improve classroom atmosphere	N/A
N/A	N/A

Abbreviations: PA, physical activity; FV, fruit and vegetable; N/A, not applicable.

Process coordinator: *'For some directors the project is very close to their heart, they want this very much. For others that is not so much the case, but they see the importance and have accepted that they have to work on it. And some directors have little connection to the subject, which decreases their focus on it.'*

Almost all teachers underpinned the importance of paying attention to health at school, but the project's additional value within this context was not always clear. Various teachers reported to already incorporate health within the curriculum prior to the project, and not seeing any necessity for further improvement.

Teacher 10: *[Researcher]: 'So there is not really a theme right now that you can think of as something you would choose to work on within the project?' [Teacher]: 'No, it is not that we think, "Oh we should do something regarding health."''*

This limited perceived necessity for change impeded implementation of disruptive activities. When school directors and teachers were asked whether they were satisfied with the activities implemented at the project's end or if they would have liked to implement more disruptive changes, the majority reported to be content with what was achieved throughout the project.

Innovation Characteristics

Clarity of the project's content, aims, and operationalisation was suboptimal for school directors, managers, and teachers. The large amount of freedom to implement activities made various stakeholders feel overwhelmed and unsure about what was expected of them. Furthermore, the categories in which implemented activities had to fall were not always clear to stakeholders. Especially the categories 'rest and relaxation' and 'social involvement' were difficult to grasp. The difficulty with these categories was also visible in the activities implemented in the schools (Table 1), as most implemented activities fell in the categories 'healthy and sustainable nutrition' and 'sufficient PA'.

The most-often mentioned aspects playing a role in stakeholders' choice for a specific activity were its degree of compatibility with the school context and its complexity to work with. Several schools chose to work with a specific programme integrating PA within the curriculum, and when asked for their rationale behind this choice, directors and teachers praised the ease of incorporating the programme within their daily practice.

Director 11: *'This method is just very easy and clear, which means that teachers do not have to spend a lot of time getting acquainted with it.'*

Other activities, such as the provision of a school lunch, did not get off the ground because stakeholders perceived them as too complex.

Teacher 3: *'Of course we would like to offer a healthy lunch to students, but looking at all the extra work this would bring… […] Organisation is a limitation. Whilst I think that all colleagues would like to offer this. But the question is to what extent this would be realistic and feasible.'*

Characteristics of the Innovation Strategy
In most schools, project responsibility rested mainly with the school director. Despite efforts of the process coordinator to increase school-wide involvement, directors found it difficult to delegate tasks to their team. They mentioned wanting to 'protect' their staff considering the already high work load and limited time.

Director 3: *'I am now responsible for the whole project, although I would like to appoint a coordinator. But right now with all the other tasks, I do not delegate it to my team but carry it myself.'*

This approach led to a lack of bottom-up involvement, and teachers often mentioned not being aware of project details and/or not feeling ownership for their school's plans. Teachers were often informed about an initiative's implementation rather than being involved during preparation. This made the implementation and especially integration of activities extremely difficult due to limited project involvement and ownership amongst staff.

Teacher 7: *'It was more a management commitment to work on [the project]; we [the staff] were not explicitly asked what we thought about it. It was not that we were very enthusiastic about it.'*

The lack of bottom-up involvement also made the project largely dependent on one person, which limited sustainability. In schools where teachers were more engaged in implementation, there was clear and regular communication within teams (both in general and regarding the project), which motivated and stimulated staff to be involved.

Teacher 4: *'I have to say, the collaboration is great. Everybody is like, "We are going to do this." If we come across a problem, it is discussed, something new is thought of, and we will continue with that.'*

The process coordinator's presence was vital for project implementation. Whilst schools had to focus on a multitude of subjects (e.g., educational quality and COVID-19, staff turnover), the process coordinator had a constant focus on the project and stimulated stakeholders to work on it. Furthermore, she provided schools with inspiration for potential activities.

Manager 2: *'[Process coordinator] makes sure that everybody is up-to-date […] I think that has really been a facilitator, that there is somebody who always has the focus on this despite everything that is happening around us.'*

Other external project support was also very beneficial, as several schools contacted the Municipal Health Services or other health promotion experts. Furthermore, various interview participants mentioned the positive influence of sharing experiences from other schools working on health promotion.

Director 8: *'The overview which [process coordinator] shared, with all the activities schools are working on, that was very nice. It gives me a lot of energy and makes me think, "Oh I like that as well!"'*

The experiences from other schools not only served as inspiration, but also provided stakeholders with tips and tricks on how to handle certain situations and even made some stakeholders more willing to work on the project. The positive experiences one school had with a programme integrating PA within the curriculum directly led to two other schools also choosing to implement this programme. Several stakeholders mentioned that they would have liked more knowledge and experience transfer between schools, as they were not aware of all activities implemented within the project. However, this transfer was hindered by COVID-19, which limited the possibility to organise school visits or information meetings.

Table 2 provides an overview of the main facilitators and barriers to the integration of health within the participating schools, as mentioned by school directors, managers, and teachers in questionnaires and interviews.

Table 2. Main facilitators and barriers to the integration of health within the participating schools.

Category	Facilitators	Barriers
Socio-political context		COVID-19-related restrictions (e.g., school closure, safety regulations, and national focus on limiting educational disadvantages) and the corresponding complexity of the constantly changing situation at school
Organisation *(school)*	• Clear health-related vision within the school • Window of opportunity (e.g., designing a new school building)	• Lack of attention for the project due to other dominating issues (e.g., staff turnover and relocation) • Limited time available for the project due to already full curriculum
Personal *(school directors, managers, teachers)*	• Internal motivation to incorporate health within the school context (e.g., as a result of high perceived importance of the subject) • Availability of a 'coordinator' (school director or other staff member) with continuous attention to the project who can stimulate other team members	• High (perceived) workload • No perceived necessity for incorporating health within the school context
Innovation	Compatibility of an activity with the regular curriculum	• Limited clarity of the project as a whole (e.g., its aims and operationalisation) • Complexity of an activity (e.g., time and effort needed to prepare implementation)
Innovation strategy	• Clear and regular communication within teams • Coordination and support from process coordinator who keeps the project alive within the schools • External project support (e.g., from local health promotion experts) • Sharing ideas and experiences across schools	• Top-down decision making, resulting in lack of involvement of various stakeholders

Discussion

The present study examined the implementation of health-promoting activities in multiple real-world school contexts and identified various influencing factors. As opposed to the majority of implementation research on health-promoting schools, no pre-defined intervention was provided in the present project. Rather, schools were encouraged to implement activities fitting their context, wishes, and needs.

Overall, the original project ambitions were not met and limited implementation was observed. The most important reasons for this were related to *project commitment and bottom-up involvement*, repeatedly identified as key factors in the implementation of school-based health-promoting programmes [12,13,23]. Lack of project commitment and bottom-up involvement were observed at different stages and on different levels (project level, educational board level, and school level). On project level, there were clear differences between the original HPSF trial and the present project. The original HPSF trial's project team worked extensively on creating *commitment* for and *involvement* in HPSF across school directors, teachers, parents, children, and the school environment [14,23]. These efforts were made to a much lesser extent in the present project. Given the educational board's initial enthusiasm, it was hypothesised that schools would share this enthusiasm and would involve relevant stakeholders. However, in many schools, enthusiasm about the project was less than anticipated and limited time and/or efforts were spent on involving relevant stakeholders. Given the importance of stakeholder involvement for sustainable implementation [23–26], for future projects it is crucial to provide schools with more extensive guidance and support on how to adequately do this [27]. A process coordinator could play a more proactive role in this, e.g., by organising regular meetings to ensure project involvement and commitment of all relevant stakeholders from the beginning.

On educational board level, there was enthusiasm about HPSF and the ambition to implement comparable activities in their schools. However, the decision to participate in the present project was not made in collaboration with school directors and/or teachers. Rather, these stakeholders were merely informed about project participation, indicating a low level of bottom-up involvement at the project's start. Furthermore, the board's project vision and ambitions were not clearly communicated to the schools. As a result of the board's lack of guidance, most school directors felt overwhelmed by the freedom of choice they had when developing school-specific plans, which negatively influenced their project commitment and involvement. *Leadership engagement* (e.g., through setting and communicating clear project boundaries, expectations, and goals) has previously been described to facilitate the implementation of various school-based programmes [28–31].

Leadership engagement was not only suboptimal at educational board level, also on school level there was room for improvement. Most school directors carried the project largely by themselves and were hesitant to involve their team as this could further increase their already high workload. This greatly limited bottom-up involvement and project integration within schools, as other staff members were not aware of the project's details and experienced limited ownership and/or motivation to work on it. In various schools, it was observed that bottom-up involvement in general was limited: school directors took the lead in most decision-making, whilst staff members played a less proactive role. These dynamics might, therefore, have been part of the schools' general culture. To change this culture, external project support should be more equipped to support and guide schools extensively in stimulating bottom-up project involvement as the present study showed that schools find it difficult to do this on their own.

In most schools, teachers were already satisfied with their students' health status and the amount of attention payed to health before the project. This might have limited their *perceived necessity to change*, which is an important factor in the decision to implement health-promoting activities [13,25]. Focussing on health benefits might therefore not always be the right strategy to create commitment for health integration in schools. It is important to use information fitting a school's specific context and needs when trying to motivate them to work on health promotion. In some schools, this might be information regarding health benefits, but in other schools, this could, e.g., be mentioning the opportunity for a school to distinguish itself from other schools.

COVID-19 and its subsequent restrictions also had a negative influence on project implementation. Approaching the project with a long-term plan was difficult as the situation called for many ad-hoc decisions. This contributed to a lack of project vision, motivation, and stakeholder involvement, thereby impeding sustainable implementation of health-promoting activities in schools [12,13,23,32]. Schools that were more successful in dealing with these barriers approached the project with a *clear health-related vision* and had *regular communication* within the team. Through this approach, they perceived the project as an 'add-in' rather than an 'add-on'.

A facilitating factor was the presence of the *process coordinator*, who stimulated stakeholders to work on the project through sharing other schools' experiences and providing information regarding potential activities. However, schools needed extensive guidance for which the process coordinator not always had enough time as she had to guide all participating schools. For widespread dissemination of school-based health-promoting activities, it might, therefore, be better to first focus on schools in which there is already some motivation to work on the subject. The school's drive is an important foundation for successful implementation and focussing attention on fewer schools provides more room to concentrate on creating commitment and bottom-up involvement. The experiences of motivated schools can subsequently be used to stimulate other, less internally motivated schools to work on the subject.

To make widespread and sustainable dissemination feasible, schools should rely less on external project support and feel empowered to work on the subject independently. To achieve this and to facilitate integration within schools, it is important to identify and train in-school champions and/or school-wide project groups. These people should be enthusiastic about the subject and have the skills, power, and knowledge to involve and activate other staff members to work on the subject. The importance of identifying and empowering organisation champions to successfully scale up public health interventions has been described previously in other comparable research within and beyond the school-setting [13,27,28,33–35].

Strengths and limitations

The strength of this study was the mixed methods approach, which stimulated data triangulation and complementation [23,36]. In addition, usage of Fleuren et al.'s framework [21] facilitated comparison with other studies using the same framework [12,13]. Furthermore, following diverse schools in their natural setting allowed for a real-world insight in project implementation. This provided a valuable addition to the process evaluation of the original HPSF trial (a more controlled situation) that was previously performed [23]. It should, however, be noted that all participating schools were member of the same educational board and were located in the same municipality. To further increase the experience base, it would be beneficial to investigate implementation in schools from other educational boards and/or located in different areas.

A limitation of the present study is the fact that only one researcher conducted the interviews. The risk of social desirability was minimised by stressing confidentiality and the fact that participants could not give any wrong answers and by carefully formulating interview questions. To reduce bias related to the subjective interpretation of qualitative data, two researchers coded (part of) the interviews, notes were kept on researchers' objectivity, ambiguities during coding were discussed with colleagues, and data interpretation was done in collaboration with two other researchers.

Implications for Practice

Figure 2 provides an overview of important activities to be undertaken by various stakeholders throughout development, adoption, and implementation of school-based health-promoting projects. All activities are based on important influential factors observed in the present study and in comparable research [12,13,23,28,30,32,37].

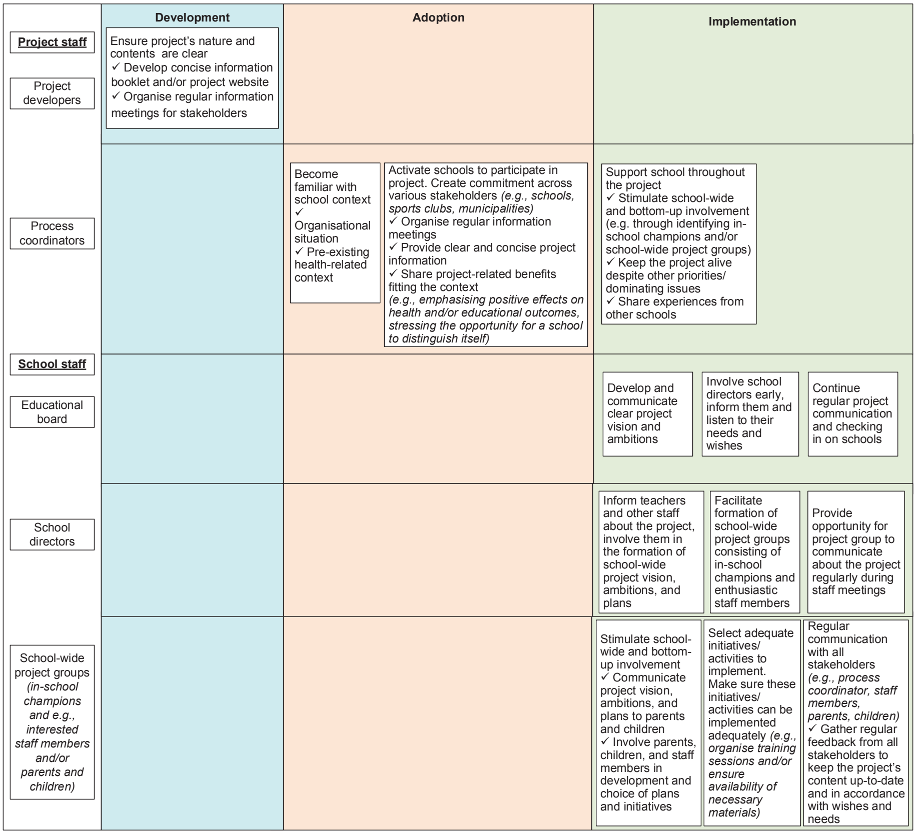

Figure 2. Overview of activities to be undertaken by various stakeholders throughout project development, adoption, and implementation.

Conclusions

The present project's original ambitions were not met. This was due to several reasons, the most important being a lack of commitment creation, bottom-up involvement, and project vision on several levels (project level, educational board level, and school level). This, together with issues such as high staff turnover, COVID-19, and high workload, resulted in the implementation of small activities with limited focus on long-term integration. For future projects, it would be beneficial to provide more extensive support at the start of the project to create commitment, bottom-up involvement, and a project vision. Furthermore, identifying and empowering in-school champions and/or school-wide project groups should be a priority to decrease schools' reliance on extensive long-term external project support and to facilitate project integration and widespread dissemination.

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Supplementary Table S1. Characteristics of Interview Participants.

Table S1. Characteristics of interview participants.

Characteristic	*n*	%
Stakeholder interviewed	23	
School director	7	29.2
Childcare manager	2	8.0
Teacher	13	54.2
Other [a]	1	8.0
Sex interviewee	23	
Male	8	34.8
Female	15	65.2

[a] Process coordinator (who was interviewed at two different moments to discuss the project's progress).

CHAPTER 9

Effects of School-Based Health-Promoting Activities on Children's Health: A Pragmatic Real-World Study

Hahnraths MTH, Winkens, B, van Schayck CP. Effects of School-Based Health-Promoting Activities on Children's Health: A Pragmatic Real-World Study.

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Abstract

More insight into the health effects of scaled-up school-based interventions in real-world settings is vital to sustainably integrate health in all schools. This study investigated the effects of the scaled-up Healthy Primary School of the Future (HPSF) initiative in real-world school contexts on children's health (behaviours). From 2019 to 2022, 11 Dutch primary schools implemented HPSF-related activities. In 315 children from study years 4 to 6 (aged 7–11 years) from these schools, anthropometric measurements were performed and questionnaires assessing the children's dietary behaviours and physical activity were administered. COVID-19 greatly the limited implementation of HPSF-related activities. Therefore, the results were compared between schools categorised as medium implementers and schools categorised as low implementers. After correction for baseline, waist circumference in the medium implementer group was significantly higher at one-year follow-up (B = 1.089, $p = 0.003$) and two-year follow-up (B = 1.665, $p < 0.001$) compared with waist circumference in the low implementer group. No significant effects were observed for other outcomes. This study showed hardly any effects of the scaled-up HPSF initiative, mainly due to the limited implementation caused by COVID-19. More research investigating the real-world effectiveness of HPSF and comparable programmes is greatly encouraged to advance the field of school-based health promotion.

Introduction

Globally, the prevalence of childhood overweight and obesity is increasing, and this trend is also visible in the Netherlands [1,2]. As childhood overweight and obesity are known to track into adulthood and increase the risk of both immediate and long-term health problems, reducing their prevalence is vital [3]. Important causes of overweight and obesity are unhealthy lifestyle behaviours (e.g., unhealthy dietary behaviours and insufficient physical activity (PA)). Because lifestyle habits formed during childhood are likely to persist throughout adulthood, early development of a healthy lifestyle is expected to result in both immediate and long-term health benefits [4–6].

Schools are key environments for health promotion. At school, children from various socioeconomic backgrounds come together during critical developmental years, and teachers have the opportunity to educate children about health and serve as role models [7–9]. Over the years, many health-promoting interventions have been developed, implemented, and evaluated with the aim of integrating health in schools [10–14].

The 'Healthy Primary School of the Future' (HPSF) is a school-based health-promoting initiative previously implemented in several Dutch schools. The initiative consists of two core components: the daily provision of a healthy school lunch and the daily implementation of structured PA sessions after lunch. Two 'full HPSF schools' implemented both the lunch component and the PA component. Two 'partial HPSF schools' implemented the PA component only, and four schools continued with their regular curriculum, serving as control schools in an efficacy trial [15,16]. Longitudinal analyses revealed significant positive intervention effects on outcomes such as children's body mass index (BMI) z-scores and dietary and PA behaviours [17–19]. Following the efficacy trial's positive results, other Dutch primary schools became interested in implementing HPSF-related activities. This created the opportunity to 'scale-up' HPSF, i.e., to implement the initiative, which was previously successful on a relatively small scale in a controlled setting, under real-world conditions into broader practice [20]. Scaling-up meant working with a wide variety of schools with unique contexts. Moreover, schools themselves would be mainly responsible for the implementation of HPSF-related activities, as researchers would have limited control over the situation (unlike during the original HPSF trial [15]). Although multiple studies have investigated the efficacy of school-based health-promoting interventions under relatively controlled conditions [10,13,21], there is less research on the effectiveness of such interventions in real-world situations. Gaining insight into the health effects of scaled-up school-based interventions in diverse settings is thus vital to sustainably integrate health in more schools, which can positively impact the health of many children [22,23].

To evaluate the implementation and effectiveness of the scaled-up HPSF initiative, a follow-up research project involving 12 Dutch primary schools was initiated. The schools were not obliged to implement a clear-cut intervention as they were in the HPSF trial; instead, they had the opportunity to implement activities that fit their contexts. This setup facilitated the development of pragmatic, school-specific interventions, which was hypothesised to stimulate sustainable integration of health in the schools. The present study aimed to investigate whether the previously observed positive intervention effects on children's health-related outcomes would be retained after scaling-up HPSF. In order to achieve this, the study aimed to answer the following research questions:

1. What are the effects of the implemented health-promoting activities on children's body composition (BMI z-score and waist circumference)?
2. What are the effects of the implemented health-promoting activities on children's PA and dietary behaviours?

Methods

Study Design

This effectiveness evaluation was part of a research project investigating the scaling-up of HPSF using a non-randomised, non-controlled design. As we were specifically interested in the 'natural implementation' and the effectiveness of HPSF in a real-world context, no control group was included and researchers solely played an observing role. This made it possible to observe the implementation of HPSF-related activities without researchers interfering by forcing some schools to implement a specific set of activities or to implement no activities (in the case of control schools). The study involved 12 primary schools that were all members of one educational board.

Setting

The educational board of the 12 participating schools expressed its desire to implement HPSF-related activities. All schools were located in one rural municipality in the northern part of the province of Limburg, the Netherlands. At baseline, the schools' pupil numbers varied from 31 to 263 (three schools had < 100 pupils). One school provided special needs education. Two schools were in the process of merging at baseline, two schools were planning to relocate to other school buildings, and the construction of a new school building for a third school was ongoing. The educational board's aim was that all schools would eventually implement a daily healthy school lunch and structured PA sessions; the two main intervention components allocated in the original HPSF trial [15]. However, unlike in the original trial, the road towards implementation was not controlled by researchers. Instead, schools were free to decide whether, when, and to what degree they would implement health-promoting activities. All activities had to fit into at least one of the following categories (developed by the educational board): (1) healthy and sustainable nutrition, (2) sufficient PA, (3) sufficient rest and relaxation, and (4) collaboration. The last two categories were not a prominent part of the original HPSF trial but were included in the present project because stakeholders underpinned their importance for children's health and well-being. The schools were mainly responsible for their implementation processes but could ask for assistance from a process coordinator appointed by the educational board. This coordinator organised meetings with directors, managers, and staff members to support the implementation processes. The coordinator had an advising role and never forced schools to implement certain activities. Researchers played an observing role to gain insight into the implementation processes.

Comparison of Schools

As the present study investigated the effectiveness of health-promoting activities under real-world conditions and all participating schools were free to implement activities of their choice, there were no intervention or control groups. The ambition at the start of the study was to divide the schools into categories on the basis of their adherence to four HPSF key points. These key points defined HPSF's optimal implementation and were formulated by stakeholders involved in the original HPSF trial to facilitate HPSF's further dissemination. In short, these key points entailed: (1) active involvement of various stakeholders (e.g., school staff, children, and parents), (2) taking a school-wide approach, (3) all children engaging in at least one hour of PA every day, and (4) all children consuming a daily healthy lunch at school. More details on the categorisation method based on the HPSF key points are described elsewhere [24].

In contrast to the educational board's initial ambitions, project implementation mainly concerned small, incidental activities (e.g., small adaptations to the schoolyard). The main reasons for this limited implementation were the COVID-19 pandemic and its related restrictions, a lack of commitment and bottom-up involvement, and a high workload. More in-depth information on implementation and factors influencing it is reported elsewhere [25]. The limited implementation had implications for data categorisation in the present study, as the previously proposed categorisation method could not be used due to low variation in the number of HPSF key points that schools adhered to. Instead, schools were categorised on the basis of the implemented activities' intensity. This resulted in the formation of two groups: medium implementers (six schools) and low implementers (five schools) (due to the merging of two schools at the start of the project, 11 schools are included in the remainder of this paper instead of the 12 schools that started project participation). The project's effectiveness on various health outcomes was compared between these two groups. An overview of the activities implemented within each school and the corresponding categorisation is reported in Table 1; this overview was previously published elsewhere [25].

Participants

At baseline, all children in study years four to six (internationally comparable to grades two to four) and their parents/caregivers (n = 649) were invited to participate in the study through information brochures for parents/caregivers. There were no further inclusion or exclusion criteria. In addition to providing information brochures, researchers visited classrooms to inform children about the study and to encourage them to participate. After school, parents had the opportunity to ask the researchers questions. All participants were required to complete an informed consent form, signed by both parents/caregivers. The need for ethical approval for the overall research project was waived by the Medical Ethics Committee Zuyderland in Heerlen (METC-Z no. METCZ20190144).

Data Collection Procedures

Measurements were conducted in May–July 2020 (T0), 2021 (T1), and 2022 (T2). In each school, data were collected yearly during one measurement week. Inter-rater variability was minimised by training researchers according to a strict protocol.

Anthropometric Measurements

In line with COVID-19-related restrictions applicable at the time, anthropometric measurements were performed in the schoolyard. Children were measured wearing light clothing and no shoes. All anthropometric measurements were performed twice, and a third measurement was conducted if the difference between the first two measurements exceeded a pre-set limit (weight ≥ 0.2 kg, height ≥ 0.5 cm, waist circumference ≥ 1.0 cm) [15]. Weight was measured to the nearest 0.1 kg (Weighing Scale 803, Seca, Hamburg, Germany) and height was measured to the nearest 0.1 cm (Stadiometer 213, Seca, Birmingham, United Kingdom) [15]. Waist circumference was measured with a measuring tape to the nearest 0.1 cm, following the World Health Organisation's assessment protocol (model 201, Seca, Hamburg, Germany) [26].

Questionnaires

Participating children and one of their parents/caregivers were asked to fill out various questionnaires that were largely similar to those used during the original HPSF trial [15].

Child questionnaire: All participating children filled out a digital questionnaire assessing their dietary and PA behaviours. The questionnaire was filled out in class during class hours in the presence of at least one researcher. It took about 30 minutes to complete the questionnaire as other aspects (e.g., well-being) were also assessed.

Child lunch questionnaire: A digital recall questionnaire containing 13 questions regarding children's lunch intake was filled out by all participating children. It was filled out immediately after lunchtime in class in the presence of at least one researcher and took about five minutes to complete.

Parental questionnaire: A digital parental questionnaire was used to gather information on parental education level and country of birth and children's health behaviours. Parents/caregivers of all participating children received the questionnaire, which took about 30 minutes to complete as other aspects (e.g., quality of life) were also explored. Parents had approximately two months to complete the questionnaire. Two reminders were sent during this period if the questionnaire was not yet completed.

Measures

Covariates

Children's age, study year, and sex were collected through the educational board's database. The parental questionnaire was used to gather information on children's socioeconomic background and ethnicity. Socioeconomic status (SES) was calculated as the mean of standardised scores on maternal and paternal education level [27]. The mean scores were categorised into low, middle, and high SES scores on the basis of tertiles. Children's ethnicity was determined by the country of birth of both parents and divided into (1) Western background (including the Netherlands and all other European countries (excluding Turkey), North America, Japan, Indonesia, and Oceania) and (2) non-Western background [28]. If at least one of the parents was born in a non-Western country, the child's ethnicity was assigned as non-Western.

Outcomes

Information on children's BMI and waist circumference was gathered through anthropometric measurements. Children's BMI was assessed by height and weight; age- and sex-specific BMI cut-off points were used to define overweight and obesity [29]. BMI z-scores were calculated using Dutch reference values [30].

Table 1. Activities implemented in the various schools at the end of data collection and subsequent categorisation into medium and low implementers [25].

Medium Implementers		
School	**Healthy and sustainable nutrition**	**Sufficient PA**
1	Daily provision of FV item	(Limited) usage of PA floor for toddlers and preschoolers
3	• Daily provision of FV item • Pilot to investigate healthy lunch provision (not integrated yet)	• Various staff workshops related to PA integration • Increased amount of education provided outdoors • Adaptation schoolyard (more active elements) • Pilot to investigate structured PA sessions during lunch break time (not integrated yet)
4	Daily provision of FV item	• Integration of an additional 20 minutes of PA every day (using certified method) • Usage of specific game consoles for outside play
6	• Daily provision of FV item • Various activities focussed on healthy nutrition (e.g., Family Food Vlogs, classroom-based quiz, Family Food Experience) • Introduction new school-wide dietary policy	• Adaptation schoolyard (more active elements) • Integration of PA in curriculum
9	• Daily provision of FV item • Daily provision of dairy serving • Expansion of school garden	Integration of an additional 20 minutes of PA every day (using certified method)
11	Daily provision of FV item	Integration of an additional 20 minutes of PA every day (using certified method)
Low Implementers		
School	**Healthy and sustainable nutrition**	**Sufficient PA**
2	N/A	• Various staff workshops and information evenings for parents related to PA integration in education • Adaptation schoolyard (more active elements)
5	N/A	N/A
7	N/A	• Adaptation schoolyard (more active elements) • Staff workshop regarding reflex integration
8	Daily provision of FV item	N/A
10	N/A	N/A

Note. Due to the merging of two participating schools, 11 schools are included in Table 1 instead of the 12 schools that were originally participating in the project. Abbreviations: PA, physical activity; FV, fruit and vegetable; N/A, not applicable.

Sufficient rest and relaxation	Social involvement
Incidental yoga lessons provided by pedagogical employee	N/A
N/A	• Support from volunteers during lunch pilot and FV provision • Support from local companies to provide lunch during pilot
N/A	N/A
N/A	Active role for pupils' voice group and parents in nutrition-related plans
Development of relaxation spaces throughout the school	Active role for volunteers in maintaining school garden
N/A	N/A

Sufficient rest and relaxation	Social involvement
Provision of incidental yoga lessons in kindergarten	N/A
N/A	N/A
N/A	N/A
N/A	N/A
Usage of certified method to improve classroom atmosphere	N/A

The child questionnaire was used to gain insight into children's PA behaviour. The questionnaire contained ten items derived from the International Physical Activity Questionnaire for Children (IPAQ-C), which has acceptable validity [31–33]. Activity scores between 1 and 5 were obtained for each item, after which the mean of these scores was calculated to obtain the total activity summary score (ranging from 1 (low PA) to 5 (high PA)) [31].

Water consumption during school hours was derived from the child questionnaire ranging from never (0) to every day (3). Soft drink consumption during the past week was derived from the parental questionnaire ranging from never (0) to every day (7). A composite score for healthy dietary behaviours was computed from four separate questions. This score was calculated by averaging the weekly consumption (ranging from never (0) to every day (7)) of breakfast consumption and intake of fruit, warm and raw vegetables, and water throughout the day, as reported in the parental questionnaire.

The child lunch questionnaire assessed children's consumption of certain food types during lunch. The items were summarised into six dichotomous (yes/no) food types: fruits, vegetables, grains (bread and cereals), dairy (milk/yoghurt and cheese), water, and butter. To shed more light on the nutritional value of the children's lunches, the different food types consumed were summed and a dichotomous variable was created indicating whether children consumed at least two of the food types during lunch.

Data Analysis

Data were analysed using IBM SPSS Statistics for Windows (version 27.0, IBM Corp, Armonk, NY, USA). Pearson's chi-square tests and independent-samples t-tests were conducted to compare the participants' observed baseline characteristics, i.e., age, study year, sex, SES, ethnicity, BMI z-score, waist circumference, and PA and dietary behaviours, between the medium and low implementer group. Linear mixed model analyses were used to assess the longitudinal intervention effects on children's BMI z-score, waist circumference, and PA and dietary behaviours; logistic mixed models were used for binary outcomes. Since measurements were repeated within participants, a two-level model with measurements as the first level and participants as the second level was used. The model's fixed part consisted of group (medium/low implementers), time (T0/T1/T2), the interaction term of group and time, and the covariates sex (boy/girl), study year at baseline (four/five/six), SES (low/middle/high), and children's BMI z-score at baseline. In the analyses of children's BMI z-score, weight status at baseline (underweight/normal weight/overweight) was included instead of BMI z-score at baseline, as this was already corrected for by the model (baseline was included as outcome measure). An unstructured covariance structure for repeated measures was used. Since this model used a likelihood-based approach for missing outcome data, assuming missing at random (MAR), no (multiple) imputation was required. For all analyses, a two-sided *p*-value ≤ 0.05 was considered statistically significant. Categorical outcomes (lunch intake outcomes) resulted in odds ratios (ORs) with corresponding 95% confidence intervals.

Results

Demographic Characteristics

Of the 649 children from study years four to six at baseline, 315 (48.5%) handed in a completed informed consent form to be included in the study. The schools had a median of 31 participating children at baseline (25^{th} percentile = 10; 75^{th} percentile = 39). The parents of 287 children (91.1%) filled out the parental questionnaire at least once. A detailed overview of the included participants at each time point can be found in Supplementary Figure S1. Table 2 provides an overview of the sample's baseline characteristics.

Effects on Body Composition

For BMI z-score, the interaction between group and time was not significant ($p = 0.214$), showing no significant difference in the change in BMI z-score over time between medium and low implementers (Table 3). For waist circumference, the interaction between group and time was significant ($p < 0.001$). At both T1 and T2, the increase from baseline in waist circumference in the medium implementer group was significantly higher than the increase in the low implementer group (Table 3, Figure 1). Descriptive data regarding the observed BMI z-score and waist circumference at T0–T2 can be found in Table S1.

Table 2. Characteristics of participants at baseline (T0) (*n* = 315).

Characteristic	*n*	Total % / M	SD
Sex (% boys) [1]	315	43.8	
Age (years)	315	9.19	0.98
Study year (%) [1]	315		
Four	100	31.7	
Five	99	31.4	
Six	116	36.8	
Ethnicity (% Western) [1]	283	96.8	
SES (%) [1, 2]	284		
Lowest tertile	54	19.0	
Middle tertile	86	30.3	
Highest tertile	144	50.7	
BMI z-score	315	-0.13	0.89
Overweight/obese (%) [1]	315	9.8	
Waist circumference (cm)	315	57.81	5.96
PA summary score (1-5)	315	2.98	0.66
Healthy dietary behaviours (mean days/week) [3]	256	5.56	0.95
Soft drink consumption (mean days/week)	256	4.17	2.76
School water consumption (0-3) [4]	315	1.33	1.17
Fruit at lunch (% yes) [1]	315	34.3	
Vegetables at lunch (% yes) [1]	315	25.1	
Grains at lunch (% yes) [1, 5]	315	93.0	
Dairy at lunch (% yes) [1, 6]	315	35.2	
Water at lunch (% yes) [1]	315	29.5	
Butter at lunch (% yes) [1]	315	61.0	
At least two healthy food groups at lunch (% yes) [1, 7]	315	87.9	

[1] Analysed by X^2 test. [2] Due to clustering of SES scores at several scores, the tertile group sizes are unequal. [3] Healthy dietary behaviours: composite score for frequency of consumption of breakfast, fruit, vegetables, and water. [4] School water consumption ranged from never (0) to daily (3). [5] Grains consisted of the following items: bread and cereals.

Medium Implementers			Low Implementers				
n	% / M	SD	*n*	% / M	SD	X^2 / t-value	*p*-value
143	49.7		172	39.0		3.629	0.057
143	9.21	1.00	172	9.17	0.96	0.320	0.749
143			172			3.836	0.147
48	33.6		52	30.2			
37	25.9		62	36.0			
58	40.6		58	33.7			
131	95.4		152	98.0		1.552	0.213
131			153			4.921	0.085
32	24.4		22	14.4			
39	29.8		47	30.7			
60	45.8		84	54.9			
143	-0.15	0.82	172	-0.10	0.94	-0.462	0.645
143	7.0		172	12.2		2.395	0.122
143	56.84	4.66	172	58.62	6.77	-2.741	0.006 *
143	3.04	0.64	172	2.94	0.67	1.285	0.200
114	5.57	0.96	142	5.56	0.95	0.118	0.906
114	4.31	2.74	142	4.06	2.78	0.722	0.471
143	1.43	1.22	172	1.25	1.13	1.378	0.169
143	34.3		172	34.3		0.000	0.995
143	24.5		172	25.6		0.051	0.822
143	92.3		172	93.6		0.202	0.653
143	37.1		172	33.7		0.382	0.536
143	32.9		172	26.7		1.407	0.236
143	59.4		172	62.2		0.251	0.616
143	87.4		172	88.4		0.068	0.795

[6] Dairy consisted of the following items: milk/yoghurt and cheese. [7] Items in the healthy food groups included: fruit, vegetables, grains, dairy, water, and butter. * Significant difference between medium and low implementers ($p \leq 0.05$). Abbreviations: M, mean; SD, standard deviation; SES, socioeconomic status; BMI, body mass index; PA, physical activity.

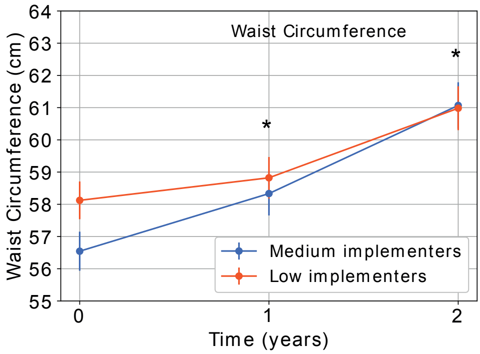

Figure 1. Estimated means of children's waist circumference at T0–T2.

Note. All analyses included sex, study year at T0, SES, and BMI z-score at T0 as fixed factors.* Significant difference between medium and low implementers after correction for baseline ($p \leq 0.05$).

Table 3. Estimated intervention effects at T1 and T2 on body composition and PA and dietary behaviours.

Outcome		Medium Implementers vs. Low Implementers B (95% CI)	*p*-value
BMI z-score	T1–T0	-0.052 (-0.135; 0.030)	0.210
	T2–T0	0.013 (-0.083; 0.108)	0.793
Waist circumference (cm)	T1–T0	1.089 (0.377; 1.801)	0.003 *
	T2–T0	1.665 (0.774; 2.556)	< 0.001 *
PA summary score (1–5)	T1–T0	-0.146 (-0.294; 0.002)	0.053
	T2–T0	-0.133 (-0.342; 0.075)	0.209
Healthy dietary behaviours (days/week)	T1–T0	-0.070 (-0.251; 0.110)	0.444
	T2–T0	-0.018 (-0.224; 0.188)	0.863
Soft drink consumption (days/week)	T1–T0	0.106 (-0.789; 1.002)	0.815
	T2–T0	-0.359 (-1.232; 0.514)	0.418
Water consumption at school (0–3)	T1–T0	-0.148 (-0.433; 0.137)	0.307
	T2–T0	-0.224 (-0.617; 0.169)	0.263

Note. Analysed by linear mixed model analyses. All analyses included sex, study year at T0, SES, and BMI z-score at T0 or weight status at T0 (only for BMI z-score) as fixed factors. B = estimated group effect in terms of T1–T0 or T2–T0 based on linear mixed model analysis. * Significant difference between medium and low implementers ($p \leq 0.05$). Abbreviations: BMI, body mass index; PA, physical activity; CI, confidence interval.

Effects on PA and Dietary Behaviours

The interaction between group and time was not significant for any outcomes related to PA and dietary behaviours, meaning that the change in PA and dietary behaviours over time did not significantly differ between medium and low implementers (Tables 3 and 4). Descriptive data regarding the observed PA and dietary behaviours at T0–T2 can be found in Table S1.

Table 4. Estimated intervention effects at T1 and T2 on lunch outcomes.

Outcome		Medium Implementers vs. Low Implementers OR (95% CI)	*p*-value
Fruit (% yes)	T1–T0	1.449 (0.771; 2.724)	0.249
	T2–T0	1.096 (0.533; 2.252)	0.803
Vegetables (% yes)	T1–T0	1.752 (0.948; 3.236)	0.073
	T2–T0	1.169 (0.584; 2.337)	0.658
Grains (% yes)	T1–T0	1.244 (0.338; 4.574)	0.742
	T2–T0	1.830 (0.486; 6.888)	0.370
Dairy (% yes)	T1–T0	0.829 (0.490; 1.402)	0.483
	T2–T0	1.148 (0.657; 2.006)	0.626
Water (% yes)	T1–T0	0.915 (0.501; 1.670)	0.771
	T2–T0	0.946 (0.507; 1.765)	0.861
Butter (% yes)	T1–T0	1.086 (0.629; 1.877)	0.766
	T2–T0	1.002 (0.567; 1.770)	0.995
At least two healthy food groups during lunch (% yes)	T1–T0	0.680 (0.257; 1.802)	0.437
	T2–T0	1.144 (0.408; 3.209)	0.798

Note. Analysed by Generalised Estimating Equations. All odds ratios were adjusted for sex, study year at T0, SES, and BMI z-score at T0. Abbreviations: OR, odds ratio; CI, confidence interval.

Discussion

The present study investigated the effectiveness of the scaled-up HPSF initiative in several real-world primary school contexts. Despite HPSF's positive health impact observed in the original efficacy trial [17–19], only limited effects of the scaled-up initiative could be detected in the present study. However, this does not diminish HPSF's potential health impact. The lack of observed effects can be attributed to the limited implementation of health-promoting activities. Important reasons for this limited implementation were restrictions related to the COVID-19 pandemic. Due to national safety regulations, schools were forced to close on several occasions and had to cope with numerous sudden changes in their environment. This greatly limited schools' ability and capacity to work on the project. Further elaboration on the negative impact of the COVID-19 pandemic on project implementation can be found elsewhere [25]. Considering the challenges caused by the COVID-19 pandemic, the limited project implementation and consequent minimal effects are no surprise. Unfortunately, this means that it remains unknown what the effectiveness of the scaled-up HPSF initiative would have been in the absence of the COVID-19 pandemic, in which case schools would have had the opportunity to implement more extensive health-promoting activities.

The significant increase in waist circumference in medium implementers compared with low implementers at both T1 and T2 is striking. Differences in the measurement period could not have influenced this observed trend, as follow-up measurements were performed after exactly one and two years. Furthermore, inter-rater variability was minimised by training researchers to follow a strict protocol and by checking the collected data for potential errors. Also, selective dropout influencing the results was ruled out, as dropout was minimal (Supplementary Figure S1). At baseline, waist circumference in the medium implementer group was significantly lower than that in the low implementer group. Potentially, the higher increase in waist circumference observed in the medium implementer group over time represented a regression to the mean. There are no commonly accepted reference values for waist circumference in Dutch children. However, a comparison of the present study's waist circumference values with reference values from Fredriks et al. [34] supports the regression to the mean hypothesis, as the baseline mean waist circumference of medium implementers was lower than the reference value reported by Fredriks et al. for children of comparable age [34].

Strengths and Limitations

The present study is one of the few studies that have investigated the effectiveness of a scaled-up school-based health-promoting initiative in a real-world context, and therefore, it has the potential to provide valuable information for researchers, policymakers, and other stakeholders [22,23,35,36]. However, the project's pragmatic nature and the limited researcher involvement (researchers solely acted as observers and had no influence on project implementation) made the project and research vulnerable to external influences. The study's non-randomised nature can be seen as a limitation. However, including schools on the basis of their willingness to participate was a deliberate choice, as it reflects the real-world process of school-based health promotion. Not including a control group in the study (all participating schools implemented health-promoting activities) followed the same reasoning.

At the project's start, a strong difference in the intensity of project implementation between the schools was expected, which could subsequently serve as a way to categorise and compare schools. However, limited implementation in all schools restricted the ability to create distinct categories and compare schools using the method previously described elsewhere [24]. Instead, schools were categorised into medium implementer and low implementer groups. The small difference in the intensity of the implemented activities between these groups might have contributed to the lack of observed effects. Furthermore, as there was no standardised intervention allocated, all schools implemented their own set of health-promoting activities. Categorising schools into two groups meant that schools implementing (slightly) different activities were combined into the same group, and using a different combination of schools within the groups could have potentially led to different results. However, it was argued that the activities implemented by schools combined in one group were comparable and that the utilised categorisation was, therefore, acceptable. Furthermore, analyses using a different categorisation with three groups (high, medium, and low implementers) showed comparable results, which led to the conclusion that the categorisation of schools had limited influence on the study's results.

The generalisation of the study's results should be performed with caution, especially considering the sample's low ethnic diversity and the fact that all schools were from one educational board and located in one municipality.

Subjective measurements, such as the questionnaires used, might lead to socially desirable answers [37]. To minimise the risk of bias, participants were informed about confidentiality and the fact that there were no right or wrong answers.

Implications for Research and Practice

As the present effectiveness evaluation was largely influenced by the COVID-19 pandemic and its related restrictions, it would be beneficial to perform a comparable study in the absence of a global pandemic to provide more insight into HPSF's effectiveness when schools have the opportunity to implement more extensive health-promoting activities. Furthermore, considering the fact that previous research on the effectiveness of scaled-up interventions often revealed lower intervention effects than those that were previously observed in efficacy trials, successfully scaling-up interventions remains a challenge [36,38–30]. Therefore, it is vital that future research does not merely focus on the efficacy of school-based health-promoting programmes in relatively controlled settings, but moves to the investigation of the effectiveness of programmes when they are implemented in diverse real-world settings. This could further advance the evidence base and could provide valuable information for intervention developers, policymakers, and other stakeholders.

In addition, it should be noted that children's health behaviours are not only influenced by the school environment; other settings, such as the home environment, also play an important role [40–42]. Including intervention components targeting the home setting (e.g., family-based activities) is therefore advised to maximise school-based health-promoting programmes' impact.

Conclusions

The present study showed hardly any effects of the scaled-up HPSF initiative in real-world school contexts. This minimal effectiveness can be attributed to the limited implementation of health-promoting activities due to the COVID-19 pandemic and its related restrictions. To better inform intervention developers, policymakers, and other stakeholders, more research on the effectiveness of HPSF and other school-based health-promoting programmes in diverse, real-world settings is needed.

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Supplementary Table S1. Observed outcomes at the various time points (T0–T2).

Table S1. Observed outcomes at the various time points (T0–T2).

T0
Outcome
BMI z-score
Waist circumference (cm)
PA summary score (1–5)
Healthy dietary behaviours (days/week) [1]
Soft drink consumption (days/week)
Water consumption at school (0–3) [2]
Fruit (% yes)
Vegetables (% yes)
Grains (% yes) [3]
Dairy (% yes) [4]
Water (% yes)
Butter (% yes)
At least two healthy food groups during lunch (% yes) [5]
T1
Outcome
BMI z-score
Waist circumference (cm)
PA summary score (1–5)
Healthy dietary behaviours (days/week) [1]
Soft drink consumption (days/week)
Water consumption at school (0–3) [2]
Fruit (% yes)
Vegetables (% yes)
Grains (% yes) [3]
Dairy (% yes) [4]
Water (% yes)
Butter (% yes)
At least two healthy food groups during lunch (% yes) [5]

Medium Implementers			Low Implementers		
n	% / M	SD	*n*	% / M	SD
143	-0.15	0.82	172	-0.10	0.94
143	56.84	4.66	172	58.62	6.77
143	3.04	0.64	172	2.94	0.67
114	5.57	0.96	142	5.56	0.95
114	4.31	2.74	142	4.06	2.78
143	1.43	1.22	172	1.25	1.13
143	34.3		172	34.3	
143	24.5		172	25.6	
143	92.3		172	93.6	
143	37.1		172	33.7	
143	32.9		172	26.7	
143	59.4		172	62.2	
143	87.4		172	88.4	

Medium Implementers			Low Implementers		
n	%/M	SD	*n*	% / M	SD
137	-0.14	0.83	168	-0.03	0.97
137	58.49	5.64	168	59.40	6.68
137	3.19	0.58	168	3.25	0.59
90	5.38	0.94	121	5.56	0.90
90	4.07	2.67	121	3.63	2.88
137	1.47	1.13	168	1.40	1.16
137	31.4		168	26.8	
137	31.4		168	23.8	
137	94.2		168	93.5	
137	39.4		168	39.3	
137	38.0		168	31.0	
137	59.1		168	60.7	
137	86.1		168	88.7	

Table S1. Continued.

T2
Outcome
BMI z-score
Waist circumference (cm)
PA summary score (1–5)
Healthy dietary behaviours (days/week) [1]
Soft drink consumption (days/week)
Water consumption at school (0–3) [2]
Fruit (% yes)
Vegetables (% yes)
Grains (% yes) [3]
Dairy (% yes) [4]
Water (% yes)
Butter (% yes)
At least two healthy food groups during lunch (% yes) [5]

[1] Healthy dietary behaviours: composite score for frequency of consumption of breakfast, fruit, vegetables, and water. [2] School water consumption ranged from never (0) to daily (3). [3] Grains consisted of the following items: bread and cereals. [4] Dairy consisted of the following items: milk/yoghurt and cheese. [5] Items in the healthy food groups included: fruit, vegetables, grains, dairy, water, and butter. Abbreviations: M, mean; SD, standard deviation; SES, socioeconomic status; PA, physical activity

Medium Implementers			Low Implementers		
n	% / M	SD	*n*	% / M	SD
136	-0.10	0.88	166	-0.05	0.98
136	61.12	5.94	166	61.57	7.11
136	3.12	0.62	166	3.17	0.65
82	5.45	0.90	119	5.52	0.84
82	3.35	2.61	119	3.43	2.70
136	1.63	1.20	166	1.73	1.17
136	22.8		166	23.5	
136	19.9		166	19.9	
136	94.9		166	92.8	
136	48.5		166	38.0	
136	44.9		166	38.6	
136	55.1		166	56.6	
136	89.7		166	86.7	

9

Supplementary Figure S1. Flowchart Study Participation.

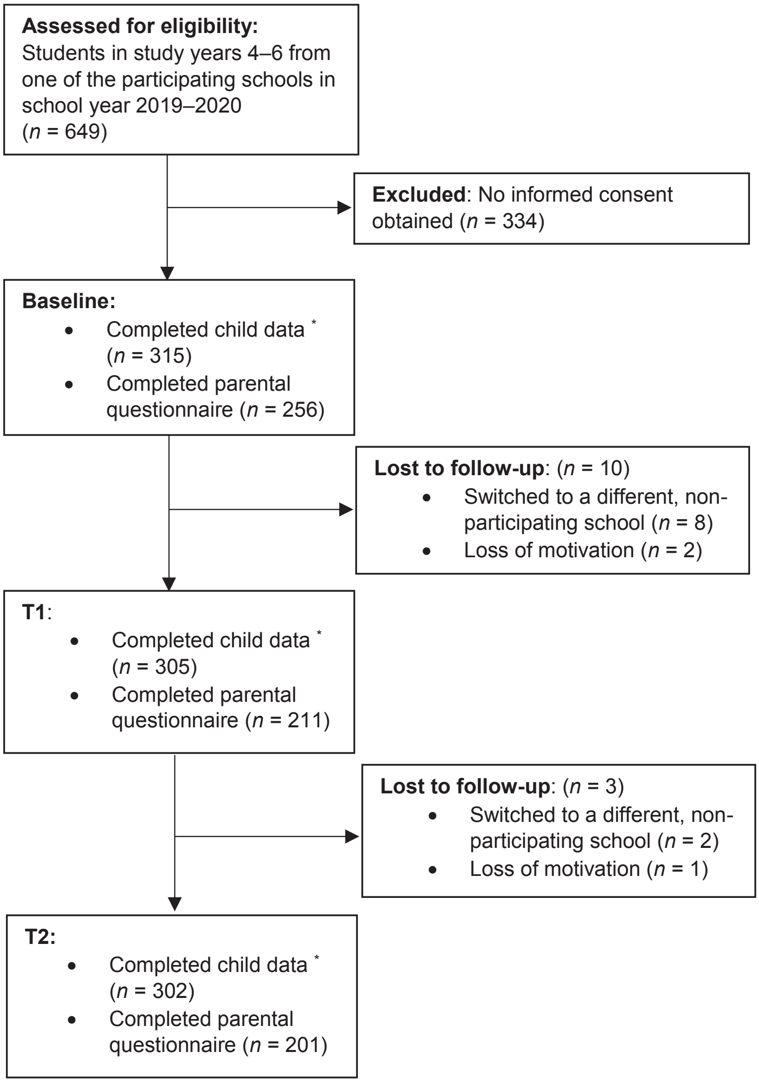

Figure S1. Flowchart study participation.

* Child data concerns anthropometric measurements and child-reported questionnaires.

CHAPTER 10

General Discussion

The research presented in this dissertation had several aims. To gain more insight into children's health literacy (HL) and its potential role in health promotion in children, two studies on the translation of an instrument to measure children's HL and the subsequent investigation of a potential relationship between children's HL and various health outcomes were performed. Furthermore, included studies investigated how and to what degree health-promoting activities were developed and implemented in diverse school settings, which factors were important during the development and implementation process, and to what extent and in what way the implemented activities influenced children's health (behaviours).

This chapter summarises and discusses the most important findings from the reported studies and provides implications and recommendations for research and practice. This is done in three sections: (1) the potential role of HL in children's health, (2) the effects of Kokkerelli and the Healthy Primary School of the Future (HPSF), and (3) the implementation of HPSF in a real-world context. The chapter ends with a general conclusion.

The Potential Role of HL in Children's Health

Although HL is a concept that is investigated regularly in adults, little knowledge is available on children's HL [1]. Considering the relationship between HL and several health outcomes in adults [2,3] and the idea that HL is a concept that develops throughout life, gaining more insight into children's HL and ways to improve this could be a valuable addition to the field of health promotion [4–7]. To provide more insight into the HL of Dutch children, the European Health Literacy Survey Questionnaire for Children (HLS-Child-Q15) was translated to Dutch and used to explore the HL distribution in a sample of 209 Dutch children (aged 8–11 years) (**Chapter 2**). The translated questionnaire had high internal consistency and moderate-to-strong item-total correlations. However, a high percentage of children selecting the 'do not know' answer option for six of the 15 items revealed comprehension problems. Questions asked by children during questionnaire administration furthermore indicated that children tended to answer on the basis of their knowledge and experience (e.g., 'I know what to do to relax' or 'I relax often') instead of on the basis of their perceived ease or difficulty to deal with health information. These interpretation problems were also seen in the qualitative pre-test of the original HLS-Child-Q15-DE [8]. HL scores were significantly higher for older children (10–11-year-olds compared with 8–9-year-olds) and for children in higher grades (fourth-grade students compared with third-grade students). These findings support the hypothesis that HL evolves throughout life and underpin the important role education (and therefore schools) can play in HL development.

Through translating the HLS-Child-Q15, the first Dutch measurement instrument for children's HL has become available. This provides new opportunities to investigate (the development of) children's HL in more detail and to develop interventions targeting children's HL. However, the comprehension and interpretation problems that were observed in the sample might indicate that HL is a difficult concept for children to grasp and that the HLS-Child-Q15 needs further tailoring to the target group (e.g., by simplifying item phrasing and/or adding pictures/example items). Children should be actively involved in the development and adaptation phase to make sure that the items connect adequately to their everyday life. Additionally, adult guidance might be beneficial for successful administration of the questionnaire, although excessive adult interference should be avoided to minimise influencing children's answers. A general supervision protocol might be helpful to ensure adequate adult guidance. Furthermore, more research is needed to investigate the instrument's test-retest reliability and construct validity (e.g., through repeated administration and/or comparing the instrument with other HL-related questions).

After translation of the HLS-Child-Q15, the instrument was used to look into the association between Dutch children's HL and (1) their body mass index (BMI) z-score, (2) their dietary behaviours, and (3) the amount of physical activity (PA) they engage in (**Chapter 3**). In a sample of 139 children (aged 8–11 years), the HLS-Child-Q15 was administered together with questions regarding children's dietary and PA behaviours. Furthermore, children's height and weight were measured to calculate their BMI z-score. A significant positive association was found between children's HL and their PA behaviours (i.e., children with higher HL tended to be more physically active). No significant association was found between children's HL and their BMI z-score and/or dietary behaviours. The fact that a significant association with HL was found for children's PA behaviours but not for their dietary behaviours might be the result of differences in the amount of autonomy children have over these behaviours. Potentially, children in this age range (8–11 years) have more autonomy over their PA behaviours than over their diet. Whilst parents/caretakers are most often responsible for family food shopping and preparation, children can decide more freely whether or not to engage in PA, both during and after school time. The absence of a significant association between children's HL and their BMI z-score and/or dietary behaviours could also be the result of limited variation in the sample. The BMI of the majority of the sample was within the normal range for children of this age group [9,10], indicating limited representativeness of the sample for the rest of Dutch children [11].

The study was one of the few studies worldwide and the first study in the Netherlands to assess the association between children's HL and several aspects of their health and lifestyle. However, considering the homogeneity of the present sample, additional research in a larger, more diverse sample is needed to further investigate this subject. Furthermore, considering that parents are important role models that can have a large influence on their children's (health) behaviours, it would be interesting to look into the association between parental HL and children's HL, something that has not yet been explored. Investigating the association between older children's HL and their health behaviours would also be of interest, as adolescents are hypothesised to have more autonomy over for example their dietary behaviours.

Following the two studies on children's HL that were described in the first part of this dissertation, there are various general recommendations to be made.

- *Further adaptation of the HLS-Child-Q15:*
    - Decrease the comprehension and interpretation issues, e.g., by including pictures/example items, simplifying phrasing of items and/or answer options, or experimenting with different degrees of adult guidance during questionnaire administration.
    - Involve children in the adaptation process to make sure the items connect adequately to children's everyday life.
- *Further testing of the HLS-Child-Q15:*
    - Investigate the instrument's test-retest reliability and discriminant and convergent validity by repeated administration and delivering the questionnaire in combination with other HL-related questions.
- *Further insight into children's HL:*
    - Administer the HLS-Child-Q15 (or–if available–other instruments assessing children's HL) in a larger, more diverse sample (e.g., in terms of ethnicity, educational level, and/or socio-economic status) to investigate the results' generalisability.
    - Study the association between HL and health (behaviours) in adolescents to see if these results differ from the results found in primary school-aged children.
    - Explore the potential association between parental and children's HL.

The Effects of Kokkerelli and HPSF

The second part of this dissertation (**Chapters 4–6**) described the effects of the primary school-based health-promoting interventions Kokkerelli and HPSF on a range of children's health outcomes.

Kokkerelli

Over the last years, various school-based health-promoting interventions aiming to improve children's (determinants of) fruit and vegetable (FV) intake have been developed, implemented, and evaluated [12–16]. Although evidence suggests that multi-component school-based interventions have the greatest potential to improve children's (determinants of) FV intake, interventions combining a classroom-based curriculum with experiential learning strategies (e.g., garden- or cooking-related activities) are still relatively seldom described [17–19]. The Dutch Kokkerelli learning street intervention is a multi-component school-based nutrition education intervention combining classroom-based and experiential learning strategies. The intervention consists of nine different 'learning streets': separate three-week programmes that each focus on one specific FV product. All learning streets include classroom-based lessons, a visit to a grower's farm, and a cooking workshop. To investigate the short-term and longer-term effects of the Kokkerelli intervention on children's determinants of FV intake (knowledge, taste preferences, attitudes, and intention), a quantitative evaluation was done (**Chapter 4**). In four control schools and 15 intervention schools, child-reported questionnaires were administered at baseline, directly after the intervention, and three months after the intervention. Significant positive short-term intervention effects were found for knowledge, taste preferences, attitude towards the assessed FV product, and general attitude towards healthy products. No significant intervention effects were observed at the longer term. The lack of significant longer-term intervention effects might be due to the intervention's limited intensity and duration [20]. The intervention consisted of four lessons/activities that took place within a three-week time span, after which schools continued with their regular curriculum. Furthermore, the intervention took place during school hours and limited efforts were made to include parents and the home setting, which are also known to have a large influence on children's dietary behaviours [21–23]. When looking at other comparable multi-component school-based nutrition education interventions that did show longer-term intervention effects, it can be seen that these interventions had a higher intensity and/or included components targeting parents and the home environment [17,24]. Repeating the Kokkerelli intervention several times a year and/or in various study years might therefore lead to longer-lasting effects, as well as extending the intervention with components targeting the home environment (e.g., family activities and/or homework assignments).

This study contributed to the evidence base regarding the effects of school-based nutrition education programmes deploying both traditional and experiential learning strategies [18]. Although no significant longer-term effects of the Kokkerelli intervention were found, the study provides insights and suggestions to improve this intervention and comparable interventions (e.g., through increasing intervention intensity and duration and/or by including a parental component). In this way, the study provides valuable information that can help intervention developers, researchers, schools, and other stakeholders in the field to maximise the impact of school-based nutrition education programmes. However, more research including a larger and more diverse sample is needed and other, more detailed measurement instruments should be used to investigate children's determinants of FV intake. Furthermore, the effects of the Kokkerelli intervention on children's actual FV intake should be studied, as the present study only looked at the effects on children's determinants of FV intake.

HPSF's Effects on Fruit and Vegetable Familiarity, Taste Preferences, and Intake

HPSF is a school-based health-promoting intervention that was implemented in several primary schools in the Parkstad region in Limburg, the southern part of the Netherlands. The intervention consisted of two main changes: (1) the provision of a daily healthy school lunch, and (2) daily structured PA sessions after lunch [25]. Although HPSF's positive effects were previously demonstrated on a wide range of health outcomes (e.g., BMI z-score, waist circumference, and dietary and PA behaviours) [26–28], the working mechanisms behind these observed effects were less clear. More insight into these mechanisms is valuable as it can facilitate further improvement of HPSF and comparable school-based health-promoting interventions. To investigate the effects of increased FV exposure through HPSF's healthy school lunch on children's FV familiarity, preferences, and intake, a quantitative evaluation was performed (**Chapter 5**). In two full HPSFs (focus: nutrition and PA) and two partial HPSFs (focus: PA), questionnaires were administered annually from 2015 to 2019 in 833 7–12-year-old children. These questionnaires measured the amount of unfamiliar and disliked FV items and children's FV intake. Analyses revealed significant positive intervention effects on children's vegetable familiarity after one and three years' exposure to HPSF (lower number of unfamiliar vegetable items). Significant unfavourable intervention effects were observed for vegetable preferences after one year (higher number of disliked vegetable items) and fruit intake after one and four years (lower fruit intake). The limited observed intervention effects could be the result of various reasons. Children's FV familiarity and preferences at baseline were already relatively high, indicating that there might have been limited room for improvement following exposure to the daily school lunch through HPSF. Furthermore, the type of exposure might have played a role in the limited effects that were observed. Although children were visually exposed to FV items as part of the school lunch, they were not obliged to consume FV, as they were free to compose their own meal from the lunch buffet. It is likely that the increased visual exposure, together with the encouragement from teachers and educational staff, led to an increase in FV familiarity. However, as FV tasting was not a standard part of the lunch, increased taste exposure did not always occur (only when a child decided to consume FV as part of their lunch). Previous research indicated that in order to be effective, exposure must take place in the same domain in which changes in preferences are desired (e.g., actual tasting is needed to increase taste preferences) [29,30]. The lack of increased taste exposure within HPSF could therefore explain the lack of observed intervention effects on taste preferences. Better results on preferences and intake might be achieved when the intervention is extended with a component focussed on the actual tasting of FV items. The age of the children included in the study sample (7–12 years) might also have played a role in the limited observed effects. The ease of food acceptance and preference formation seems to decrease as a child matures, and more exposure over a longer time seems necessary to influence older children's dietary behaviours. Furthermore, preferences formed early in life (i.e., during a child's first four years) tend to have a persistent long-term influence on food choices [29,31]. HPSF might therefore not have been powerful enough to influence the already-existing preferences of the children in the study sample, and it would be interesting to investigate the intervention's effects in younger children to see if the results would differ. The unfavourable intervention effects that were observed for fruit intake after one and four years might be attributable to compensatory behaviours [32–35]. Children might have consumed less fruit outside school hours as they felt that the extra fruit they had already eaten while at school would compensate for their consumption at home. The usage of more extensive instruments to measure children's FV intake (e.g., including questions on consumption time) could help to gain more insight into the potential occurrence of these compensatory behaviours.

This study shed more light onto the effects of increased FV exposure through the lunch provided as part of the HPSF intervention on children's FV familiarity, preferences, and intake. The study provides valuable suggestions for improvement to increase HPSF's impact, such as including less familiar FV items in the lunch and extending the intervention with a tasting component to increase children's taste exposure. More research should be performed to investigate the impact of the intervention on younger children's FV familiarity, preferences, and intake. Furthermore, the usage of other, more sensitive measurement instruments should be considered, as the questionnaires used in this study utilised three-point semantic differential rating scales for taste preferences and did not look at different dimensions of FV familiarity (e.g., familiarity of smell, taste, texture).

HPSF's Effects in the Home-Setting

As already discussed, HPSF is a school-based health-promoting intervention, meaning that all intervention components primarily focus on the school environment. The intervention's effects have therefore predominantly been investigated in this setting as well. However, gaining more insight into how changes in the school context might affect the home setting could provide valuable information to optimise the potential of lifestyle interventions targeting children. The impact of school-based interventions on health behaviour in the home context is seldom specifically investigated [13,15]. In HPSF's case, various behavioural changes in the home setting were mentioned during informal conversations with parents and teachers. However, quantitative analyses revealed no statistically significant intervention effects on children's health behaviour in the home context [36]. This discrepancy led to the hypothesis that HPSF-related changes in the home setting might have been more extensive and multidimensional than could be captured using quantitative methods alone. Therefore, a qualitative evaluation was performed which aimed to further investigate if exposure to the HSPF intervention resulted in any patterns of behaviour change in the home setting (**Chapter 6**). Between 2018 and 2019, 27 semi-structured interviews were conducted with parents from two HPSFs. In these interviews, questions were asked regarding participants' appreciation of HPSF and any perceived changes in PA and dietary behaviours in the home setting. The interviews revealed several behavioural changes at home following HPSF. These changes were initiated by both children and parents and entailed improvements in healthy behaviours as well as unhealthy compensatory behaviours. Children were found to be important change agents in the transfer of HPSF's contents to the home context. By changing their own behaviour at home, they influenced the rest of their family (e.g., by asking for healthy products that they had come to know at school or by questioning dietary habits of family members). Parents might be more open for behavioural changes when they are proposed by their children instead of other information sources, a phenomenon previously described as child-to-adult-intergenerational learning in relation to various other topics [37–41]. Despite the fact that HPSF primarily focussed on the school setting, parents were also directly influenced by the intervention and subsequently changed their behaviour at home. Reasons for behavioural change included increased awareness and perceived support to adopt healthy behaviours. However, various parents mentioned that the limited provision of HPSF-related information decreased their ability to implement all desired changes at home. Other barriers to behaviour change in the home setting included no perceived necessity for change and time and financial constraints. Globally, three key factors necessary for behavioural change initiated by parents could be identified: (1) awareness of one's behaviour, (2) willingness to change, and (3) ability to change (including e.g., financial and practical abilities and parental food literacy). These three prerequisites for behavioural change have previously been described under various names in other behaviour change research [42,43]. Next to the healthy changes that were mentioned, several parents reported that they themselves or their children engaged in unhealthy behaviours at home, as they felt that these behaviours were being compensated by the healthy changes implemented at school. The occurrence of this compensatory behaviour is something that has repeatedly been described in relation to various health behaviours [33–35,44,45].

Our study was one of the first to specifically investigate the impact of a school-based health-promoting intervention on health behaviours in the home setting. Both child-to-adult intergenerational learning and parent-initiated changes played an important role in the transfer of health behaviours from school to home and are therefore key mechanisms to maximise school-based health-promoting interventions' impact. It is recommended to further stimulate parental involvement through e.g., family activities, homework assignments, and/or more extensive provision of intervention-related information. The fact that behavioural changes at home were found in this qualitative study but were not observed in previous quantitative analyses underpins the importance of taking a mixed-methods approach to get a more in-depth picture of the phenomenon under investigation [46–48]. Behavioural change comes about slowly, consists of various aspects, and is often hard to identify, and the qualitative nature of the interviews conducted in the present study might have facilitated participants to become aware of the changes that might have occurred.

The findings from the studies on the effectiveness of Kokkerelli and HPSF can be used to further improve these specific interventions as well as other, comparable interventions. In short, there are several general recommendations to maximise school-based health-promoting interventions' impact that follow from the studies presented in this part of the dissertation. Furthermore, several research-oriented recommendations can be made.

- *Further improvement of school-based health-promoting interventions:*
    - Increase interventions' (longer-term) impact through guaranteeing adequate intervention duration and sufficient intervention intensity (e.g., by repeating an intervention several times a year or over multiple study years).
    - Include an intervention component involving actual taste exposure in interventions aiming to increase children's FV taste preferences and intake through increased exposure (e.g., the lunch in the HPSF intervention).
    - Stimulate an intervention's transfer from school to the home setting through increasing parental involvement and child-to-adult-intergenerational learning (e.g., by including family activities, homework assignments, and/or more extensive intervention-related information provision).

- Provide guidance and support to both parents and children to prevent/minimise the occurrence of compensatory behaviours potentially diminishing intervention effects.
- *Further insight into school-based health-promoting interventions' (longer-term) effects:*
    - Re-evaluate the intervention effects of Kokkerelli and HPSF after intervention adaptation (e.g., increasing intervention duration and intensity and/or stimulating parental involvement).
    - Use more sensitive and detailed data collection instruments to investigate the effects of Kokkerelli and HPSF.
    - Take a mixed-methods approach combining quantitative and qualitative instruments when investigating an intervention's effects on behavioural outcomes.

The Implementation of HPSF in a Real-World Context

The last part of this dissertation comprised of research performed on the implementation and effectiveness of the scaled-up HPSF initiative in several real-world primary school contexts (**Chapters 7–9**).

Following HPSF's positive impact that was previously demonstrated in the efficacy trial in the Parkstad region [26–28], educational board Prisma, overarching several primary schools in the Peel en Maas municipality, expressed its interest in implementing HPSF-related initiatives in its context. This interest led to the initiation of the HPSF scaling-up project, which was set up in close collaboration with Hoera childcare centres and Maastricht University. In this project, the 11 primary schools within educational board Prisma were free to implement health-promoting activities fitting their unique context and the wishes and needs of various stakeholders (e.g., directors, managers, teachers, parents, and children). The health-promoting activities had to fall in at least one of the following four categories: (1) healthy and sustainable nutrition, (2) sufficient PA, (3) sufficient rest and relaxation, and (4) social involvement. It was hypothesised that by giving schools the freedom to implement activities fitting their context instead of making them implement a pre-defined intervention (as was the case in the HPSF efficacy trial), sustainable integration of health promotion within the school system would be stimulated. Furthermore, this set-up more accurately represented a real-world situation than the relatively controlled setting in which HPSF's efficacy was previously demonstrated, which could provide valuable information to facilitate further dissemination of the HPSF initiative. Schools were responsible for the implementation of health-promoting activities within their context, but they could ask for help from a process coordinator appointed by the educational board. This coordinator organised regular meetings with various stakeholders and provided them with ideas for possible activities. Researchers played an observing role in the project. They gathered data on the schools' implementation processes through observing relevant meetings, administering questionnaires, and conducting semi-structured interviews with school directors, managers, and teachers. Furthermore, they gathered data on children's health and well-being (through anthropometric measurements and parental and child-reported questionnaires) to investigate the impact of the implemented health-promoting activities on a range of children's health outcomes. Collection of implementation data and effectiveness data took place from 2019 to 2023.

As there is limited information on how to analyse and report about the combination of effectiveness data and implementation data collected as part of intervention evaluation in complex and diverse settings [49,50], the set-up of the HPSF scaling-up project posed several (methodological) challenges. Therefore, an approach for data categorisation was proposed which could facilitate structuring the study's results and relating the degree of implementation to any impact on effectiveness outcomes that might be observed (**Chapter 7**). A variety of existing theories and approaches and their advantages and disadvantages was discussed. Furthermore, the newly proposed approach was further specified by (hypothetically) applying it to the HPSF scaling-up project. Inspired by Rogers' Diffusion of Innovations theory [51], participating schools would be categorised as innovators/early adopters, early majority, late majority, or laggards. Categorisation would take place at the end of the project (after finishing data collection) and would be done on the basis of the schools' degree of innovativeness. This degree of innovativeness would be operationalised through the number of HPSF key points that schools adhered to at the end of the project. Four HPSF key points defining optimal implementation of HPSF were formulated by stakeholders involved in the efficacy trial to facilitate further dissemination of HPSF. For optimal implementation, various stakeholders (e.g., school staff, children, and parents) should be actively involved (key point 1) and a school-wide approach should be taken, meaning that implemented activities should reach all children within a school (key point 2). Furthermore, all children should engage in at least one hour of PA every day (key point 3) and should consume a daily healthy lunch at school (key point 4). If a school participating in the HPSF scaling-up project would adhere to all four HPSF key points at the end of data collection, this would be defined as having the highest degree of innovativeness and the school would be categorised in the innovators/early adopters category. Alternatively, schools not adhering to any key points at the end of data collection would have the lowest degree of innovativeness and would consequently fall in the laggards category.

Categorising schools using this approach could ease comparison and could serve as a way to structure the study's results. Furthermore, the approach could be used to generate more insight into HPSF's effectiveness under varying circumstances, as it provides the opportunity to compare HPSF's impact observed in the efficacy trial with any effects observed in the scaling-up project. However, the approach is not yet empirically tested and elaboration and adaptation are necessary for further improvement and to increase its validity. For example, the categorisation of schools in the different adopter categories is rather imprecise when using dichotomised key points (i.e., categorising schools on the basis of whether or not they adhere to the various key points). Using a more continuous categorisation approach could provide a more nuanced and sensitive degree of implementation for the various schools, something that was also impossible to do in the HPSF efficacy trial where schools were categorised as full HPSFs, partial HPSFs, or control schools. Obtaining this more sensitive degree of implementation would facilitate the identification of certain HPSF principles that result in more health-related impact than others, and the recognition of general implementation factors and/or strategies that would facilitate the implementation of these principles in various settings. Besides the relative impreciseness of data categorisation, it should be noted that categorisation with the proposed approach happens at one moment in time. As implementation is thought to be a continuous process that is never finished, categorisation at a different moment could therefore lead to different results. This is in line with the continuously changing complex and real-world settings in which the HPSF scaling-up project takes place. To stimulate further adaptation of the proposed data categorisation approach and the development of other adequate and feasible evaluation approaches, knowledge and experience sharing among researchers evaluating interventions in complex, real-world systems is encouraged.

To gain insight into the implementation processes in the various schools participating in the HPSF scaling-up project, an implementation study was performed in which relevant meetings were observed, questionnaires were administered, and semi-structured interviews were conducted with school directors, managers, and teachers (**Chapter 8**). The framework by Fleuren, Wiefferink, and Paulussen was used to identify factors influencing implementation in the various schools [52]. This framework was previously used in dissemination research in the school setting [53,54] and states that an innovation process is influenced by characteristics of the socio-political context (e.g., existing rules and regulations), the organisation (e.g., staff capacity, available time and resources), the innovation strategy (e.g., coordination and communication), the innovation's user(s) (e.g., beliefs and perceived support), and the innovation itself (e.g., compatibility and complexity) [52].

Despite the educational board's initial aim to implement the HPSF intervention (i.e., a daily healthy school lunch and structured PA sessions) in several of its schools, the HPSF scaling-up project resulted in the implementation of small, incidental health-promoting activities only (e.g., the daily provision of a FV item and/or small adaptations to the schoolyard). Implementation research revealed various factors to have played a role in this limited implementation. The project largely took place during the COVID-19 pandemic, which was a major factor limiting implementation. Schools were forced to close on several occasions and had to deal with high staff absenteeism and strict safety regulations (e.g., social distancing and limited presence of parents/volunteers within the school) after re-opening. These challenges, combined with the quickly changing situation that often called for ad-hoc decision making, limited schools' capacity to implement activities and made it difficult to develop and adhere to a long-term project plan. As the COVID-19 pandemic had a substantial impact on the project, more research is needed to investigate the implementation of HPSF in diverse, real-world settings in the absence of a pandemic restricting schools' ability and capacity to implement health-promoting activities. Various other factors limiting implementation could be identified. The most important factors were related to project commitment and bottom-up involvement, repeatedly identified as key factors in the implementation of school-based health-promoting programmes [53–55]. Lack of project commitment and bottom-up involvement were observed at different stages and on different levels (project level, educational board level, and school level). Project responsibility was primarily placed with the educational board and the individual schools, meaning that unlike during the HPSF efficacy trial, there was no external project team working on creating project commitment and involvement across school directors, teachers, staff members, parents, and children [25,55]. It was hypothesised that the enthusiasm of the educational board to implement HPSF-related initiatives would stimulate commitment and involvement across other stakeholders. However, the educational board did not include school directors, teachers, and/or parents in the decision to participate in the scaling-up project, which indicated a low level of bottom-up involvement from the start of the project. Limited leadership engagement at the educational board level (e.g., a lack of setting and communicating clear project expectations and goals) made that school directors and staff members felt overwhelmed by the project and did not know what was expected of them, further limiting project involvement. Given the importance of commitment creation, stakeholder involvement, and leadership engagement for sustainable implementation [55–62], for future projects it is crucial to provide extensive support at the project's start (e.g., through using co-creation methods) to guide educational boards and schools in how to adequately do this [63]. On school level, school directors were primarily responsible for all project-related issues and were hesitant to involve their team as this could further increase their workload, which was already being perceived as high. As a result, teachers experienced limited ownership and/or motivation to work on the project, something that was further aggravated by a limited perceived necessity to work on the project [54,57]. In most schools, teachers were already satisfied with children's health status and the amount of attention being payed to health promotion prior to the project. Focussing on health benefits might therefore not always be the right strategy to create commitment for health promotion in schools. It is important to use information fitting a school's specific context when trying to motivate them to work on health promotion. In some schools (e.g., the schools involved in the HPSF efficacy trial, where children's health status was alarming), this might be information regarding health benefits, but in other schools (e.g., schools located in regions with less health issues), this could be mentioning the opportunity for a school to distinguish itself from other schools. Obtaining a detailed overview of a school's context is therefore a vital step to relate the subject of health promotion to a school's specific needs and wishes and cannot be disregarded when aiming to integrate health promotion in a school. A school's context and the needs and wishes of various stakeholders should guide the choice for and implementation of various health-promoting activities. The focus does not necessarily need to be on widespread implementation of a specific set of pre-defined intervention components (e.g., the school lunch and the PA sessions that were part of the HPSF intervention evaluated in the original efficacy trial). Rather, schools should be able to implement activities that are in line with an intervention's underlying principles and that they feel are appropriate for their context. Schools can for example work on HPSF's underlying principle of stimulating children's healthy dietary behaviours at school by implementing a healthy lunchbox policy instead of providing a healthy school lunch as was done in the HPSF efficacy trial. To further advance the evidence base and to provide valuable information for intervention developers, policymakers, and other stakeholders, it would be beneficial to investigate the effectiveness of these different 'intervention variations' on children's health.

Besides factors limiting implementation, various facilitating influences could be identified during the HPSF scaling-up project, such as the presence of the process coordinator. Through sharing other schools' experiences and providing information regarding potential health-promoting activities, this coordinator stimulated stakeholders to work on the project. For widespread dissemination of school-based health-promoting initiatives, the long-term presence of an external process coordinator at every school is not feasible. Instead, it might be better to identify and train in-school champions and/or school-wide project groups who can take over after the process coordinator supported schools in the stimulation of involvement and commitment and the formation a health-related vision. These champions and members of the project group can use their motivation, enthusiasm, and persistence to stimulate the sustainable implementation of health-promoting activities within their school context [64]. The importance of identifying and empowering organisation champions (e.g., by appointing a teacher as a healthy school coordinator) to successfully scale up public health interventions has been described previously in other comparable research within and beyond the school-setting [61,63,65–67].

Our study used a mixed-methods approach to investigate the implementation of the scaled-up HPSF initiative. Following diverse schools in their natural setting allowed for a real-world insight in project implementation, which provided a valuable addition to the process evaluation of the original HPSF trial (a more controlled situation) that was previously performed [55]. The process evaluation of the original HPSF trial followed a contextual action-oriented research approach (CARA), which aided the formation of a detailed picture of the implementation processes within a complex context [55]. However, a challenge related to this approach is that it is time consuming and demands a lot from researchers. When health promotion is disseminated to substantially more schools, close involvement of researchers during the implementation process is no longer feasible. Furthermore, within CARA, researchers are actively participating in the implementation process and can therefore influence implementation and/or effectiveness. To reflect the daily reality in the schools as accurately as possible without the potential influence of researchers, it was chosen not to follow CARA in the implementation study described in this dissertation. Instead, researchers took on an observing role and were not actively involved in the implementation processes at the various schools. The framework by Fleuren et al. was used to identify factors influencing implementation in the various schools [52]. This framework was chosen as it was previously used in comparable research [53,54] and provides a comprehensive overview of different factors potentially influencing implementation. There are various other frameworks, models, and theories to evaluate (factors influencing) implementation, such as the evaluation roadmap developed by McKay et al. [68]. According to Nilsen, these approaches can, on the basis of their aim, be divided into three categories: (1) process models (approaches that aim to describe and/or guide the process of translating research into practice), (2) determinant frameworks/classic theories/ implementation theories (approaches that aim to understand and/or explain what influences implementation outcomes), and (3) evaluation frameworks (approaches that aim to evaluation implementation) [69]. When selecting a framework, model, or theory for implementation research, alignment with the study's aims is recommended. In line with the aim of the implementation research described in this dissertation (to identify factors influencing implementation of health-promoting activities in complex and diverse school-contexts), we therefore chose a determinant framework (the framework by Fleuren et al.) to support our research. For implementation research with a different aim other implementation frameworks, models, or theories might be more suitable.

As there is limited information on the impact of school-based health-promoting interventions in diverse, real-world settings, an effectiveness evaluation was performed of the impact of the scaled-up HPSF initiative on children's health and well-being (**Chapter 9**). Between 2019 and 2022, anthropometric measurements were performed and questionnaires assessing children's dietary and PA behaviours were administered in 315 children from study years 4–6 of the 11 schools participating in the scaling-up project. The initial aim prior to data collection was to compare the gathered data using the data categorisation approach proposed in Chapter 7 of this dissertation. However, as implementation within the project was limited, there was a low variation in number of HPSF key points adhered to by the schools. This made it impossible to divide the schools in the four proposed categories (innovators/early adopters, early majority, late majority, and laggards). Instead, schools were categorised on the basis of the intensity of the activities that they implemented. This resulted in the formation of two groups: medium implementers (six schools) and low implementers (five schools). Table 1 in Chapter 9 of this dissertation provides a detailed overview of the activities implemented within each school and the corresponding categorisation. The project's effectiveness on various health outcomes was compared between the medium implementers and the low implementers. After correction for baseline, waist circumference in the medium implementer group was significantly higher at one-year and two-year follow-up compared with the low implementer group. No significant effects were observed for other outcomes. The minimal effects are mainly due to limited implementation, which was the result of various factors (e.g., the COVID-19 pandemic and limited bottom-up involvement, commitment, and perceived necessity for change). The significant increase in waist circumference in medium implementers compared with low implementers at one-year and two-year follow-up is striking. Various potential causes for this increase were investigated and ruled out (e.g., measurement errors and/or selective dropout). Potentially, the significant increase in medium implementers' waist circumference corresponds to a regression to the mean, as at baseline, waist circumference in the medium implementer group was significantly lower than in the low implementer group. However, this hypothesis cannot be verified, as there are no commonly accepted reference values for waist circumference in Dutch children.

This study is one of the few studies investigating the effectiveness of a scaled-up school-based health-promoting initiative in a real-world context, and therefore had the potential to provide valuable information for researchers, policymakers, and other stakeholders [70-73]. However, the pragmatic nature of the HPSF scaling-up project made the project and the corresponding research vulnerable to external influences. Limited implementation of health-promoting activities within the schools restricted the ability to create distinct categories and compare schools with each other using the data categorisation approach proposed in Chapter 7 of this dissertation. Alternative categorisation of the schools in medium implementers and low implementers was necessary (see Table 1 in Chapter 9), and the small differences in intensity of implemented activities between these groups might have contributed to the lack of observed effects. The fact that no standardised intervention was allocated and all schools implemented their own set of health-promoting activities further complicated comparison between schools. Categorising schools into two groups meant that schools implementing (slightly) different activities were combined into the same group, and using a different combination of schools within the groups could potentially have led to different results. However, when categorising schools it was made sure that the activities implemented by schools combined in one group were comparable, and analyses using a different categorisation with three groups (high, medium, and low implementers) showed comparable results. This led to the conclusion that the categorisation of schools had limited influence on the study's results. To better inform intervention developers, policymakers, and other stakeholders, more research is needed into the effectiveness of HPSF and other school-based health-promoting programmes in diverse, real-world settings. Widespread dissemination of these programmes will likely lead to schools implementing (slightly) different versions of the programmes to make them fit schools' contexts (e.g., schools adapting HPSF by implementing a healthy lunchbox policy instead of providing a healthy school lunch). Gaining more insight into the effectiveness of different intervention variations could help to identify certain intervention principles that lead to more health-related impact than others do. Besides focussing on different intervention variations, future effectiveness research should preferably be done in a more diverse sample (e.g., including schools with varying degrees of ethnic diversity, from different educational boards, and/or located in different areas) and in the absence of a pandemic greatly restricting schools' ability to implement health-promoting activities.

Following the research performed as part of the HPSF scaling-up project, there are several general recommendations that can be made.

- *Research combining implementation data and effectiveness data in complex, real-world settings:*
    - Further test and adapt the data categorisation approach proposed in this dissertation (e.g., increase its sensitivity by using a more continuous categorisation method).
    - Increase the evidence base regarding this specific research field through knowledge and experience sharing among researchers performing comparable research.
- - *Further integration of health-promoting initiatives in diverse school settings:*
    - Gain a detailed overview of a school's context, wishes, and needs and use setting-specific information that is relevant for a school to create commitment and motivation within a school to work on health promotion.
    - Support educational boards and schools in the stimulation of bottom-up involvement and commitment and the formation of a health-related vision.
    - Although there is no complete evidence about their effectiveness yet, openness to (slightly) different intervention variations is advised, as this will facilitate widespread dissemination of health-promoting initiatives to more school settings. Do not hold on to specific intervention components (e.g., providing a healthy school lunch), but focus on the underlying intervention principles (e.g., stimulating children's healthy dietary behaviours at school).
    - Limit schools' long-term dependence on external support by identifying and training in-school champions and/or school-wide project groups who can involve and activate other staff members to work on health promotion.
- *Further insight into the dissemination of HPSF and comparable interventions in diverse school settings:*
    - Perform a comparable effectiveness study in the absence of a global pandemic to investigate HPSF's effectiveness when schools have the opportunity to implement more extensive health-promoting activities.
    - Investigate the effectiveness of (different variations of) other scaled-up school-based health-promoting programmes implemented in diverse real-world settings to further advance the evidence base and to provide valuable information for intervention developers, policymakers, and other stakeholders.

Health Promotion beyond the School Setting

Integrating health promotion in the school setting can be a powerful tool. At school, there is no differentiation between children from different socioeconomic backgrounds; all children are exposed to the same school environment. Once the school day is over, however, socioeconomic differences and other (environmental) factors can play a much greater role. Frameworks such as the ANGELO framework (ANalysis Grid for Environments Linked to Obesity) identify various environments that influence (children's) health behaviours [74]. To ensure and maximise the effectiveness of health promotion efforts, it is important that these efforts are aligned across the different environments of influence. Initiatives such as 'Jongeren op Gezond Gewicht' (JOGG) aim to stimulate the formation of healthy environments for children, e.g., through initiating healthy changes at sports clubs and by limiting children's marketing of unhealthy products in supermarkets [75]. To ensure that children are exposed to the same healthy environment in the different settings in which they reside (e.g., school, sports club, home) a strong collaboration between school-based health-promoting initiatives such as HPSF and initiatives targeting different environments such as JOGG is desirable.

In addition, health-promoting initiatives and programmes should not only focus on improving health behaviours such as dietary habits and PA. They should also take into account factors that often underlie an unhealthy lifestyle (e.g., low educational level, (financial) stress) as these challenges often make it difficult to implement healthy behavioural changes.

General Conclusion

The aim of the research presented in this dissertation was to gain more insight into children's HL and to evaluate the implementation and effectiveness of various health-promoting activities in complex and diverse primary school settings. The research shed light on the potential influence of children's HL on their health (behaviours) and the importance of further investigating this subject. It also provided valuable recommendations to further improve the Kokkerelli and the HPSF intervention, such as including elements to stimulate parental involvement and to increase the actual tasting of FV items. The research revealed several challenges for the implementation of health promoting activities in diverse school contexts. However, when health promotion is integrated in a school context, it can have a high potential impact. Through the school environment, numerous children can be reached during critical developmental years. Stimulating children to form and engage in healthy lifestyle habits from a young age is likely to lead to an adult population with healthier habits. Furthermore, children can influence their parents and other family members' health behaviours, thereby expanding the positive impact of school-based health promotion to a wider population.

Considering the potential health impact of school-based health-promoting interventions, it is recommended to integrate health promotion within each school context. To achieve this, it is important to move from evaluating school-based health-promoting interventions in relatively small, controlled contexts to testing the interventions' impact in diverse, real-world settings in which various external influences and challenges can limit interventions' effectiveness. When aiming to integrate health promotion in schools, gaining an elaborate overview of a school's context is necessary to align the subject with a school's specific wishes and needs. Different intervention variations should be welcomed to make the intervention fitting for various school contexts, as long as the focus is still on an intervention's underlying principles. The effectiveness of these different intervention variations should be evaluated to gain more insight into their impact. Schools should be guided in the process of stimulating commitment and bottom-up involvement and the creation of a health-related vision, and efforts should be made to reduce the various barriers that schools experience with regard to the implementation of health-promoting initiatives (e.g., limited space in the curriculum, high workload, and limited financial resources). Furthermore, in-school champions and/or school-wide project groups should be identified and trained to decrease schools' long-term dependence on external support and to facilitate long-term integration of health promotion in the schools' context.

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APPENDIX

Summary

The aim of the research presented in this dissertation was to evaluate the implementation and effectiveness of various health-promoting activities in complex and diverse primary school settings. To gain more insight into children's health literacy (HL) and its potential role in health promotion in children, two studies on the translation of an instrument to measure children's HL and the subsequent investigation of a potential relationship between children's HL and various health outcomes were presented. Furthermore, the included studies investigated how and to what degree health-promoting activities were developed and implemented in diverse school settings, which factors were important during the development and implementation process, and to what extent and in what way the implemented activities influenced children's health (behaviours) and well-being.

Chapter 2 described the translation of a questionnaire to measure children's HL (HLS-Child-Q15) to Dutch and the exploration of primary school-aged children's HL distribution. The HLS-Child-Q15-DE was translated following guidelines from the World Health Organisation and administered digitally to 209 Dutch schoolchildren (aged 8–11-years). The HLS-Child-Q15-NL had high internal consistency (Cronbach's $\alpha = 0.860$) and moderate to strong item-total correlations (mean = 0.499). For six of the 15 items, > 10% of participants answered 'do not know', indicating comprehension problems. Higher HL scores were observed for 10–11-year-olds (compared with 8–9-year-olds; $p = 0.021$) and fourth-grade students (compared with third-grade students; $p = 0.019$). These findings support the idea that HL evolves throughout life and underpin the importance of schools in this process. With the HLS-Child-Q15-NL, a Dutch measurement instrument for children's HL is available, although it needs further tailoring to the target group. More research is needed to decrease comprehension problems and to investigate retest reliability and construct validity.

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Chapter 3 further looked into the impact of Dutch children's HL on (1) their body mass index (BMI) z-score, (2) their dietary behaviours, and (3) the amount of physical activity (PA) they engage in. A sample of 139 children (aged 8–11 years) filled out a digital questionnaire, including an HL measurement instrument (HLS-Child-Q15) and questions regarding their food intake and PA. Furthermore, children's height and weight were measured and background information was collected using a parental questionnaire. Multiple regression revealed a significant positive relation between children's HL and their PA ($p = 0.002$). No significant association between children's HL and their BMI z-score or dietary behaviours was found. In conclusion, HL of children in primary school was associated with some aspects of children's lifestyle, although more research in a larger, more diverse sample is needed to further investigate this.

Chapter 4 described the quantitative evaluation of the short-term and longer-term effects of a multi-component school-based nutrition education intervention combining classroom-based and experiential learning strategies (the Kokkerelli intervention) on children's determinants of their fruit and vegetable (FV) intake (knowledge, taste preferences, attitudes, and intention). Data were collected in Dutch primary schools (four control schools and 15 intervention schools) through child-reported questionnaires at baseline, directly after the intervention, and three months after the intervention. After correction for baseline values, sex, age, and FV product assessed in the questionnaire, the intervention group showed a significant increase in knowledge (p = 0.001; standardised effect size (ES) = 0.60), taste preferences (p = 0.002; ES = 0.52), attitude towards the assessed FV product (p = 0.004; ES = 0.48), and general attitude towards healthy products (p = 0.01; ES = 0.39) over the short term, when compared to the control group. The significant intervention effects did not sustain over the longer term. The findings implicate short-term intervention success, although more research and intervention adaptations (e.g., repeating the intervention over several years or including components stimulating parental involvement) are recommended to increase the impact of the Kokkerelli intervention, especially over the long term.

Chapter 5 presented the results of the quantitative evaluation of the effects of repeated FV exposure through the Healthy Primary School of the Future (HPSF) intervention on children's FV familiarity, preferences, and intake. The study had a longitudinal quasi-experimental design comparing two full HPSFs (focus: nutrition and PA) with two partial HPSFs (focus: PA) in the Netherlands. Annual measurements (child-reported questionnaires) were conducted from 2015 to 2019 in 833 7–12-year-old children. After correction for baseline values, full HPSFs had, on average, a lower number of unfamiliar vegetable items after one year (p = 0.009; ES = -0.28) and three years (p = 0.008; ES = -0.35) and a higher number of disliked vegetable items after one year (p = 0.016; ES = 0.24) than partial HPSFs. Unfavourable intervention effects were observed for fruit intake after one year (p = 0.030; odds ratio (OR) = 0.609) and four years (p = 0.005; OR = 0.451). Repeated FV exposure had limited effects on children's FV familiarity, preferences, and intake, likely due to insufficient actual taste exposure. Extending the lunch of HPSF with an actual tasting component might lead to more prominent effects on children's FV familiarity, preferences, and intake. Considering the widespread implementation of school-based mere exposure efforts, it is highly relevant to further investigate under which circumstances mere exposure can effectively contribute to improvements in (determinants of) FV intake.

Chapter 6 reported the impact of HPSF on the health behaviours of children and parents in the home setting as qualitatively examined through the use of 27 semi-structured interviews with parents from two HPSFs. HPSF resulted in various behavioural changes at home, initiated by both children and parents. Parents reported improvements in healthy behaviours, as well as compensatory, unhealthy behaviours. Reasons for behavioural change included increased awareness, perceived support to adopt healthy behaviours, and children asking for the same healthy products at home. Barriers to change included no perceived necessity for change, lack of HPSF-related information provision, and time and financial constraints. Both child-to-adult intergenerational learning and parent-initiated changes play an important role in the transfer of health behaviours from school to home and are therefore key mechanisms to maximise school-based health-promoting interventions' impact.

Chapter 7 described the evaluation of primary school-based health-promoting activities in complex systems as part of the HPSF scaling-up project. Furthermore, an approach for data categorisation was presented that could facilitate structuring the study's results and relating the degree of implementation to any impact on effectiveness outcomes that might be observed. This data categorisation approach could be useful to generate more insight into an intervention's effectiveness under varying circumstances, and optimal support and advice could be provided to stakeholders to achieve maximum impact of population-based health-promoting interventions in complex, real-world systems. However, the proposed approach is a first suggestion and further testing and adaptation is necessary to increase its usefulness. Knowledge and experience sharing among researchers performing comparable research can increase the knowledge base regarding this subject and is therefore encouraged.

Chapter 8 elaborated on (factors influencing) the implementation of health-promoting activities in various Dutch primary schools participating in HPSF's scaling-up project. Data were collected during three school years (2019–2022) through observations, questionnaires, and semi-structured interviews. The project resulted in the implementation of small, incidental activities (e.g., the provision of a daily FV item). Important reasons for the limited implementation were lack of commitment and bottom-up involvement. School directors and teachers were not involved early on in the project, which limited project support and commitment. On school level, directors largely carried project responsibility themselves, hindering project sustainability and integration. The COVID-19 pandemic, related restrictions such as school closures and social distancing measures, and the rapidly changing situation made that schools had difficulties forming long-term visions and plans. Other observed barriers included limited perceived necessity to change, high workload, and high staff turnover. Important facilitators were the presence of a process coordinator and sharing experiences from other schools. More extensive support is needed to create commitment, bottom-up involvement, and a project vision. Furthermore, identifying and empowering in-school champions and/or school-wide project groups is desirable to decrease schools' dependence on long-term external support. The findings can be used by various stakeholders throughout development, adoption, and implementation, and can facilitate widespread dissemination and sustainable integration of school-based health-promoting interventions.

Chapter 9 presented the results of the effectiveness evaluation of the scaled-up HPSF project in various real-world school contexts. From 2019 to 2022, Dutch primary schools participating in the project independently implemented HPSF-related activities. In 315 participating children from study years 4–6 from these schools, anthropometric measurements were performed and questionnaires assessing children's dietary and PA behaviours were administered. The COVID-19 pandemic greatly limited implementation of HPSF-related activities. Therefore, results were compared between schools categorised as medium implementers and schools categorised as low implementers. After correction for baseline values, children's sex, study year at baseline, and children's socio-economic status, waist circumference in the medium implementer group was significantly higher at one-year follow-up (corrected mean difference B = 1.089, $p = 0.003$) and two-year follow-up (B = 1.665, $p < 0.001$) compared with the low implementer group. No significant effects were observed for other outcomes. The study showed hardly any effects of the scaled-up HPSF initiative, mainly due to limited implementation caused by the COVID-19 pandemic. To better inform intervention developers and policymakers, more research is needed into the effectiveness of HPSF in diverse, real-world settings in the absence of a pandemic restricting schools' ability and capacity to implement health-promoting activities.

Chapter 10 discussed the most important findings from the research described in this dissertation and provided recommendations for research and practice. The research shed light on the potential influence of children's HL on their health (behaviours) and the importance of further investigating this subject. It also provided suggestions to further improve the Kokkerelli and the HPSF intervention, such as including elements to stimulate parental involvement. Considering the potential health impact of school-based health-promoting interventions, it is recommended to integrate health promotion within each school context. To achieve this, it is important to move from evaluating school-based health-promoting interventions in relatively small, controlled contexts to testing the interventions' impact in diverse, real-world settings in which various external influences and challenges can limit interventions' effectiveness. The HPSF scaling-up project described in this dissertation largely took place during the COVID-19 pandemic, which had a negative influence on the project and limited the ability to investigate the implementation and effectiveness of HPSF-related activities in the participating schools. However, the performed research still provided valuable recommendations for actions to be undertaken by various stakeholders throughout the development, adoption, and implementation of school-based health-promotion. When aiming to integrate health promotion in schools, gaining an elaborate overview of a school's context is necessary to align the subject with a school's specific wishes and needs. Schools should be guided in the process of stimulating commitment and bottom-up involvement and the creation of a health-related vision, and efforts should be made to reduce the various barriers that schools experience with regard to the implementation of health-promoting initiatives (e.g., limited space in the curriculum, high workload, and limited financial resources). Furthermore, in-school champions and/or school-wide project groups should be identified and trained to decrease schools' long-term dependence on external support and to facilitate long-term integration of health promotion in the schools' context.

APPENDIX

Samenvatting

Het doel van het onderzoek gepresenteerd in dit proefschrift was om de implementatie en effectiviteit van verschillende gezondheidsbevorderende activiteiten in complexe en diverse basisschool-settingen te evalueren. Twee studies zijn geïncludeerd die tot doel hadden om meer inzicht te krijgen in de gezondheidsvaardigheden van kinderen en de mogelijke rol hiervan in gezondheidsbevordering. Daarnaast onderzochten de beschreven studies hoe en in welke mate gezondheidsbevorderende activiteiten geïmplementeerd werden in diverse school-settingen, welke factoren van belang waren tijdens het implementatieproces en in welke mate en op welke manier de geïmplementeerde activiteiten de gezondheid en het welzijn van kinderen beïnvloedden.

Hoofdstuk 2 beschreef de vertaling naar het Nederlands van een vragenlijst om gezondheidsvaardigheden in kinderen te meten (HLS-Child-Q15). De HLS-Child-Q15-DE werd vertaald volgens richtlijnen van de Wereld Gezondheidsorganisatie en vervolgens digitaal voorgelegd aan 209 Nederlandse basisschoolleerlingen (8–11 jaar oud). De HLS-Child-Q15-NL had een hoge interne consistentie (Cronbach's $\alpha = 0,860$) en matige tot sterke item-totaal correlaties (gemiddelde = 0,499). Voor zes van de vijftien items selecteerde > 10% van de deelnemers de antwoordoptie 'weet ik niet', wat wees op begripsproblemen. Hogere gezondheidsvaardigheden-scores werden gevonden voor 10–11-jarigen (vergeleken met 8–9-jarigen; $p = 0,021$) en voor deelnemers uit groep zes (vergeleken met leerlingen uit groep vijf; $p = 0,019$). Deze bevindingen ondersteunen de hypothese dat gezondheidsvaardigheden zich ontwikkelen over de tijd en onderschrijven het belang van scholen in dit proces. Met de HLS-Child-Q15-NL is er een Nederlands instrument beschikbaar om gezondheidsvaardigheden bij kinderen te meten. Het instrument behoeft echter verdere aanpassing aan de doelgroep. Meer onderzoek is nodig om begripsproblemen te verminderen en de test-hertest betrouwbaarheid en de constructvaliditeit te onderzoeken.

Hoofdstuk 3 ging dieper in op de impact van gezondheidsvaardigheden van Nederlandse kinderen op (1) hun body mass index (BMI) z-score, (2) hun voedingsgedrag, en (3) hun mate van fysieke activiteit. Een digitale vragenlijst inclusief vragen over gezondheidsvaardigheden (HLS-Child-Q15) en vragen over voeding- en beweeggedrag werd ingevuld door een steekproef van 139 kinderen (8–11 jaar oud). Daarnaast werden de lengte en gewicht van deze kinderen gemeten en werd er achtergrondinformatie verzameld via een oudervragenlijst. Statistische analyses toonden een significante positieve relatie aan tussen de gezondheidsvaardigheden van kinderen en de mate van fysieke activiteit ($p = 0,002$). Geen significante relatie werd gevonden tussen de gezondheidsvaardigheden van kinderen en hun BMI z-score of voedingsgedrag. Er kan geconcludeerd worden dat gezondheidsvaardigheden samenhingen met sommige aspecten van de leefstijl van basisschoolleerlingen, maar dat er meer onderzoek nodig is in een groter en meer divers sample om dit verder te bestuderen.

Hoofdstuk 4 beschreef de kwantitatieve evaluatie van de korte termijn- en langere termijneffecten van een multi-component voedingseducatieprogramma dat klassikale en experiëntiële leerstrategieën combineert (de Kokkerelli interventie) op verschillende determinanten van groente en fruit (GF) inname van kinderen (kennis, smaakvoorkeuren, attitudes en intentie). Gegevens werden verzameld in Nederlandse basisscholen (vier controlescholen en vijftien interventiescholen) via kindvragenlijsten voor de interventie (baseline), direct na de interventie en drie maanden na de interventie. Na correctie voor baselinewaardes, geslacht, leeftijd en het GF product behandeld in de vragenlijst vertoonde de interventiegroep een significante verhoging op de korte termijn van kennis (p = 0,001; gestandaardiseerde effectmaat (Engelstalige afkorting: ES) = 0,60), smaakvoorkeuren (p = 0,002; ES = 0,52), attitude tegenover gemeten GF product (p = 0,004; ES = 0,48) en algemene attitude tegenover gezonde producten (p = 0,01; ES = 0,39), vergeleken met de controlegroep. Deze significante interventie-effecten waren niet zichtbaar op de langere termijn. De bevindingen wijzen op de korte termijneffectiviteit van de Kokkerelli interventie. Meer onderzoek en aanpassingen aan de interventie (bijvoorbeeld het herhaald aanbieden van de interventie of het toevoegen van componenten om ouderbetrokkenheid te stimuleren) worden geadviseerd om de impact van de interventie, vooral op de langere termijn, te verhogen.

Hoofdstuk 5 presenteerde de kwantitatieve evaluatie van de effecten van herhaalde blootstelling aan GF via de Gezonde Basisschool van de Toekomst interventie (Engelstalige afkorting: HPSF) op de GF bekendheid, smaakvoorkeuren en inname van kinderen. De studie had een longitudinaal quasi-experimenteel design waarin twee volledige HPSF-scholen (met een focus op voeding en beweging) en twee gedeeltelijke HPSF-scholen (met een focus op beweging) in Nederland met elkaar vergeleken werden. Jaarlijkse metingen (kindvragenlijsten) werden uitgevoerd tussen 2015 en 2019 in 833 7–12-jarigen. Na correctie voor baselinewaardes vertoonden de volledige HPSF-scholen een lager aantal onbekende groente-items na één jaar (p = 0,009; ES = -0,28) en drie jaar (p = 0,008; ES = -0,35) en een hoger aantal niet lekker gevonden groente-items na één jaar (p = 0,016; ES = 0,24) dan de gedeeltelijke HPSF-scholen. Ongunstige interventie-effecten werden gevonden voor fruitinname na één jaar (p = 0,030; odds ratio (OR) = 0,609) en vier jaar (p = 0,005; OR = 0,451). Herhaalde blootstelling aan GF had beperkte effecten op de GF bekendheid, smaakvoorkeuren en inname van kinderen, waarschijnlijk door het gebrek aan smaakblootstelling. Uitbreiding van de HPSF interventie met een component waarin kinderen structureel GF producten proeven leidt mogelijk tot meer prominente effecten op de GF bekendheid, smaakvoorkeuren en inname van kinderen. Gezien de wijdverspreide implementatie van blootstellingsinterventies op scholen is het relevant om verder onderzoek te doen naar de omstandigheden waarin blootstelling effectief kan bijdragen aan het verbeteren van (determinanten van) GF inname bij kinderen.

Hoofdstuk 6 rapporteerde over de impact van HPSF op het gezondheidsgedrag van ouders en kinderen in de thuissetting, hetgeen kwalitatief onderzocht is met behulp van 27 semigestructureerde interviews met ouders van twee HPSF-scholen. HPSF resulteerde in verschillende gedragsveranderingen in de thuissetting, geïnitieerd door zowel ouders als kinderen. Ouders rapporteerden zowel verbeteringen in gezond gedrag als het optreden van ongezond gedrag als compensatie voor het gezonde gedrag op school. Redenen voor gedragsverandering waren onder andere een verhoogd bewustzijn, meer ervaarde steun om gezond gedrag te vertonen en kinderen die thuis om gezonde producten vroegen waarmee ze op school kennis hadden gemaakt. Barrières voor gedragsverandering waren onder andere geen ervaarde noodzaak tot verandering, beperkte informatievoorziening met betrekking tot HPSF, tijdsgebrek en financiële beperkingen. Zowel intergenerationeel leren van kinderen naar ouders als ouder-geïnitieerde veranderingen spelen een belangrijke rol bij de overdracht van gezondheidsgedrag van de schoolcontext naar de thuissetting en zijn daarom belangrijke mechanismes om de impact van gezondheidsbevorderende interventies op school te maximaliseren.

Hoofdstuk 7 beschreef de evaluatie van gezondheidsbevorderende activiteiten in complexe systemen als onderdeel van het HPSF-opschalingsproject. Daarnaast werd een data-categorisatieaanpak gepresenteerd die het structureren van onderzoeksresultaten en het relateren van implementatiegraad aan geobserveerde effectiviteit zou kunnen faciliteren. Deze aanpak kan gebruikt worden om meer inzicht te verkrijgen in de effectiviteit van een interventie onder diverse omstandigheden, en hierdoor kan er optimale support gegeven worden aan betrokkenen om maximale impact van gezondheidsbevorderende interventies in complexe, 'real-world' systemen te bewerkstelligen. De voorgestelde aanpak is echter slechts een eerste suggestie. Verdere aanpassing en evaluatie, alsmede het delen van kennis en ervaringen tussen onderzoekers in vergelijkbare onderzoeksgebieden, is nodig om de bruikbaarheid van de methode te verhogen en het kennisniveau met betrekking tot dit onderwerp te vergroten.

Hoofdstuk 8 ging dieper in op (factoren van invloed op) de implementatie van gezondheidsbevorderende activiteiten in verschillende Nederlandse basisscholen deelnemend aan het HPSF-opschalingsproject. Gegevens werden verzameld gedurende drie schooljaren (2019–2022) via observaties, vragenlijsten en interviews. Het project resulteerde in de implementatie van kleine, incidentele activiteiten (bijvoorbeeld het dagelijks aanbieden van een GF product). Belangrijke redenen voor deze beperkte implementatie waren gebrek aan commitment en bottom-up betrokkenheid. Schooldirecteuren en leerkrachten waren niet vanaf het begin van het project betrokken, wat resulteerde in beperkte projectwaardering en commitment. Op schoolniveau werd het project voornamelijk uitgevoerd door de directeur, hetgeen de duurzaamheid en integratie van het project beperkte. Daarnaast was het door de COVID-19 pandemie, de daaraan gerelateerde beperkingen zoals verplichte schoolsluitingen en afstand houden en de snelveranderende situatie voor scholen moeilijk om lange termijnvisies en -plannen te maken. Overige barrières voor implementatie waren onder andere geen ervaarde noodzaak tot verandering, een hoge werkdruk en een groot personeelsverloop. Factoren die implementatie positief beïnvloedden waren onder andere de aanwezigheid van een procescoördinator en het delen van ervaringen tussen scholen. Uitgebreidere ondersteuning is nodig om scholen te begeleiden bij het creëren van commitment, het stimuleren van bottom-up betrokkenheid en het vormen van een projectvisie. Daarnaast is het wenselijk om het identificeren en trainen van ‘in-school champions’ en/of school-brede projectgroepen te stimuleren om scholen minder afhankelijk te laten zijn van externe support op de lange termijn. De bevindingen kunnen gebruikt worden door diverse stakeholders tijdens ontwikkeling, adoptie en implementatie en kunnen de verdere disseminatie en duurzame integratie van gezondheidsbevordering in de school-context faciliteren.

Hoofdstuk 9 presenteerde de resultaten van de effectiviteitsevaluatie van het HPSF-opschalingsproject in diverse ‘real-world’ school-contexten. Nederlandse basisscholen deelnemend aan het project implementeerden tussen 2019 en 2022 zelfstandig HPSF-gerelateerde activiteiten. Binnen de scholen werden gegevens van 315 deelnemende kinderen verzameld middels antropometrische metingen en vragenlijsten over voedings- en beweeggedrag. De COVID-19 pandemie zorgde voor beperkte implementatie van HPSF-gerelateerde activiteiten binnen de scholen, waardoor de resultaten van de effectiviteitsevaluatie vergeleken werden tussen scholen gecategoriseerd als ‘medium implementers’ en scholen gecategoriseerd als ‘low implementers’. Na correctie voor baselinewaardes vertoonden medium implementers een significante verhoging in middelomtrek na één jaar (gecorrigeerd gemiddeld verschil B = 1,089, $p = 0{,}003$) en twee jaar (B = 1,665, $p < 0.001$) vergeleken met low implementers. Geen significante effecten werden gevonden voor andere uitkomstmaten. De studie toonde weinig tot geen effectiviteit van de opgeschaalde HPSF-interventie aan, hetgeen voornamelijk te wijten is aan beperkte implementatie ten gevolge van de COVID-19 pandemie. Om interventieontwikkelaars en beleidsmakers beter te informeren is meer onderzoek nodig naar de effectiviteit van HPSF in diverse, 'real-world' contexten in de afwezigheid van een pandemie die scholen beperkt in het implementeren van gezondheidsbevorderende activiteiten.

Hoofdstuk 10 bediscussieerde de belangrijkste bevindingen van het onderzoek gepresenteerd in dit proefschrift en beschreef diverse aanbevelingen voor onderzoek en praktijk. De mogelijke invloed van gezondheidsvaardigheden van kinderen op hun gezondheid en het belang van verder onderzoek naar dit onderwerp werd besproken. Daarnaast werden verschillende suggesties gedaan om de Kokkerelli- en de HPSF-interventie verder te verbeteren, zoals het uitbreiden van de interventies met elementen om ouderbetrokkenheid te stimuleren. Gezien de potentiële gezondheidseffecten van gezondheidsbevorderende interventies op scholen is de integratie van gezondheidsbevordering in elke school-context aan te raden. Om dit te bereiken, is het belangrijk om over te stappen van het evalueren van gezondheidsbevorderende interventies op scholen in relatief kleine, gecontroleerde contexten naar het testen van de impact van deze interventies in diverse, 'real-world' omgevingen waarin verschillende externe invloeden en uitdagingen de effectiviteit van interventies kunnen beperken. Het in dit proefschrift beschreven HPSF-opschalingsproject vond grotendeels plaats tijdens de COVID-19 pandemie, wat een negatieve invloed had op het project en de mogelijkheid beperkte om de implementatie en effectiviteit van HPSF-gerelateerde activiteiten in de deelnemende scholen te onderzoeken. Het uitgevoerde onderzoek leverde echter wel waardevolle aanbevelingen op voor acties die door verschillende stakeholders kunnen worden ondernomen tijdens de ontwikkeling, adoptie en implementatie van gezondheidsbevorderende activiteiten op scholen. Om de integratie van gezondheidsbevordering in scholen te stimuleren, is het noodzakelijk om een gedetailleerd beeld van een school-context te verkrijgen om zo het onderwerp gezondheidsbevordering af te kunnen stemmen op de specifieke wensen en behoeften van een school. Scholen dienen begeleid te worden bij het stimuleren van commitment en bottom-up betrokkenheid en het creëren van een gezondheidsvisie, en er dient gestreefd te worden naar het verminderen van de verschillende barrières die scholen ervaren bij het implementeren van gezondheidsbevorderende initiatieven (beperkte ruimte in het curriculum, hoge werkdruk, beperkte financiële middelen etc.). Bovendien is het raadzaam om 'in-school champions' en/of school-brede projectgroepen te identificeren en trainen om scholen minder afhankelijk te maken van externe support op de lange termijn en om de duurzame integratie van gezondheidsbevordering in de school-context te faciliteren.

APPENDIX

Valorisation

This chapter of the dissertation focusses on the valorisation of the described findings, which entails the process of creating value from knowledge by making it suitable for scientific and societal use. The relevance of the results is first described from a scientific viewpoint, discussing important lessons learned and efforts made to disseminate the findings to a scientific audience. Second, the results' societal relevance is described, both on a regional level for the schools that participated in the research project and on a national level.

Scientific Relevance

Through the translation of the HLS-Child-Q15 that has been described in this dissertation, the first Dutch measurement instrument for children's health literacy (HL) has become available which can be used by other researchers to advance the exploration of HL in children; a relatively new research field. Furthermore, the research presented in this dissertation focussed on the implementation and effectiveness of health-promoting activities in diverse, real-world school settings. Although there are various research projects evaluating the effects of school-based health-promoting interventions in relatively controlled contexts [1–3], much less research is available on the further dissemination of these interventions in diverse, real-world contexts [4,5]. Despite the fact that implementation and subsequently effectiveness of the Healthy Primary School of the Future (HPSF) scaling-up project was limited due to the COVID-19 pandemic, the performed studies can still provide researchers with valuable lessons to design and execute implementation and effectiveness studies in a real-world context. In addition, the description of a novel data categorisation approach can help researchers performing comparable research to relate the implementation degree to any impact on effectiveness outcomes that might be observed and it stimulates the discussion on this subject.

To disseminate this dissertation's results to the scientific community, several scientific articles have been published in (inter)national peer-reviewed journals. Furthermore, findings have been presented at (inter)national conferences.

Societal Relevance

The societal impact of the presented research is described both on a regional level for the schools that participated in the HPSF scaling-up project and on a national level.

Impact in Participating Schools

The focus on real-world implementation and the chosen research design made that researchers were merely observers who did not actively influence implementation and/or provide explicit feedback to the participating schools during the project. However, schools did become more aware of their potential impact on children's health and well-being. In an effort to sustainably integrate health within the schools, the educational board and the various schools formed a so-called 'physical activity-team'. This team consists of teachers providing physical education lessons at the various schools whilst at the same time being responsible for all other health-related subjects and activities within the schools. The idea is that the presence of this team will ensure that the increased attention for children's health and well-being will remain present after the project's end. The HPSF scaling-up project also resulted in a strengthening of the network of (regional) organisations working on school-based health promotion (e.g., the Municipal Health Services, Kids University for Cooking, het Bewegend Kind, Springlab). In this way, schools can easily reach out to external support if desired.

Other developments within the region of Northern Limburg are also beneficial for the sustainability of the project. The 'Regio Deal Noord-Limburg' is an agreement between more than 30 partners with a focus on health [6]. For the period of 2020 to 2023, subsidy is provided by the Dutch government to stimulate various health-related projects and initiatives. Further dissemination of HPSF through Northern Limburg is one of these projects. With help of HPSF coordinators appointed by the Province of Limburg, schools are stimulated to implement HPSF-related activities. At the end of the HPSF scaling-up project, three of the participating schools reached out to these coordinators for guidance on implementation of HPSF-related activities, although none of these schools had the intention to implement healthy school-provided lunches at the short term. Furthermore, with the appointment of a new councillor Youth, Education, Public Health, and Culture in Peel en Maas in 2022, the municipality's attitude towards the HPSF scaling-up project changed. With the new councillor, the municipality now plays a more pro-active role in stimulating schools to pay attention to health where before, they would predominately stress the importance of schools' freedom to decide whether or not to pay attention to the subject.

Throughout the HPSF scaling-up project, newsletters were developed and disseminated within the schools and across the various project partners to inform stakeholders about the project-related activities that took place. Furthermore, the impact of the project on children's health and well-being was summarised and communicated through factsheets to the various stakeholders within the participating schools (directors, teachers, parents, and children). Schools used these factsheets as a guideline during the formation of their health-related plans and ambitions for after the project.

National Impact

Since the development of HPSF in 2015, the initiative has been receiving substantial attention. It has served as a 'spark' to light the fire of school-based health promotion. The COVID-19 pandemic and the cost of living crisis underpin the importance of health and the need for healthy nutrition for school-going children even more. Policymakers, researchers, journalists, and other members from the population vocalised their desire and ambition to provide children with healthy meals (breakfast and/or lunch) at school. HPSF can serve as an important example and can provide valuable guidelines to further shape these ambitions.

After the original HPSF efficacy trial, the HPSF foundation was established and the Province of Limburg appointed two HPSF coordinators to guide and stimulate further dissemination of HPSF across Limburg and the rest of the Netherlands. The results and experiences described in this dissertation can serve as guidelines to facilitate the integration of HPSF in other schools. A grand awarded by the MUMC+ in 2022 provides the opportunity to further look into the adaptability of HPSF to different school contexts [7].

HPSF is continuously developing. Efforts to extend HPSF with green schoolyard renovations are currently being evaluated in various schools in the Netherlands and Belgium. The evaluations of HPSF's effects in the home setting and on children's fruit and vegetable familiarity, taste preferences, and intake can be used to further extend the intervention with e.g., family-based activities and/or more taste exposure to fruit and vegetables to increase intervention impact.

To disseminate the results described in this dissertation to the general public, various efforts have been made. The results were summarised and disseminated via the HPSF website (www.degezondebasisschoolvandetoekomst.nl). Furthermore, annual reports were composed for the Province of Limburg and the project was pitched at the HPSF symposium and the 'Just Eat It?!' symposium, described in an article for www.iamafoodie.nl [8], presented as part of a webinar for a national childcare organisation [9] and described in an article for regional newspaper 'De Limburger' [10].

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APPENDIX

List of Publications

Publications Presented in this Dissertation

Hahnraths MTH, Heijmans M, Bollweg TM, Okan O, Willeboordse M, Rademakers J. Measuring and Exploring Children's Health Literacy in the Netherlands: Translation and Adaptation of the HLS-Child-Q15. Int J Environ Res Public Health. 2021;18(10):5244.

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Hahnraths MTH, Jansen JPM, Winkens B, van Schayck CP. The Effects of a Multi-Component School-Based Nutrition Education Intervention on Children's Determinants of Fruit and Vegetable Intake. Nutrients. 2022;14(20):4259.

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Hahnraths MTH, Willeboordse M, van Schayck CP. Implementing Health-Promoting Initiatives in Diverse Primary School Contexts in the Netherlands: Practical Lessons Learnt. Health Educ. 2023;123(2):55–72.

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Other Publications

Willeboordse, M, Bartelink, NHM, van Assema, P, Kremers, SPJ, Savelberg, HHCM, Hahnraths, MTH, Vonk, L, Oosterhoff, M, van Schayck, CP, Winkens, B, Jansen MWJ. Battling the Obesity Epidemic with a School-Based Intervention: Long-Term Effects of a Quasi-Experimental Study. PLoS One. 2022;17:e0272291.

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CP. “Mam, Dat is Eigenlijk Niet Zo Gezond”; Impact van ‘De Gezonde Basisschool van de Toekomst’ in de Thuisomgeving [‘Mummy That’s Not Really Healthy’; Impact of ‘The Healthy Primary School of the Future’ in the Home Setting]. Ned Tijdschr Geneeskd. 2023;167:D6991.
**Authors contributed equally to the manuscript.*

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Simons A, Hahnraths MTH. De Gezonde Basisschool van de Toekomst: Een gezonde leefstijl bij jonge kinderen als basis voor een gezonde generatie [The Healthy Primary School of the Future: a healthy lifestyle in young children as the foundation for a healthy generation]. Basisschoolmanagement. 2023;37:14–17.

Presentations

Hahnraths MTH, Willeboordse M, van Schayck, CP. (2021). Healthy Childcare Centre of the Future: Implementation Research in Complex School Contexts. Video pitch at the HPSF symposium, Venlo, the Netherlands, 22 September 2020.

Hahnraths MTH, Willeboordse M, van Schayck, CP. (2021). Healthy Childcare Centre of the Future: Implementation Research in Complex School Contexts. Poster presentation at the Maastricht UMC+ Science Day, Maastricht, the Netherlands, 30 September 2021.

Hahnraths MTH, Willeboordse M, Jungbauer ADHM, de Gier C, Schouten C, van Schayck CP. (2021). ‘Mummy, Can I Join a Sports Club?’ A Qualitative Study on the Impact of Health-Promoting Schools on Health Behaviours in the Home Setting. Oral presentation at the spring meeting Werkgroep Voedingsgewoonten (WeVo), Netherlands Nutrition Centre, the Hague, the Netherlands, 28 April 2022.

Hahnraths MTH, Willeboordse M, Jungbauer ADHM, de Gier C, Schouten C, van Schayck CP. (2021). ‘Mummy, Can I Join a Sports Club?’ A Qualitative Study on the Impact of Health-Promoting Schools on Health Behaviours in the Home Setting. Oral presentation at the 21st Annual Conference of the International Society of Behavioural Nutrition and Physical Activity, Phoenix, AZ, USA, 18-21 May 2022.

Hahnraths MTH*, van Engelen BHW*, Willeboordse M, Bartelink NHM, van Assema P, Kremers SPJ, Savelberg HHCM, Vonk L, Oosterhoff M, van Schayck CP, Winkens B, Jansen MWJ. (2022). Battling the Obesity Epidemic with a School-Based Intervention: Long-Term Effects of a Quasi-Experimental Study. Oral presentation at the 21st Annual Conference of the International Society of Behavioural Nutrition and Physical Activity, Phoenix, AZ, USA, 18-21 May 2022.
**Authors contributed equally to the presentation.*

Hahnraths MTH, Willeboordse M, van Schayck, CP. (2021). Healthy Childcare Centre of the Future: Implementation Research in Complex School Contexts. Poster presentation and pitch at the Just Eat It?! Symposium, Venlo, the Netherlands, 13 October 2022.

Hahnraths MTH, Willeboordse M, van Schayck, CP. (2023). Implementing Health-Promoting Activities in Diverse Primary School Contexts in the Netherlands: Practical Lessons Learnt. Oral presentation at the CaRe days, Eindhoven, the Netherlands, 10 May 2023.

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APPENDIX

About the Author

Marla Hahnraths was born in Meerssen, the Netherlands on August 14, 1997. In 2015, she completed secondary school *cum laude* at Stella Maris College in Meerssen. She studied Nutrition and Health at Wageningen University from 2015 to 2018 and obtained her Bachelors of Science degree *cum laude*. During the last year of her Bachelor's degree, she followed several courses at the Faculty of Psychology and Neuroscience at Maastricht University and started working as a student assistant at the department of Health Promotion. For her bachelor thesis, she conducted a literature study on the effects of primary school-based interventions on children's fruit and vegetable intake. After graduating, she continued her education at Maastricht University, where she studied Health Education and Promotion and continued to work as a student assistant at the department of Health Promotion. As part of her master thesis, she investigated the effects of the preschool-based SuperFIT intervention on fruit and vegetable intake in children aged 2–4 years. In 2019, she obtained her Masters of Science degree *cum laude*.

After graduating, she started her PhD project at the department of Family Medicine and the Care and Public Health Research Institute (CAPHRI) at Maastricht University. Her PhD research focused on the impact and implementation of health-promoting initiatives in complex and real-world primary school settings. Marla has presented her work at several national and international conferences, symposia, and meetings. The most important scientific findings of her PhD research are described in this dissertation. During her PhD project, Marla was also involved in teaching and supervising students at BSc and MSc level and obtained her University Teaching Qualification (UTQ) in 2023.

APPENDIX

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