The development, implementation and evaluation of an integrated overweight prevention approach for pre-schoolers

THE DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF AN INTEGRATED OVERWEIGHT PREVENTION APPROACH FOR PRE-SCHOOLERS: SUPERFIT.

Ilona van de Kolk

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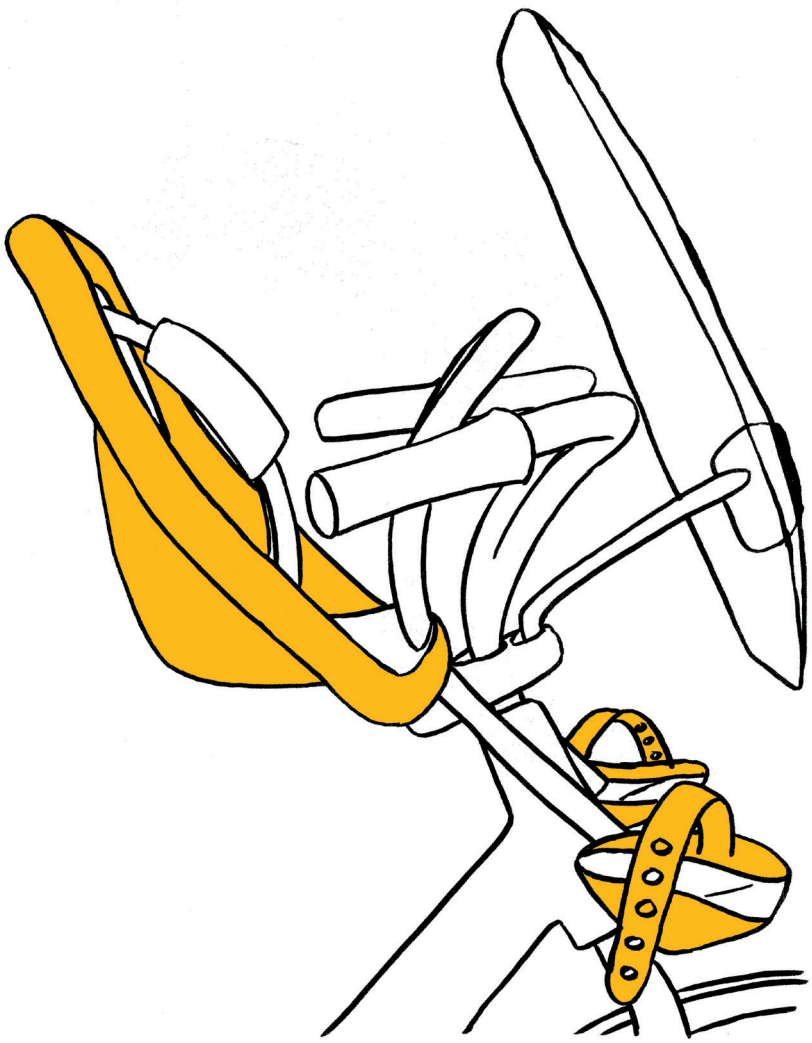


Chapter 1

General Introduction

Childhood overweight and obesity, and related behaviours

Overweight and obesity are related to various chronic diseases, such as cardiovascular diseases (CVD), cancer, diabetes type 2 and psychosocial problems [1, 2]. Childhood overweight and obesity are an important public health problem, with worldwide 41 million children under the age of five being overweight or obese [3, 4]. In the Netherlands, around 8% of the two-year old boys and girls have overweight or obesity [5]. This prevalence increases to 9.1% boys with overweight or obesity and 16.3% girls with overweight or obesity for four-year-olds [5]. With increasing age, the prevalence of childhood overweight and obesity increases even further [5, 6]. Childhood overweight and obesity are also known to track into adulthood and weight status between two and six years of age is most predictive for overweight and obesity later in life [7, 8]. As a result, childhood overweight and obesity are a very persistent health problem that is hard to change once it is established [9, 10].

Overweight and obesity are predominantly the result of a disruption in energy-balance, which is caused by both unhealthy dietary habits and a lack of physical activity [11]. Such energy balance-related behaviours (EBRB) are also known to track from childhood into adulthood [12-14]. Further, these lifestyle behaviours are related to health issues, also in early life. Physical activity is, for example, related to motor development, cognitive development, psychosocial wellbeing, fitness, and bone and skeletal health [15]. Unhealthy nutrition in early life is related to the development of CVD and cancers [10, 16, 17]. In particular, added sugar intake (e.g., through sugar-sweetened beverages) in children is associated with CVD, dental caries, and adiposity in children [18, 19].

Although a common perception may be that being active is in the nature of young children (two-to-four years old, from now on called 'pre-schoolers'), they are not getting enough daily physical activity; in fact, they are particularly highly sedentary [20-23]. International guidelines recommend a minimum of 180 minutes of physical activity per day [24]. Studies showed that pre-schoolers spend between 15.3-16.4% corresponding to 108-127 minutes of their waking hours per day in physical activity [22, 25]. With increasing age, the amount of time spent in physical activity declines [22, 26, 27]. Further, international recommendations for screen time for pre-schoolers are a maximum of 60 minutes of sedentary screen time [24]. Preschool children spend on average 80-112 minutes in sedentary screen time [22, 23]. Overall, they spend a large part of their day sedentary [20, 25].

With regard to nutrition, pre-schoolers often already have unhealthy dietary patterns [28]. For example, adherence to dietary guidelines is low, especially for fruit and vegetables (F&V), sugar, and total energy intake [29-32]. For F&V intake, a study showed that 27.5% of a Dutch sample met the recommendation for fruit intake (150 grams per day) and 69.3% met the lower bound recommendation for vegetables intake (50 grams per day) [28]. Added

sugar intake accounts for 12-17% of the total energy intake in children [18, 31, 33], where the World Health Organization recommends an intake of <10% of total energy [34]. Sugar intake in children is often shown to be even higher than adult sugar intake [33, 35]. Over the last decades, an increase in children's total energy intake was seen, resulting mostly from foods high in added sugar, solid fat and salt [36]. In the Netherlands, 43.7% pre-schoolers exceed the recommended daily energy intake [28]. Based on these findings, it is important to promote the development of healthy lifestyle behaviours at this young age.

Socio-ecological and systems perspective on health behaviours

Traditionally, theories explaining behaviour (e.g., the theory of planned behaviour [37]) focus on the role of cognitive variables such as attitude, motivation and self-efficacy. However, the environment has an important influence on behaviour. For instance, someone can have a very positive attitude towards physical activity, but if there are no safe bike paths this person may never engage in the behaviour. This influence of the environment is incorporated by socio-ecological models of behaviour [38]. There are several examples of socio-ecological models, such as the Environmental Research framework for weight Gain prevention (EnRG) [39], the ecological model of Health behaviour [40], and the Social Ecological Model for Health Promotion [41]. Socio-ecological models have in common that they propose a multi-level influence of determinants, i.e., factors on an intrapersonal interpersonal, organizational, and community level influence behaviour [38]. These influences interact across levels and therefore, multi-level interventions may be most effective in changing health behaviour [38]. The ANalysis Grid for Environments Linked to Obesity (ANGELO) framework can be used to specifically describe the environmental determinants related to overweight and obesity [42]. The ANGELO-framework describes four types of environment, the socio-cultural (the attitudes, beliefs, and values within a community or society), the physical (what is available, both tangible and non-tangible), the economic (what are the costs), and the political environment (rules, regulations, policies) [42].

The interaction between determinants and levels can be referred to as thinking in systems. An important characteristic of a system is that "its impact is more than the sum of its individual parts" (Wachs, 2000 p. 262). This stresses the importance to take influences on behaviour into account not as isolated factors, but as interacting components within a system [43, 44]. Bronfenbrenner describes different levels of systems. Micro-systems directly influence behaviour and for children are for example the home, school or neighbourhood [45]. When interactions between different micro-systems exist, this is considered a meso-system [45]. For pre-schoolers there are two dominant micro-systems in which they are cared for, home and Early Care and Education (ECE) [46]. As these micro-systems interact, this means that characteristics of the ECE system may influence pre-schoolers' behaviour differently

depending on the characteristics of the home system and vice versa. Inconsistencies between these micro-systems may result in suboptimal child development and wellbeing [47]. This may also be the case for healthy behaviours [48] and research has indicated the negative influence of inconsistencies between the home and childcare settings on children's EBRB [49]. It is assumed that increasing the consistency between these settings with regard to healthy EBRB will result in greater effects than targeting these settings individually. Therefore, an integrated intervention approach to promote healthy EBRB in pre-schoolers is advocated.

The influence of the home and ECE systems on pre-schoolers behaviour

The home setting is the most important setting to influence and shape the behaviour of pre-schoolers. In particular, parents exert a great influence on the EBRB of their children. One way in which they influence their children's behaviour is through their general parenting style [50]. General parenting style is considered the overarching way parents interact with their children in different situations. It reflects parents' views on how children should be raised. There are two dimensions in general parenting: responsiveness and demandingness, a parenting style that is high in both dimensions (an authoritative parenting style) is related to healthier child outcomes, including healthier EBRB and lower BMI [50]. Parents influence the behaviour of children also through parenting practices. Parenting practices are considered specific strategies parents adopt to influence a specific behaviour [51]. Among these practices, two specific categories can be distinguished with nutrition-related and physical activity-related practices. The use of favourable parenting practices, such as monitoring dietary intake and stimulating physical activity, is related to healthier EBRB in children [52]. Unfavourable parenting practices, for example restrictive feeding practices or restricting physical activity for safety, are associated with unhealthy EBRB [53, 54]. Interventions in the family-setting have been promising in promoting healthy EBRB in children [55-57]. In particular, interventions that use direct or active parental involvement appear to be effective in changing the behaviours of children [58]. Moreover, interventions combining parents and children in the activities and focusing on 'having fun together' appear to be effective in promoting healthy behaviour within the family [59].

The ECE setting is another important setting for pre-schoolers. In countries belonging to the Organization for Economic Co-operation and Development (OECD), a majority of pre-schoolers is partially cared for in formal childcare [60]. In the Netherlands, 41% of the children up to three years old attend formal childcare, which increases to 82% of children between the age of three and five [61]. Childcare use has been associated with a higher risk of overweight in children attending childcare [62-64], although other studies have shown a protective effect of childcare use on childhood overweight and obesity [65-67]. There may be several reasons for the association between childcare use and childhood overweight and obesity. A systematic review showed that pre-schoolers spend their time in the ECE

setting mostly sedentary [68]. However, there is a great variability between studies, and some studies have also shown a positive effect of childcare use on children's PA [68, 69]. Factors in the ECE setting have been both positively and negatively associated with PA in pre-schoolers. Factors that have shown to be supportive for children's PA are, for example, natural elements in outdoor play area, outdoor play area size, childcare staff activity-related practices, and provision of active opportunities [70, 71]. Other factors that may be positively related to children's PA are availability of portable play materials, educator training and indoor play space [71, 72]. Further, studies have also indicated perceived facilitators and barriers by childcare workers to promote PA in the ECE setting. A lack of time, rules and policies regarding safety, inadequate equipment and unsuitable clothing are examples of perceived barriers [73, 74]. Available resources (e.g., workshops), using music, and supportive colleagues were mentioned as facilitating factors for PA in the ECE setting [73]. With regard to nutrition, the use of supportive practices by childcare staff, such as providing non-food rewards or modelling healthy dietary intake influence children's dietary intake [75]. Further, the availability of healthy food products may influence the intake of these products [76]. The nutritional policy within the ECE setting is an important factor that may influence the intake of children [77]. Perceived barriers and facilitators for healthy nutrition in the ECE setting are, for example, policies, trained staff and budget [78]. Interventions in the ECE setting have shown to be effective in improving children's weight status and changing children's EBRB [79-81].

Nowadays, healthy school initiatives are widely implemented internationally (following the World Health Organizations' Health Promoting Schools Framework [82]) as well as nationally (Programme Healthy School, *'Programma Gezonde school'* [83]) [84, 85]. However, these initiatives generally start in primary school and therefore, reach children from four-to-five years old onwards. The ECE setting remains underrepresented within the healthy school movement. It is important to draw attention to this important setting and start similar actions in the ECE setting.

The SuperFIT intervention approach

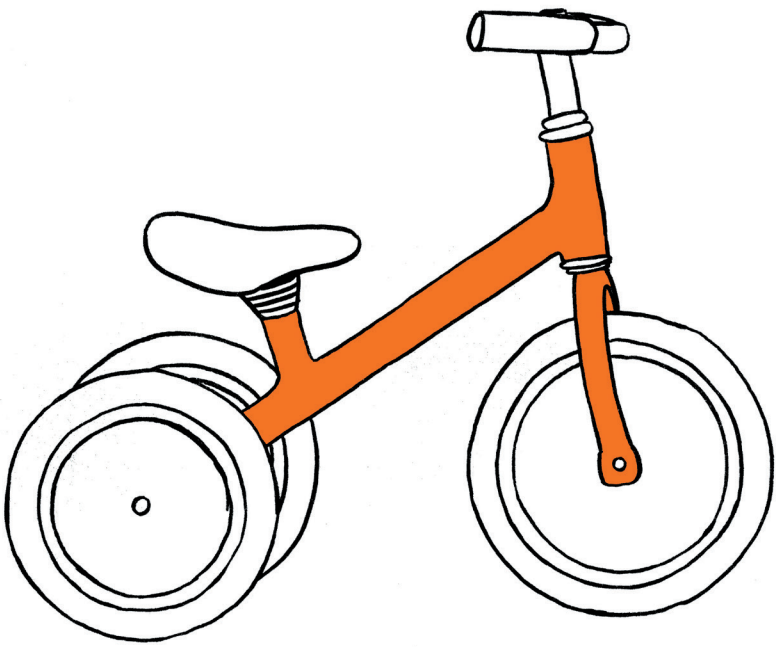
A comprehensive, integrated intervention approach to promote healthy EBRB in pre-schoolers was initiated in Sittard-Geleen, a municipality in the south of the Netherlands. A partnership between a childcare organization, a local PA-providing organization and health promotion experts was formed to develop the intervention. SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial) is based on three main principles. The first principle is that both nutrition and physical activity should be addressed in the intervention activities [11]. The second principle is a multi-setting approach incorporating both the ECE and the home settings [48, 86]. In addition, the community setting is taken into account in the SuperFIT approach. The third principle focuses on the integration

of different types of environment (physical, sociocultural, and political) and implementing intervention activities in all types of environments [39, 86]. The ECE setting is the primary point of entry for the SuperFIT approach. It is not a one-size-fits-all intervention programme but is adaptable to the individual situation of an ECE organization and location. In a process of co-creation with the target population, the different intervention strategies, following the three main principles, are chosen on those aspects within an organization that need change.

This dissertation

The aim of this dissertation was to conduct formative research, develop and evaluate an integrated intervention (SuperFIT) to promote healthy behaviour in pre-schoolers in both the ECE and home setting. Formative research, the first part of this dissertation, was performed to serve as input for intervention development. The importance of parental involvement in interventions is recognized. However, little is known on the role of direct parental involvement in intervention effectiveness. A systematic review on the effectiveness of childcare-based interventions that included direct parental involvement was performed. The results of this study are presented in chapter 2. Further, a needs assessment was performed among childcare managers, childcare workers and parents, in order to explore influencing factors in the childcare setting, the influence of the home setting in the childcare setting, and possible needs that were expressed regarding components of a possible intervention. The results of the needs assessment are presented in chapter 3. Based on these two studies, SuperFIT was developed and implemented in the pilot region. Chapter 4 describes the development and evaluation design (both process and effect evaluation) of SuperFIT. A quasi-experimental design was adopted for the effect evaluation. The process evaluation was performed using a mixed-methods design.

The second part of this dissertation describes the evaluation of SuperFIT. The effect evaluation aimed to evaluate the changes on dietary intake (presented elsewhere, [87]), physical activity, sedentary behaviour and BMI z-score caused by SuperFIT. The effects of SuperFIT on physical activity, sedentary behaviour and BMI z-score are presented in chapter 5. The process evaluation aimed to investigate the changes in the individual settings, implementation and maintenance of SuperFIT. The results of the process evaluation for the preschool setting are presented in chapter 6. A general discussion on the studies presented in this dissertation is given in chapter 7.



Chapter 2

Systematic review of interventions in the childcare setting with direct parental involvement: Effectiveness on child weight status and energy balance-related behaviours

van de Kolk I, Verjans-Janssen SRB, Gubbels JS, Kremers SPJ, Gerards SMPL.

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Abstract

Background

The early years are a crucial period to promote healthy energy balance-related behaviours in children and prevent overweight and obesity. The childcare setting is important for health-promoting interventions. Increasingly, attention has been paid to parental involvement in childcare-based interventions. The aim of this systematic review is to evaluate the effectiveness of these interventions with direct parental involvement on the children's weight status and behavioural outcomes.

Methods

A systematic search was conducted in four electronic databases to include studies up until January 2019. Studies written in English, describing results on relevant outcomes (weight status, physical activity, sedentary behaviour and/or nutrition-related behaviour) of childcare-based interventions with direct parental involvement were included. Studies not adopting a pre-post-test design or reporting on pilot studies were excluded. To improve comparability, effect sizes (Cohen's d) were calculated. Information on different types of environment targeted (e.g., social, physical, political and economic) was extracted in order to narratively examine potential working principles of effective interventions.

Results

A total of 22 studies, describing 17 different interventions, were included. With regard to the intervention group, 61.1% found some favourable results on weight status, 73.3% on physical activity, 88.9% on sedentary behaviour, and all on nutrition-related behaviour. There were studies that also showed unfavourable results. Only a small number of studies was able to show significant differences between the intervention and control group (22.2% weight status, 60.0% physical activity, 66.6% sedentary behaviour, 76.9% nutrition behaviour). Effect sizes, if available, were predominantly small to moderate, with some exceptions with large effect sizes. The interventions predominantly targeted the socio-cultural and physical environments in both the childcare and home settings. Including changes in the political environment in the intervention and a higher level of intensity of parental involvement appeared to positively impact intervention effectiveness.

Conclusion

Childcare-based interventions with direct parental involvement show promising effects on the children's energy balance-related behaviours. However, evidence on effectiveness is limited, particularly for weight-related outcomes. Better understanding of how to reach and involve parents may be essential for strengthening intervention effectiveness.

Background

In the past decades, the prevalence of childhood overweight and obesity has increased dramatically, and although a plateauing of the prevalence can be seen [88], their prevention remains an important issue in public health. Research on childhood overweight and obesity has shown that weight status in young children (age 2 – 6 years old) is most predictive for weight status as adults [7, 89].One cause of overweight and obesity is a disruption in the body's energy balance [90]. Promoting healthy energy balance-related behaviours (EBRB), such as the consumption of fruit and vegetables, higher levels of daily physical activity and low levels of sedentary behaviour (e.g., television viewing), is important to prevent childhood overweight and obesity [11, 91]. It is known that overweight-related lifestyle behaviours track from childhood into adulthood, just like weight status [14]. Therefore, early childhood provides a window of opportunity for the prevention of overweight and obesity [92]. EBRB are influenced by multiple factors, such as the child's environment [39]. From a socio-ecological perspective, different types of environments and different settings can influence behaviour [39, 42, 48]. Environments can be categorized into sociocultural (attitudes, beliefs and values related to nutrition and physical activity within a setting); physical (what is available); economic (costs related to nutrition and physical activity); and political (rules, regulations, policies, and laws related to nutrition and physical activity) [42].

One setting that influences children's EBRB is childcare. Many young children (Europe: 84%, United States: 67%) spend a significant amount of time in childcare [46, 61]. Several studies have examined the role of the childcare setting on the children's weight status, and the results mostly indicated a higher risk of overweight in children attending childcare [62-64, 93]. This might be due to the influence of the sociocultural environment through the childcare workers' nutrition and physical activity practices [75] as well as characteristics of the physical environment, such as play materials and playground features [94, 95]. The home is another setting that influences young children's EBRB. Parents can influence their children's behaviours through their general parenting style and specific parenting practices, but also through their influence on the characteristics of the physical home environment [50, 52, 96]. Types of environments and settings interact with each other in their influence on behaviour [47-49]. Given this complex nature of the determinants of EBRB, a comprehensive, multi-component approach to childhood overweight and obesity prevention is needed [48]. In other words, consistent health-promoting changes across settings should be aimed for [49]. Plus, the different types of environment and the various EBRB involved in childhood overweight should be taken into account [49].

In general, interventions aimed at the prevention of childhood overweight and obesity focus primarily on one setting. These interventions, targeting either childcare or the home, have shown desired effects on children's Body Mass Index (BMI) and EBRB [81, 97, 98]. Although

previous systematic reviews on childcare interventions took parental involvement into account [79, 81, 99], the evidence is still limited. These reviews used parental involvement in order to explain the effectiveness of childcare interventions, however, did not take into account *how* the parents were involved. To our knowledge, only one review specifically studied childcare interventions with parental involvement [100]. This review from 2014, was predominantly explorative, and included only one study in which parents were fully engaged in the intervention [100]. Given the importance of parental involvement in childcare interventions and that it is increasing, an updated and more in-depth study of the literature is needed with a focus on childcare interventions in which the parents are *directly* involved. There are two types of parental involvement: direct and indirect [58]. Direct parental involvement is defined as "parents' presence requested at education sessions and/or parents' attendance and participation requested for family behaviour counselling or parent training sessions" [58]. Indirect parental involvement is defined as "provision of information that did not require parental response, and/or invitations to parents to participate in activities, and/or communications meant to involve parents in intervention activities (e.g. homework assignments)" [58]. Direct parental involvement has been shown to increase intervention effectiveness [58]. Therefore, the current systematic review aims to evaluate the effectiveness of childcare-based interventions with direct parental involvement on weight status and EBRB of 2 – 5-year-old children.

Methods

Search strategy

A combined search was performed in order to conduct two systematic reviews, one on interventions with parental involvement in the preschool setting (current study) and one in the primary school setting [101]. A list of relevant categories and related search terms and keywords was prepared. The categories of the search were: *intervention participant (e.g., child); intervention target behaviours (e.g., physical activity/sedentary behaviour or nutrition); school environment (e.g., preschool); home environment (e.g., parent); intervention;* and *effectiveness studies*. PubMed, Web of Science, PsycINFO and ERIC were searched. An initial search was performed in June 2016, which was updated in January 2019. Studies published until January 2019 were included in this review. An example of the PubMed search can be found as supplementary material (Table S3.1). Finally, additional studies were found by reference tracking of previous (systematic) reviews and included articles.

Inclusion and exclusion criteria

Studies were included when they considered a childcare-based intervention targeting physical activity (PA), sedentary behaviour (SB) and/or nutrition behaviour (NB); the target population was children aged 2 – 5 years old; outcomes measured were BMI, BMI z-score or other weight-related outcomes (e.g. fat percentage, fat free mass) and/or children's

PA (e.g. time spent in total PA or moderate-to-vigorous PA), SB (e.g. screen time or time spent in SB), or NB (e.g. intake of fruits and vegetables, intake of nutrients); and including direct parental involvement [58]. Intervention studies solely describing indirect parental involvement [58] were excluded. Additional exclusion criteria were: not written in English; not applying a pre-post-test design; pilot studies (due to their aim of testing study feasibility instead of effectiveness); interventions in which the preschool was solely used as a location for recruitment and/or venue for the intervention (e.g., afterschool programs or parental education sessions).

Study selection

After removal of duplicates, the retrieved articles were independently screened by title/abstract by two researchers (IK and SV). Those articles selected for full-text screening were assessed on eligibility independently by IK and SV, taking into account the a priori formulated inclusion and exclusion criteria described above. Discrepancies between selected studies were discussed until consensus was reached. The initial overall agreement between the researchers was 74.5%. In case of no consensus (5 studies), a third researcher (SG) was consulted to determine eligibility.

Data extraction

Data was extracted on the following study characteristics: design, intervention characteristics (i.e., country, year, setting, duration, follow-up), number of participating childcare centres, participant characteristics (i.e., number of participants, dropout and mean age), and outcomes measured. To understand the interventions better, data was extracted on targeted behaviour, the types of environments involved in the intervention (according to the ANGELO framework [42]), the content and extent of parental involvement, and the effectiveness of the intervention on the evaluated outcomes. To evaluate the effectiveness, data was extracted from the first measurement after intervention (short-term follow-up). Additionally, in case of multiple follow-up measurements, data from the longest follow-up was used as an indication of the long-term effectiveness.

All favourable effects for the intervention group were considered a reflection of effectiveness. Positive effects were determined as: all measures for one outcome (BMI, PA, SB, NB) were significantly favourable for the intervention group. Mixed effects were determined as: at least one of the measures showed significantly favourable results for the intervention group, whereas other measures did not (e.g., significant positive change in motor skill development, but no significant or negative results for PA intensity). Negative effects were determined as: all measures for one outcome significantly favoured the control group. No effects were determined if there were no significant differences between the intervention and control groups.

Where possible, Cohen's *d* effect sizes were calculated to indicate the magnitude of effects, either significant or non-significant [102]. If information to calculate the effect size was missing, this information was requested from the authors. A total of eight authors (nine studies) were approached for additional data or clarification of their data. One author replied that he/she no longer had access to the data. Two authors could not be reached at the contact information provided in the article. None of the other authors replied to the request for additional data. The magnitude of the effect size was classified using Lipsey's cut-off points. An effect size ≤0.32 was considered small, 0.33-0.55 moderate, and ≥0.56 large [103]. Data extraction was performed by IK.

Quality assessment

Methodological quality was assessed using the 'Effective Public Health Practice Project - Quality assessment tool for Quantitative studies' that is applicable to quantitative studies of various designs [104]. Two researchers (SV and IK) independently rated the quality of the included studies. The interrater reliability was 72.1%. In case of different ratings, the researchers achieved consensus on the quality score by discussion. The quality of the studies was rated in six categories (selection bias, study design, confounders, blinding, data collection methods, and withdrawal and dropouts). The overall rating was strong when at least four categories were rated as strong and none as weak; moderate when there was one weak rating; and weak in the case of two or more weak ratings [104].

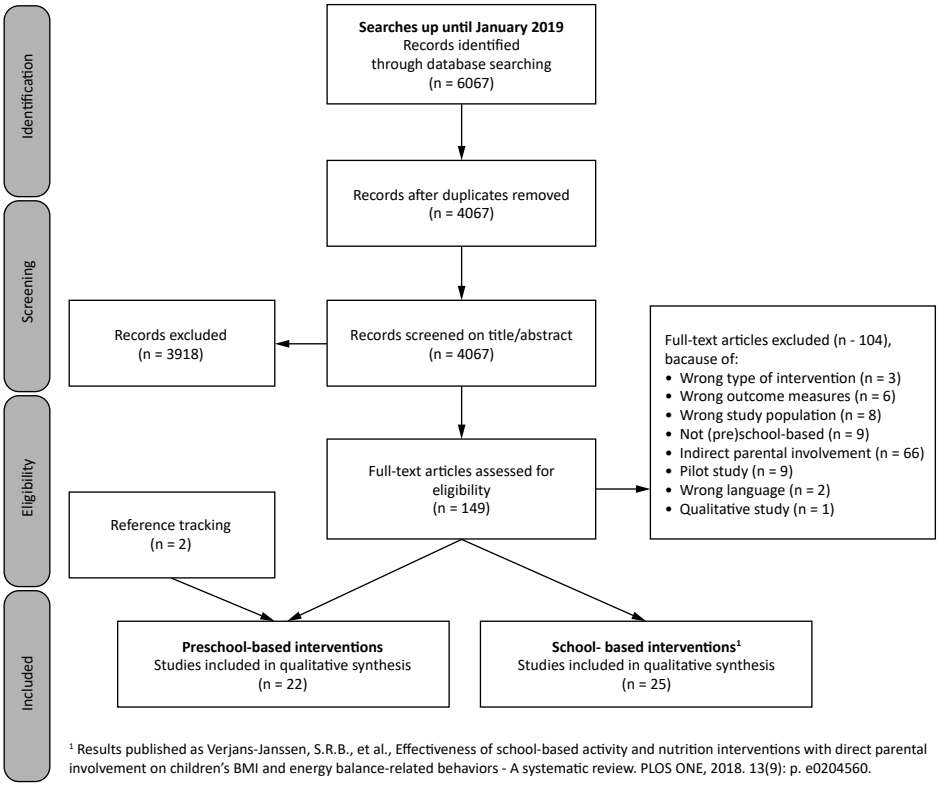
Results

Study Selection

The flow diagram of the study selection is shown in Figure 2.1. The literature searches resulted in a total of 6,067 studies. After removing duplicates, 4,067 studies were screened by title/abstract. The full text of 149 records was assessed for eligibility based on the inclusion and exclusion criteria. The most common reason for exclusion was using only indirect parental involvement in the intervention. Other reasons for exclusion were interventions not being (pre-)school-based, pilot studies, and wrong study population. Reference tracking resulted in the inclusion of two additional studies. Eventually, 22 studies on the effectiveness of preschool-based interventions and 25 studies on the effectiveness of primary school-based interventions were included. The results of the primary school-based interventions with direct parental involvement are presented elsewhere [101].

Study characteristics

The 22 included studies described results from 17 individual interventions. Details on all included studies can be found in Table 2.1. Nineteen studies adopted a cluster randomized controlled trial (c-RCT) design [105-123], although three of them described the design as a RCT [113, 114, 121]. Two studies used a quasi-experimental design (no randomization) [124, 125], and one



[1] Results published as Verjans-Janssen, S.R.B., et al., Effectiveness of school-based activity and nutrition interventions with direct parental involvement on children's BMI and energy balance-related behaviors - A systematic review. PLOS ONE, 2018. 13(9): p. e0204560.

Figure 2.1. Flowchart of the study selection.

used a retrospective design [126]. Eight interventions took place in North America [105, 107, 112-114, 119, 120, 122-124], five in Europe [108, 115-118, 126], two in China [109, 110, 125], one in South America [106] and one in the Middle East [111]. Eight interventions were implemented in childcare centres [105, 107, 112-114, 120, 124, 125], seven in preschools [106, 108, 111, 115-118, 126], and two in kindergarten [109, 110, 119]. Most interventions lasted less than one year, ranging from 6-10 weeks to 11 months, except for two interventions, one lasting one year [125] and one lasting two years [107, 121]. The interventions took place between 2011 and 2014.

Four interventions targeted NB, PA, and SB [114-117, 126], six interventions targeted NB and PA [106, 107, 113, 119, 124, 125], one intervention targeted NB and SB [112], three interventions targeted only NB [109-111, 120], and three interventions targeted only PA [105, 108, 118]. All studies, except for four [107, 109, 114, 120], reported on BMI and related outcomes. Fifteen studies reported on a variety of PA-related outcomes [105, 107, 108, 111-113, 115-119, 123-126], and nine studies reported on SB-related outcomes [105, 108, 111-117]. Thirteen studies reported on NB-related outcomes [109-117, 119, 120, 124].

Table 2.1. General characteristics of included studies.

Study	Study design	Intervention characteristics Country, period, setting, duration	No. of participating organisations	Study participant characteristics Number, drop-out, mean age	Targeted behaviour	Outcome measures and follow-up			
						BMI	PA	NB	SB
Adamo et al. (2017)[1][105]	Cluster RCT	Canada, Spring 2013 – fall 2014, Childcare centres, 6 months	12 int. childcare centres 6 con. childcare centres	N=215 34.4% 3.6 ±0.5 yrs.	PA	BMI, fat free mass, body fat percentage; 3 and 6 months	Time in total PA, time in MVPA, time in LPA[a]; 3 and 6 months	NA	Time in SB[a]; 3 and 6 months
Cespedes et al. (2013) [106]	Cluster RCT	Colombia, June – October 2009, preschools 5 months	7 int. preschools 7 con. preschools	N=1216 8.2% NR (range: 3-5 yrs.)	PA, N	BMI[a]; 6 and 18 months	NA	NA	NA
Cruz et al. (2016)[2][107]	Cluster RCT	USA, 2008-2010 Head Start Centres, 2 years	8 int. childcare centres 8 con. childcare centres	N = 655 NR† 4.1 ±0.7 yrs.	PA, N	NA	How often in PA behaviours[b]: - ball playing - dancing - playing active games - jumping - walking; 1 and 2 yrs	NA	NA
Davis et al. (2016)[2][121]	Cluster RCT	USA, 2008-2010 Head Start Centres, 2 years	8 int. childcare centres 8 con. childcare centres	N = 655 NR† 4.1 ±0.7 yrs.	PA, N	BMI[a]; 1 and 2 yrs.	NA	NA	NA
De Bock et al. (2013) [108]	Cluster RCT	Germany, 2009-2010 Preschools, 6 months	19 int. preschools 20 con. preschools	N = 809 14.6 – 31.0% 5.05 ±0.7 yrs.	PA	BMI[a]; 6 and 12 months	Time in MVPA[a]; 6 and 12 months	NA	Time in SB[a]; 6 and 12 months
Gao et al. (2016)[3][109]	Cluster RCT	China, 2001-2002, Kindergartens, 10 months	5 int. kindergartens 3 con. kindergartens	N = 2102 16.5% 5.0 ±0.9 yrs.	N	NA	NA	Breakfast patterns (frequency, food products consumed)[b]; 4 and 10 months	NA

Hu et al. (2010)[3] [110]	Cluster RCT	China, 2001-2002, Kindergartens, 10 months	5 int. kindergartens 3 con. kindergartens	N = 2102 16.5% 5.0 ±0.9	N	BMI[a]; 4 and 10 months	NA	Dietary behaviours[b]; 4 and 10 months	NA
Kaufman-Shriqui et al. (2016) [111]	Cluster RCT	Israel, 2008-2009 Preschools, 3 months	7 int. preschools 4 con. preschools	N = 238 7.6% 5.3 ±0.54 yrs.	N	BMI[a] z-score; 3 and 6 months	Time in PA during leisure time[b]; 3 and 6 months	Nutritional habits[b] (variety of foods consumed, consumption of vegetables, sweets, SSB and water); 3 and 6 months	Daily screentime[b]; 3 and 6 months
Klein et al. (2015) [126]	Retrospectively	Germany, 2006, 2008 Preschools, Unavailable	27 int. preschools 11 cont. preschools	N= 1436 NR 4.7 ±0.9 yrs.	PA, N, SB	BMI (percentile)[a]; 6 months	Motor skill tests[a] (shuttle run, stan-ding long jump, one leg stand, sit and reach, and lateral jumping); 6 months	NA	NA
Lumeng et al (2017) [112]	Cluster RCT	USA, 2011-2014 Head Start classrooms, 7 months	4 int. classrooms 2 con. classrooms	N = 697 8.5% 4.11 ±0.52 yrs.	N, SB	BMI z-score[a]; 7 months	Time playing out-doors[b]; 7 months	Intake of servings of specific foods/ food groups per day[b]; 7 months	Screentime[b]; 7 months
Natale, Lopez-Mitnik et al. (2014) [113]	Cluster RCT	USA, NR Childcare centres, 6 months	6 int. childcare centres 2 con. childcare centres	N = 307 NR 3.87 (Range: 2-5 yrs.)	PA, N	BMI z-score[a]	Time in moderate PA[b]; 3, 6 and 12 months	Dietary intake at home and child-care[b]; 3, 6 and 12 months	Screentime[b]; 3, 6 and 12 months
Natale, Messiah et al. (2014)[4] [114]	Cluster RCT	USA, 2010-2011, Childcare centres, 6 months	12 int. childcare centres 20 cont. childcare centres	N = 1211 NR 3.9 ±0.93 yrs.	N, PA, SB	NA	NA	Consumption F/V and junk food[b]; 1 school year	SB[b]; 1 school year
Natale et al. (2017)[4] [122]	Cluster RCT	USA, 2010-2011, Childcare centres, 6 months	12 int. centres 20 cont. centres	N = 1211 NR 3.9 ±0.93 yrs.	N, PA, SB	BMI z-scores[a]; 1 school year	NA	Consumption F/V and junk food[b]; 1 school year	NA

Table 2.1. Continued

Study	Study design	Intervention characteristics Country, period, setting, duration	No. of participating organisations	Study participant characteristics Number, drop-out, mean age	Targeted behaviour	Outcome measures and follow-up			
						BMI	PA	NB	SB
Nyberg et al. (2015) [116]§	Cluster RCT	Sweden, 2010-2011, Preschools, 6 months	7 int. classrooms 7 cont. classrooms	N = 243 0.9% 6.2 ±0.3 yrs.	N, PA, SB	BMI[a]; 6 and 12 months	Time in PA[a], PA habits[b]; 6 and 12 months	Intake of indicator foods (F/V, energy-dense products)[b]; 6 and 12 months	SB[b]; 6 and 12 months
Nyberg et al. (2016) [115]§	Cluster RCT	Sweden, 2012-2013 Preschools, 6 months	16 int. classrooms 15 cont. classrooms	N = 378 2.6% 6.3 ±0.3 yrs.	N, PA	BMI[a]; 6 and 12 months	Time in PA[a], PA habits[b]; 6 and 12 months	Intake of indicator foods (F/V, energy-dense products)[b]; 6 and 12 months	SB[b]; 6 and 12 months
Puder et al. (2011) [117]	Cluster RCT	Switzerland, 2008-2009, Preschools, 9 months	20 int. classes 20 cont. classes	N = 727 3,6% 5.2 ±0.6 yrs.	N, PA, SB	BMI[a], % body fat[a], Skin fold thickness[a]; 1 school year	Aerobic fitness[a], motor skills[a], level of PA[a, b]; 1 school year	Eating habits[b]; 1 school year	Media use[b]; 1 school year
Roth et al. (2015) [118]	Cluster RCT	Germany, 2007-2008, Preschools, 11 months	31 int. preschools 10 cont. preschools	N = 709 14% 4.7 ±0.6 yrs.	PA	BMI[NR], Skin fold thickness[NR]; 6, 12, and 16 months	Change in MVPA[a], Composite score of motor skills[a]; 6, 12, and 16 months	NA	NA
Story et al. (2012) [119]	Cluster RCT	USA, 2005-2006, Kindergarten, 11 months	Total of 14 schools, division NR	N = 454 NR 5.79 ±0.51 yrs.	PA, N	BMI[a]; 4 rounds (fall kindergarten, spring kindergarten, fall first grade, Spring first grade)	Total PA at school[c]; 4 rounds (fall kindergarten, spring kindergarten, fall first grade, Spring first grade)	% of calories from fat and nutrient content in school meals[a], food intake at home[b]; 4 rounds (fall kindergarten, spring kindergarten, fall first grade, Spring first grade)	NA
Wasenius et al. (2018)[1] [123]	Cluster RCT	Canada, Spring 2013 – fall 2014, Childcare centres, 6 months	12 int. childcare centres 6 con. childcare centres	N=215 34.4% 3.6 ±0.5 yrs.	PA	BMI[a]; 6 months	Fundamental Motor Skills (FMS)[a], Total PA[a]; 6 months	NA	NA

Williams et al. (2014) [120]	Cluster RCT	USA, 2010 Childcare centres, 6-10 weeks	12 int. childcare centres 12. cont. childcare centres	N = 1143 21.1 % 4.4 ±NR yrs.	N	NA	NA	At-home consumption of F/V and milk[b]; 1-week post-intervention	NA
Yin et al. (2012) [124]	Quasi experimental	USA, 2010-2011 Childcare centres, 8 months	3 int. centres 1 con. centre	N = 384 12% 4.1 ±0.56 yrs.	N, PA	BMI[a]; NR	Gross motor development[a], Outdoor step count[a]; NR	Dietary intake[a]; NR	NA
Zhou et al. (2014) [125]	Quasi experimental	China, 2010-2011 Childcare centres, 12 months	1 int. centre 1 con. centre	N = 387 4.3% 4.40 ±0.78 yrs.	PA, N	BMI[a], BMI z-score; 12 months	Physical fitness[a]; 12 months	NA	NA

BMI = Body Mass Index, Con= control, F/V = fruit/vegetables, Int= intervention, LPA= light physical activity; MVPA= moderate-to-vigorous physical activity, N= nutrition, NA= not applicable, NR= not reported, PA= Physical activity, RCT= Randomised Controlled Trial, SB = sedentary behaviour, SSB = sugar sweetened beverages, yrs.= years

†drop-out was not reported at participant level

[1,2,3,4] studies based on the same intervention, but with different outcomes or follow-up. Corresponding numbers indicate the same intervention.

[$] Studies used the same intervention, but with different populations

[a] objectively measured

[b] Parent reported

[c] teacher reported

Study quality

Three studies (13.6%) [111, 116, 117] were rated strong for methodological quality (Table 2.2). Eight studies (36.4%) got a weak rating [105, 107, 112, 113, 119, 121, 122], and the remainder of the studies (50.0%) were rated of moderate quality. Weak or moderate ratings on one of the assessed categories often resulted from a lack of reporting. For example, only two studies reported completely on blinding [105, 117]. Other weak ratings resulted from low recruitment rates [107, 112, 115] or unclear validity and reliability of the measurement instruments [107, 110, 112, 118, 119].

Table 2.2. Quality assessment of the selected studies.

Study	Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawals and dropouts	Overall rating
Adamo et al (2017) [105]	Weak	Strong	Weak	Strong	Strong	Weak	**Weak**
Cespedes et al. (2013) [106]	Strong	Strong	Strong	Moderate	Moderate	Weak	**Moderate**
Cruz et al. (2016) [107]	Weak	Strong	Strong	Moderate	Weak	Weak	**Weak**
Davis et al (2016) [121]	Weak	Strong	Strong	Moderate	Strong	Weak	**Weak**
De Bock et al. (2013) [108]	Strong	Strong	Strong	Moderate	Strong	Weak	**Moderate**
Gao et al. (2016) [109]	Moderate	Strong	Weak	Moderate	Strong	Strong	**Moderate**
Hu et al. (2010) [110]	Strong	Strong	Strong	Moderate	Weak	Strong	**Moderate**
Kaufman-Shriqui et al. (2016) [111]	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Klein et al. (2015) [126]	Moderate	Moderate	Strong	Moderate	Strong	Moderate	**Moderate**
Lumeng et al. (2017) [112]	Weak	Strong	Strong	Moderate	Weak	Strong	**Weak**
Natale, Lopez et al. (2014) [113]	Moderate	Strong	Weak	Moderate	Strong	Weak	**Weak**
Natale, Messiah et al. (2014) [114]	Moderate	Strong	Strong	Moderate	Strong	Weak	**Moderate**
Natale et al. (2017) [122]	Weak	Strong	Moderate	Moderate	Strong	Weak	**Weak**
Nyberg et al. (2016) [115]	Weak	Strong	Strong	Moderate	Strong	Strong	**Moderate**
Nyberg et al. (2015) [116]	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Puder et al. (2011) [117]	Strong	Strong	Strong	Strong	Strong	Strong	**Strong**
Roth et al. (2015) [118]	Moderate	Strong	Strong	Moderate	Weak	Strong	**Moderate**
Story et al. (2012) [119]	Strong	Strong	Strong	Moderate	Weak	Weak	**Weak**
Wasenius et al. (2018) [123]	Weak	Strong	Strong	Moderate	Strong	Weak	**Weak**
Williams et al. (2014) [120]	Moderate	Strong	Strong	Moderate	Strong	Moderate	**Moderate**
Yin et al. (2012) [124]	Moderate	Strong	Strong	Moderate	Strong	Weak	**Moderate**
Zhou et al. (2014) [125]	Weak	Strong	Strong	Moderate	Strong	Strong	**Moderate**

Intervention components

All interventions consisted of activities to change the sociocultural environment (Table 2.3). In the preschool component, these were predominantly teacher training sessions or workshops [105-107, 109-111, 113, 114, 117-122, 124-126]. Some interventions added PA lessons or nutrition lessons to the curriculum, to be delivered either by the teachers themselves or by external teachers or experts [108, 111, 112, 114-120, 122, 124-126]. Some interventions provided a manual to support the teacher in the implementation of the intervention [105, 106, 115, 116], while others offered personal assistance [106, 113, 114, 118, 122]. In the family component, intervention activities to change the sociocultural environment were mostly parent training sessions or workshops [105, 106, 109-114, 117, 118, 120, 122, 124-126]. Some interventions organized family events [107, 117, 119, 121, 124, 125]. One intervention took a participatory approach and actively involved parents in the selection of projects to be implemented that would affect both the preschool and family component [108]. In addition to these direct parental involvement activities, almost all interventions also used indirect parental involvement activities such as newsletters, information leaflets, and homework assignments [105-107, 109-112, 115-119, 121, 124-126].

Fourteen interventions included activities to change the physical environment in the preschool [105-110, 113-119, 121, 122, 124, 125]. The most commonly used intervention activities were providing equipment for PA [105-107, 114, 119, 121, 122, 125] and intervention-specific materials [115-118, 124]. Other activities were food menu changes [107, 113, 121], providing children's storybooks related to nutrition or PA [109, 110, 124], and permanent markings on indoor and outdoor play areas [125]. In the family component, seven interventions implemented activities in the physical environment [109, 110, 113, 117-120, 124]. These included take-home materials and activities [109, 110, 117, 118, 120, 124] and take-home healthy nutrition or PA-related incentives [113, 119].

Five interventions tried to change the political environment in the preschool component [107, 113, 114, 120-122, 125] by formulating or changing policies related to NB [107, 120, 121], PA [125], or both [113, 114, 122]. None of the interventions included activities to change the economic environment.

In addition to the preschool and family components, two interventions also included a community component [107, 121, 125]. For example, neighbourhood events were organized [125], or healthy food options were made increasingly available and visible in grocery stores [107, 121]. One intervention aimed at changes in the sociocultural environment through training of neighbourhood association staff, neighbourhood events, and a sports day for families [125]. Both interventions included activities to change the physical environment through increasing the availability and visibility of healthy food options at grocery stores [107, 121] and renovation of neighbourhood playgrounds and installing children's play equipment [125].

Table 2.3. Intervention components and intervention effectiveness.

Study	Int. comp.	Political env.	Sociocultural env.	Physical env.	Short-term effectiveness				Long-term effectiveness			
					BMI	PA	SB	N	BMI	PA	SB	N
Adamo et al. (2017) [105]	Childcare		Two 3-hour workshop training sessions for day-care providers, a training manual and weekly schedules. Bimonthly booster sessions during regular hours.	Music developed for PA with a guidebook, starter kit of equipment.	0 ES: 0; 0.39	0 ES: 0	0 ES: 0	NA				
	Parental		Two online training sessions (webinars) or hard copies of training material; ABC Child activities Booklet and bi-weekly postcards.									
Cespedes et al. (2013) [106]	Childcare		Teacher training sessions; personalized working sessions with a research supervisor and a teacher's guide;	Classroom educational and playful activities (storybooks, posters, videos, games and songs).	0 ES: -0.59	NA	NA	NA	0	NA	NA	NA
	Parental		3 workshops, healthy notes.									
Cruz et al. (2015) [107]	Childcare	Policy changes on food menu	Professional development for teachers through training sessions	New equipment for the classroom; F&V in school menu.	NA	+/0	NA	NA				
	Parental		Take-home materials. Family events.									
	Community			Increase availability and visibility of healthier food options at grocery stores; Provision of recipes and nutrient-related information to families.								
Davis et al. (2016) [121]	Childcare	Policy changes on food menu	Professional development for teachers through training sessions	New equipment for the classroom; F&V in school menu.	0 ES: 0.04	NA	NA	NA				
	Parental		Take-home materials. Family events.									
	Community			Increase availability and visibility of healthier food options at grocery stores; Provision of recipes and nutrient-related information to families.								

De Bock et al. (2013) [108]	Childcare	Twice-weekly 1-hour gym class delivered by external gym trainers.	In collaboration with parents 4 various projects were chosen to be implemented at the preschool.	0 ES: 0.01	+/0 ES: 0.06; 0.08	+ ES: -0.06	NA				
	Parental										
Gao et al. (2016) [109]	Childcare	Monthly education.	Illustrated book; Series of promotional pictures.	NA	NA	NA	+				
	Parental	Monthly parent-child education (at least 8 lectures or activities); Pamphlets.	Illustrated book.								
Hu et al. (2016) [110]	Childcare	Monthly education.	Illustrated book; Series of promotional pictures.	NR	NA	NA	+/0				
	Parental	Monthly parent-child education (at least 8 lectures or activities); Pamphlets.	Illustrated book.								
Kaufman-Shriqui et al. (2016) [111]	Childcare	Teacher training; Nutritional lessons; PA curriculum (also in control group).		NR	+ ES: 0.18	+ ES:-0.4	+/0 ES: NA	NR	NR	NR	+/0
	Parental	Two meetings for mothers only, one meeting for mothers and children; Weekly newsletter.									
Klein et al. (2015) [126]	Childcare	KIMO&NF: single information session on healthy lifestyle. NF: one physical education class of 60 minutes per week for 6 months.		+ ES: -0.19; -0.12	+/-/0 ES: 0.02; 0.37	NA	NA				
	Parental	KIMO&NF: single information session on healthy lifestyle, individual fitness passes with test results.									

Table 2.3. Continued

Study	Int. comp.	Political env.	Sociocultural env.	Physical env.	Short-term effectiveness				Long-term effectiveness			
					BMI	PA	SB	N	BMI	PA	SB	N
Lumeng et al. (2017) [112]	Childcare		POPS: Lessons using children's stories. POPs+ IYS: Sixty 15-20 min lessons during 'circle time' followed by small group activities.		0 ES: -0.12; 0	0 ES: -0.08; 0.12	0 ES: -0.17; 0.03	+/0 -0.32; 0.10				
	Parental		POPS: Eight 75-minute weekly lessons with reinforcing telephone contacts. POPS+IYS: 2-hour lessons for 12-14 weeks or 10 home visits, homework and follow-up phone calls.									
Natale, Lopez-Mitnik et al. (2014) [113]	Childcare	Development of nutrition and PA policies	Two trainings for teachers and staff; Weekly technical assistance visit.	Modifying menus to fit the new policies.	0 ES:-0.04	0 ES: NA	+	+				
	Parental		Monthly educational dinner.	Receiving healthy snack bag after completion of at-home activities.								
Natale, Messiah et al. (2014) [114]	Childcare	Drink policy Snack policy Physical activity policy Screen time policy	Six monthly trainings; Child curriculum; Weekly technical assistance for child curriculum.	Food tastings Music and movement CDs, rainy day activities and equipment.	NA	NA	+	+				
	Parental		Six monthly trainings.									
Natale et al. (2017) [122]	Childcare	Drink policy Snack policy Physical activity policy Screen time policy	Six monthly trainings; Child curriculum; Weekly technical assistance for child curriculum.	Food tastings Music and movement CDs, rainy day activities and equipment.	+	NA	NA	0				
	Parental		Six monthly trainings.									

Natale et al. (2017) [122]	Childcare	Drink policy Snack policy Physical activity policy Screen time policy	Six monthly trainings; Child curriculum; Weekly technical assistance for child curriculum.	Food tastings Music and movement CDs, rainy day activities and equipment.	+	NA	NA	0				
	Parental		Six monthly trainings.									
Nyberg et al. (2015) [116]	Childcare		Ten 30-minute teacher-led sessions with teacher manual and workbook	Toolbox and extra educational materials.	0 ES: -0.04	0 ES: -0.33; -0.12	0 ES: 0.06; 0.07	0 ES: -0.88; 0.40	0	0 ES: -0.18; 0.07	0 ES:-0.14; -0.13	0 ES: -1.35; 0.61
	Parental		Brochure; Two motivational interviewing sessions; Homework assignments for the children.									
Nyberg et al. (2016) [115]	Childcare		Ten 30-minute teacher-led sessions with teacher manual and workbook.	Toolbox and extra educational materials.	0 ES: -0.02	0 ES: -0.16; -0.06	0 ES: -0.03; 0.03	+/0 ES: -1.06; 0.20;	0 ES: 0.01	0 ES -0.18; -0.15	+/0 ES: -0.22; -0.21	0 ES: -0.82; 0.03
	Parental		Brochure; One group meeting at school to discuss the brochure; Two individual sessions of MI; Homework assignments for the children.									
Puder et al. (2011) [117]	Childcare		Two teacher workshops; PA lessons 4 times per week (first by HP and taken over by PT); Weekly nutrition lessons; extracurricular PA activities.	Additional sports equipment for the PA lessons; Infrastructural changes in the building.	+/0 ES: -0.23; 0.07	+/0 ES: -0.13; 0.22	+	+				
	Parental		PA and nutrition card that the child took home; morning event; three information evenings; information booklet.	CD with music for the PA cards.								

Table 2.3. Continued

Study	Int. comp.	Political env.	Sociocultural env.	Physical env.	Short-term effectiveness				Long-term effectiveness			
					BMI	PA	SB	N	BMI	PA	SB	N
Roth et al. (2015) [118]	Childcare		Daily 30-minute PA lessons provided by PT; Two afternoon workshops; supervision visits; Cards with educational content to help teachers plan and realise PA lessons.		0 ES: -0.06; 0.023	+/0 ES: -0.13; 0.20	NA	NA	0 ES: 0.03; 0.05	+/0 ES: -0.05; 0.23	NA	NA
	Parental		Three educational seminars; Booklet on healthy eating, PA; booklets and letter on the content of the seminars	Homework cards with activity games and motor tasks.								
Story et al. (2012) [119]	Childcare		School PE, class walks outdoors, in-class action breaks, and active recess; Training of PE teachers; Training of school food-service staff; teacher training.	'Action toolbox'; playground equipment; non-food rewards for classroom performance.	+/0 ES: -0.24; 0.07	0 ES: NA	NA	+/0 ES:-2.22; 1.40				
	Parental		Three family night events; motivational encouragement telephone calls; quarterly newsletter.	Take-home incentives related to PA or nutrition.								
Wasenius et al. (2018) [123]	Childcare		Two 3-hour workshop training sessions for day-care providers, a training manual and weekly schedules. Bimonthly booster sessions during regular hours.	Music developed for PA with a guidebook, starter kit of equipment.	NR	+/0 ES: 0.53; 1.49	NA	NA				
	Parental		Two online training sessions (webinars) or hard copies of training material; ABC Child activities Booklet and bi-weekly postcards.									
Williams et al. (2014) [120]	Childcare	Policy improvement to enhance nutrition.	Two classes for staff; 30-minute lessons for children (selected six out of ten possible modules).		NA	NA	NA	+/0 ES: 0; 0.18				
	Parental		30-60-minute parent classes (the same selected six out of ten possible modules).	take-home materials and activities.								

Yin et al. (2012) [124]	Childcare		Teacher training to implement a gross motor skills program during daily outdoor play; provision of structured play activities the first 15-20 minutes of outdoor play; Sesame Street Workshop Healthy Habits for Life (HHL, nine modules); food-tasting activities and contests; 6-hour initial training of staff with follow-up trainings.	Activity cards and equipment for the motor skills program; children's storybooks with nutrition and PA themes	0 ES: -0.04	+ ES: 0.03	NA	+/0 ES: NA
	Parental		Eight newsletters about HHL; parent delivered poster sessions at dismissal time; information scavenger hunt.	Take-home bag with a storybook, family activities and an interactive game; healthy snack for the child after viewing the posters.				
Zhou et al. (2014) [125]	Childcare	Policy related to outdoor play time and physical education.	Bi-weekly 60-minute training sessions (to 20 hours); physical education curriculum for outdoor play period; two training sessions (3 hours) for food services workers.	Portable play equipment; poster of children playing on the outside walls; game markings on the outdoor playground and indoor play space; permanent markings for skipping and hopping both indoors and outdoors.	0 ES: -0.61; 0.32	+ ES: -0.55; 0.45	NA	NA
	Parental		Monthly health education seminars; 12 monthly newsletters; interactive website; family events for both parent and child.					
	Community		Training of neighbourhood associations staff; neighbourhood events; hosting sports day for families.	Renovation of neighbourhood playgrounds; installation of child's play equipment				

Int.= intervention; BMI= Body Mass Index; HS+POPS= Head Start + Preschool Obesity Prevention Series; IYS = Incredible Years Series; KiMo= Kindergarten Mobile; N = Nutrition; NA= Not Applicable; NF-P= Nursery Fit-Participated; NF-NP=Nursery Fit-Not Participated; NR= Not Reported; SB = Sedentary Behaviour; PA = Physical Activity

*Effectiveness is presented as positive effects (+), all effects significantly favoured the intervention group; mixed effects (+/0/-), one of the effects significantly favoured the intervention group, the other effects were not significant or favoured the control group; negative effects (-), all effects significantly favoured the control group.

**Effect sizes are only provided for studies and outcomes for which effect sizes could be calculated. The positive or negative indicator shows the direction of effect. Depending on the outcome, this favoured the intervention group or the control group.

Study Effects

Effects on weight-related outcomes

Of the eighteen studies reporting on weight-related outcomes, eleven (61.1%) found favourable results for the intervention group for one of the weight-related outcomes [106, 112, 113, 115-117, 119, 122, 124-126] (Table 2.4). Of these eleven studies, two were positively effective on all weight-related outcomes [122, 126], and two found mixed results [117, 119]. The other studies did not find significant differences between the study groups, and some also found unfavourable results regarding some of their weight-related outcomes [119, 125]. Effect sizes were calculated for all studies except one [122]. All effects on weight-related outcomes were small, except for Cespedes et al. (2013), who found a moderate favourable effect size [106]. Four studies found unfavourable effects for the intervention group [105, 108, 118, 121]. The results of these four studies were all non-significant, with small effect sizes, except for Adamo et al. (2017), who found a moderate effect size for body fat percentage [105].

One study did not report the BMI or BMI z-score but reported non-significant differences between the groups on weight and height scores (standardized) [110]. For two studies, no conclusions on BMI or BMI z-scores could be drawn because they were not reported [123] or the data were insufficient (reporting on the whole group instead of the intervention and control groups separately) [111].

Four studies reported additional long-term follow-up measurement. Two of them reported no differences between the intervention and control group [106, 116]. The other two reported unfavourable effects for the intervention group at the long-term follow-up, although they were not significant [115, 118]. The available effect sizes for the long-term follow-up were small [115, 118].

Table 2.4. Intervention effectiveness based on reported results with effect sizes where available.

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Adamo et al. (2017) [105]	Short term follow-up: No change in BMI in the intervention group (0.0 kg/m2) compared to a decrease in the control group (-0.5 kg/m^2) (p=0.155) **ES 0.24** Larger increase of fat mass in the intervention group (0.6 kg) compared to the control group (0.2 kg) (p=0.234) **ES 0.30** Increase in fat-free mass in both the intervention (0.7 kg) and the control group (0.7 kg) (p=0.876) **ES 0** Increase in fat percent in the intervention group (1.7%) compared to a decrease in the control group (-0.6%) (p=0.253) **ES 0.39**	Short term follow-up: Increase in total physical activity in both the intervention group (1.6 min/h) and the control group (1.6 min/h) (p=0.995) **ES 0** Increase in MVPA in both the intervention group (1.3 min/h) and the control group (1.3 min/h) (p=0.932) **ES 0** Increase in LPA in both the intervention (0.3 min/h) and control group (0.3 min/h) (p=0.955) **ES 0**	Short term follow-up: Decrease in sedentary time in both the intervention (-1.6 min/h) and the control group (-1.6 min/h) (p=0.995) **ES 0**	NA
Cespedes et al. (2013) [106]	Short term follow-up: Smaller increase in BMI in the intervention (0.58 kg/m^2) compared to the control group (0.63 kg/m^2) (p=0.193) **ES -0.59** Long term measurement: No significant differences between the intervention and control group (p=0.5, no data provided).	NA	NA	NA
Cruz et al. (2016) [107]	NA	Short term follow-up: Increase in proportion 'often' ball playing in intervention group (+8.2%) compared to a decrease in the control group (-4.5%) (ns) Increase in proportion 'often' dancing in intervention group (+16.1%) compared to a decrease in the control group (-10.6%) (p<0.01) Larger increase in proportion 'often' playing active games in intervention group (+10.8%) compared to the control group (+5.9%) (ns) Larger increase in proportion 'often' jumping in intervention group (+11.8%) compared to the control group (+5.4%) (ns) Increase in proportion 'often' walking in intervention group (+2.5%) compared to a decrease in the control group (-1.3%) (ns)	NA	NA

Table 2.4. Continued

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Davis et al. (2016) [121]	Short term follow-up: Larger increase in BMI z-score in the intervention group (0.17) compared to the control group (0.11) (p=0.34) **ES 0.036**	NA	NA	NA
De Bock et al. (2013) [108]	Short term follow-up: No differences in mean change in BMI (0.064 kg/m^2) between intervention and control group (p=0.41) **ES 0.01** No differences in mean change in body fat (0.21%) between intervention and control group (p=0.32)	Short term follow-up: Increase of mean counts per 15-second interval (+1.38) in intervention group compared to control group (p=0.019) **ES 0.08** No difference in MVPA (+0.97 minutes) between intervention and control group (p>0.1) **ES 0.06**	Short term follow-up: Decrease in time in sedentary behaviour (-11 minutes) in the intervention group compared to control group (p=0.014) **ES -0.06**	NA
Gao et al. (2016) [109]	NA	NA	NA	Short term follow-up: Increase in daily breakfast frequency in the intervention group (+1.1%) compared to a decrease in the control group (-1.9) (p=0.02) Increase in quantity of food for breakfast in the intervention group compared to a decrease in the control group (p<0.001) More high-in-nutrient food types in breakfast in the intervention group compared to more high-in-energy food types in the control group (p<0.001)
Hu et al. (2010) [110]	NR	NA	NA	Short term follow-up: Some unhealthy diet-related behaviours were significantly different between the intervention and control groups (p<0.05), while others showed no significant difference. Improvement in healthy diet-related behaviours in the intervention group (p <0.05).

Kaufman-Shriqui et al. (2016) [111]	Follow-up not indicated: Reduction of BMI z-score (-0.1) in total study population (p=0.003). No group-specific scores reported.	Follow-up not indicated: Decrease of mean PA time in control group (-0.42 hours) compared to intervention group (-0.21 hours, p=0.03) **ES 0.18**	Follow-up not indicated: Increase of screen time in control group (+0.54 hours) compared to no change in intervention group (p=0.001) **ES -0.4**	Short term follow-up: Greater increase in food variety (intervention +26.5%, control +7.6%); daily vegetable consumption (intervention +24.7%, control +9.2%), and habitual water drinking (intervention +21.3%, control +10.8%) in the intervention group compared to the control group, all p<0.05. Greater decrease in daily consumption of SSB in the intervention group (-19.2%) compared to the control group (-13.6%, p=0.02). Non-significant smaller decrease in daily consumption of sweet and candies in the intervention group (-17.7%) compared to the control group (-18.2%, p=0.08) Long term follow-up: Greater increases in food variety (intervention +25.3%, control +8.1%), daily vegetable consumption (Intervention +22.3%, control +8.8%), and habitual water drinking (intervention +19%, control +11.9%) in intervention group compared to control group (all p<0.05). Decrease in daily consumption of SSB in the intervention group (-15.3%) compared to control group (-8.3%) (p=0.05) No significant difference between intervention group (-22.9%) and control group (-15.2%) in consumption of sweet and candies on daily basis (p=0.13).

Table 2.4. Continued

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Klein et al (2015) [126]	Short term follow-up: Significant decrease in BMI in group KiMo (-0.1 kg/m2), NF-P (-0.1 kg/m2) and NF-NP (-0.2 kg/m2) compared to an increase in control group (all p<0.001) **ES -0.13, -0.12, -0.19, respectively**	Short term follow-up: Motor tests: Non-significant differences in Shuttle Run between groups (KiMo -1.1 sec, NF-P -0.8 sec, NF-NP -1.0 sec and CG -1.3 sec) **ES 0.06, 0.17, 0.1, respectively** Non-significant differences in Standing Long Jump between groups (KiMo +12.6 cm, NF-P +10.8 cm, NF-NP +13.1 cm, CG +8.8 cm) **ES 0.15, 0.08, 0.17, respectively** Significant differences in Sit and Reach between KiMo (+0.7 cm, p<0.001), NF-P (+0.3, p=0.007), NF-NP (+0.6 cm, p<0.001) and control group (-0.6 cm) **ES 0.27, 0.20, 0.27, respectively** Significant negative difference in One Leg Stand between KiMo (-2.0 ground contacts, p<0.001), NF-P (-2.8 ground contacts, p=0.035) and control group (-3.2 ground contacts) **ES 0.16, 0.05, respectively** Non-significant difference between NF-NP (-3.2 ground contacts) and control group (-3.2 ground contacts) **ES 0** Non-significant differences in Lateral Jumping between KiMo (+4.4 jumps), NF-P (+4.7 jumps), NF-NP (+4.8 jumps), and control group (+4.2 jumps) **ES 0.02, 0.05, 0.06, respectively**	NA	NA

Lumeng et al. (2017) [112]	Short term follow-up: Non-significant difference in percentage overweight or obese between HS+POPS (-2.3%, p=0.35), HS+POPS+IYS (-0.6%, p=0.77) and HS (+0.6%) Non-significant differences in percentage obese between HS+POPS (-2.9%, p=0.16), HS+POPS+IYS (-2.1%, p=0.33) and HS (+0.8%) Non-significant differences in BMI z-score in children overweight or obese at baseline between HS+POPS (-0.11, p=0.98), HS+POPS+IYS (-0.16, p=0.44) and HS (-0.11) **ES 0, -0.12, respectively**	Short term follow-up: Non-significant differences in outdoor play between HS+POPS (-0.82 h/d, p=0.48), HS+POPS+IYS (-0.47 h/d, p=0.25) and HS (-0.68 h/d) **ES -0.08, 0.12, respectively**	Short term follow-up: Non-significant difference in screen time between HS+POPS (+0.55 h/d, p=0.75), HS+POPS+IYS (+0.24 h/d, p=0.11) and HS (+0.5 h/d) ES 0.03, -0.17, respectively	Short term follow-up: Non-significant differences in vegetable servings/day between HS+POPS (-0.02, p=0.90), HS+POPS+IYS (-0.05, p=0.88) and HS (-0.03) **ES 0.01, -0.02, respectively** Non-significant differences in whole fruit servings/day between HS+POPS (+0.05, p 0.86), HS+POPS+IYS (-0.02, p=0.60) and HS (+0.03) **ES 0.02, -0.04, respectively** Non-significant differences in fruit juice servings/day between HS+POPS (-0.21, p=0.77), HS+POPS+IYS (-0.06, p=0.39) and HS (-0.17) **ES -0.03, 0.10, respectively** Non-significant difference in SSB servings/day between HS+POPS (+0.01, p=0.12) and HS (+0.14) ES -0.20 Significant difference in SSB servings/day between HS+POPS+IYS (-0.07, p=0.005) and HS (+0.14) **ES -0.32**
Natale, Lopez-Mitnik et al (2014) [113]	Short term follow-up: Less increase in BMI z-score in the intervention group (+0.05) compared to the control group (+0.16) (NS) **ES -0.04**	Short term follow-up: No significant differences between intervention and control group (no data reported).	Follow-up not indicated: Significantly more time spent on the computer ($p<0.01$) and watching TV ($p<0.0001$) in the control group compared to the intervention group at school (no data reported).	Follow-up not indicated: During school time: Intervention group decreased mean junk food consumption, while the control group increased consumption. Intervention group increased mean fresh fruit and vegetable consumption. Intervention groups decreased juice consumption. Intervention group increased 1% milk consumption. Control group decreased water consumption. For all outcomes no data were reported.
Natale, Messiah et al. (2014) [114]	NA	NA	Short term follow-up: The intervention group decreased sedentary behaviour, compared to an increase in the control group ($p<0.004$).	Short term follow-up: No change in fruit/vegetable consumption in the intervention group, compared to a decrease in the control group ($p<0.05$). The intervention group decreased the consumption of junk food, compared to an increase in the control group (p=0.01).

Table 2.4. Continued

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Natale et al. (2017) [122]	Short term follow-up: The intervention group had a negative slope (β=-1.95, p=0.04) in BMI percentile growth curve, indicating a significant positive change in PBMI over time.	NA	NA	Short term follow-up: No significant difference between groups in change over time in children's fruit/vegetable consumption (β=0.04, p=0.34) and children's unhealthy food consumption (β=0.01, p=0.80).
Nyberg et al. (2015) [116]	Short term follow-up: No significant difference in BMIsds between intervention (Δ-0.11) and control group (Δ-0.06) **ES -0.04** No significant difference in change of prevalence of underweight (Δ=1.6, p=0.53), normal weight (Δ=-1.9, p=0.65), overweight (Δ=2.3, p=0.54), obese (Δ=-1.8, p=0.16). Long term follow-up: No significant difference in change of prevalence of underweight (Δ-0.8, p=0.69), normal weight (Δ+0.9, p=0.61), overweight (Δ+4.7, p=0.43), and obesity (Δ-1.8, p=0.37) between the intervention and control group. Outcomes on BMIsds not reported.	Short term follow-up: No significant differences between the intervention and control group in TPA (cpm, β=-21.2, p=0.58) or MVPA (minutes, β=-4.9, p=0.33) **ES -0.12, -0.13 resp.** Non-significant difference in 'child taken to activity in the last week' (time/week) between intervention and control group (β=-0.48, p=0.07) **ES -0.33** Long term follow-up: No significant differences between the intervention group and control group in TPA (cpm, β=-15.0, p=0.51) or MVPA (minutes, β=+2.7, p=0.60) **ES -0.09, 0.07 resp.** No significant difference in 'child taken to activity in the last week' (time/week) between intervention and control group (β=-0.27, p=0.22) **ES -0.18**	Short term follow-up: No significant difference in % time spent sedentary (β=0.4, p=0.59) between the intervention and the control group **ES 0.07** No significant difference between the intervention and the control group in screen time viewing (min/day, β=-3.59, p=0.76) **ES -0.06** Long term follow-up: No significant differences in % time spent sedentary (β=-0.8, p=0.27) between the intervention and control group. **ES -0.13** No significant difference in screen time viewing (min/day) between intervention and control group (β=-8.23, p=0.29) **ES -0.14**	Short term follow-up: No significant differences of 'servings in the precious weekday' between intervention and control group for fruit juice (β=-0.20, p=0.38) **ES -0.25**; soft drink/sugar syrup (β=-0.37, p=0.23) **ES -0.88**; milk (β=0.04, p=0.71) **ES 0.04**; flavoured milk (β=0.04, p=0.92) **ES 0.09**; vegetables (β=0.09, p=0.44) **ES 0.08**; snacks (β=-0.28, p=0.44) ES -0.48; fruit (β=0.11, p=0.26) **ES 0.08**; sweets (β=-0.003, p=0.99) **ES -0.004**; cakes/buns/cookies (β=-0.25, p=0.24) **ES -0.30**; ice-cream (β=0.08, p=0.69) **ES 0.09**. Significant difference between the intervention and the control group for 'usual servings of vegetables per day' (β=0.26, p=0.003) **ES 0.40** Long term follow-up: No significant difference of 'servings in the previous weekday, between intervention or control group for fruit juice (β=-0.21, p=0.41) **ES -0.26**; soft drink/sugar syrup (β=+0.20, p=0.63) **ES 0.45**; milk (β=-0.01, p=0.95) **ES -0.01**; flavoured milk (β=-0.18, p=0.67) **ES -0.43**; vegetables (β=+0.05, p=0.67) ES 0.05; snacks (β=-0.67, p=0.30) **ES -1.35**; fruit (β=+0.13, p=0.23) **ES 0.10**; sweets (β=+0.49, p=0.23) **ES 0.61**; cakes/buns/cookies (β=+0.38, p=0.24) **ES 0.47**; ice-cream (β=+0.41, p=0.18) **ES 0.46** No significant difference in usual servings of vegetables per day between the intervention and control group (β=+0.14, p=0.14) **ES 0.21**

Nyberg et al. (2016) [115]	Short term follow-up: No significant differences in BMI sds scores between intervention and control group (β=-0.03, p=0.46) **ES -0.02** Long term follow-up: No significant differences in BMI sds scores between the intervention and control group (β=0.013, p=0.79) **ES 0.01**	Short term follow-up: No significant differences between the intervention and the control group for TPA (cpm, β=-30.1, p=0.18) or MVPA (minutes, β=-1.5, p=0.55) **ES -0.16, -0.06 resp.** Long term follow-up: No significant differences between the intervention group and control group in TPA (cpm, β=-34.8, p=0.13) or MVPA (minutes, β=-3.6, p=0.19) **ES -0.18, -0.15 resp.**	Short term follow-up: No significant difference in sedentary time in minutes between intervention and control group (β=1.5, p=0.68) **ES 0.03** No significant difference in screen time (min/day) between the intervention and the control group (β=-2.6, p=0.79) **ES -0.03** Long term follow-up: A significant difference on sedentary time in minutes (β=-9.2, p=0.03) between the intervention and control group **ES -0.21**. No significant difference in screen time (min/day) between the intervention and the control group (β=-16.5, p=0.10) **ES -0.22**.	Short term follow-up: No significant differences of 'servings in the previous weekday' between intervention and control group for fruit juice (β=-0.24, p=0.16) **ES -0.37**; soft drink/sugar syrup (β=-0.28, p=0.25) **ES -0.60**; flavoured milk (β=-0.47, p=0.15) **ES -0.93**; vegetables (β=0.15, p=0.22) **ES 0.20**; snacks (β=-0.57, p=0.08) **ES -1.06**; fruits (β=-0.15, p=0.13) **ES -0.16**; sweets/ chocolate (β=-0.38, p=0.10) **ES -0.58**; cakes/ buns/cookies (β=0.00, p=1.00) **ES 0**; ice cream (β-0.22, p=0.22) **ES -0.29** Significant difference on aggregated variables 'unhealthy food' (β=-0.32, p=0.01); 'unhealthy drink' (β=-0.51, p=0.01) between intervention and control group. No significant difference in aggregated variable 'healthy food' (β=-0.02, p=0.79) between the intervention and control group. Long term follow-up: No significant differences of 'servings in the previous weekday' between intervention and control group for fruit juice (β=-0.09, p=0.70) **ES -0.14**; soft drink/sugar syrup (β=+0.02, p=0.95) 0.04; flavoured milk (β=-0.04, p=0.92) **ES -0.07**; vegetables (β=+0.02, p=0.85) **ES 0.03**; snacks (β=-0.46, p=0.19) **ES -0.82**; fruits (β=+0.03, p=0.76) **ES 0.03**; sweets/ chocolate (β=-0.26, p=0.29) **ES -0.39**; cakes/ buns/cookies (β=-0.33, p=0.12) **ES -0.43**; ice-cream (β=-0.22, p=0.30) **ES -0.29**. No significant differences on aggregated variables 'unhealthy food' (β=-0.15, p=0.42); 'unhealthy drink' (β=0.05, p=0.83); and 'healthy food' (β=-0.03, p=0.68) between the intervention and the control group.

Table 2.4. Continued

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Puder et al. (2011) [117]	Short term follow-up: No significant difference in BMI change between the intervention and control group (Δ-0.07, p=0.31). **ES 0.07** Significant reductions in percentage body fat (Δ-1.1, p=0.02) and sum of skinfolds (Δ-2.78, p=0.001) in the intervention group compared to the control group. **ES -0.15, -0.02, respectively** Significantly lower increase in waist circumference (Δ-1.0, p=0.001) in the intervention group compared to the control group. **ES -0.24**	Short term follow-up: Significantly higher increase in aerobic fitness in the intervention group compared to the control group (Δ+0.32, p=0.01). **ES 0.22** Significant improvement in motor agility (time to perform an obstacle course) in the intervention group compared to the control group (Δ-0.54, p=0.004). **ES -0.13** No significant difference in dynamic balance (Δ+0.2, p=0.35) and static balance (Δ=+19.4, p=0.18) between the intervention and control group. **ES 0.06, 0.04, respectively** No significant difference in TPA (cpm, Δ-12.3, p=0.54) between the intervention and control group. **ES 0.012**	Short term follow-up: Significant difference in media use (min/day) between the intervention and control group (Δ-13.4, p=0.03). **ES -0.22**	Short term follow-up: Significant difference in proportion healthy eaters between the intervention and the control group (Δ+1.9, p=0.04).

Roth et al. (2015) [118]	Short term follow-up: No significant difference between the intervention and control group on BMI (centile, Δ+0.244, p=0.857); and sum of four skinfolds (mm, Δ+1.548, p=0.272). **ES 0.023, -0.06 respectively** Long term follow-up: No significant difference between the intervention and the control group on BMI (centile, Δ+0.103, p=0.949); and sum of four skinfolds (mm, Δ+0.305, p=0.846). **ES 0.05, 0.03, respectively**	Short term follow-up: No significant (Bonferroni adjusted α) difference in MVPA between the intervention and the control group (Δ+0.005, p=0.049). Significant increase in motor skills performance (z-score) in children in the intervention group compared to the control group (Δ+0.623, p=0.001). Significant improvements in explosive leg strength (cm, Δ+3.209, p=0.004) **ES -0.07**; jumping coordination (jumps, Δ +1.451, p=0.019) **ES 0.20**; and static balance (tips, Δ-1.474, p=0.032) **ES -0.13**, in the intervention group compared to the control group. No significant improvements in agility (seconds, Δ-0.628, p=0.060) **ES -0.09**; dynamic balance (% failure, Δ-0.015, p=0.617); and throwing ability (% failure, Δ-0.020, p=0.465). Long term follow-up No significant difference in MVPA between the intervention and the control group (Δ+0.006, p=0.859). Significant increase in motor skills performance (z-score) in children in the intervention group compared to the control group (Δ=+0.590, p=0.007). Significantly better improvements in the intervention group in agility (seconds, Δ-0.689, p=0.034) **ES -0.11** and explosive leg strength (cm, Δ=+4.041, p=0.007) **ES 0.23**. No significant differences between the intervention group and control group in static balance (tips, Δ-0.306, p=0.629) **ES -0.05**; jumping coordination (jumps, Δ+1.276, p=0.089) **ES 0.18**; dynamic balance (% failure, Δ+0.051, p=0.220); and throwing ability (% failure, Δ+0.006, p=0898).	NA	NA

Table 2.4. Continued

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Story et al. (2012) [119]	Short term follow-up: No significant difference between the intervention and the control group in BMI (kg/m^2, Δ+0.34, p=0.057) **ES 0.07**; BMI z (Δ+0.01, p=0.904) **ES 0**; triceps (mm, Δ+0.02, p=0.978) **ES 0.003**; subscapular (mm, Δ+0.05, p=0.909) **ES 0.005**; % body fat (Δ0.90, p=0.122) **ES 0.07**; and % obese (Δ+2.11, p=0.503) **ES 0.04**. A significant difference in % overweight (Δ-10.14, p=0.019) between the intervention and the control group. **ES -0.24**	Short term follow-up: A greater mean in PA (combined from recess and PE class in min/week) in the intervention group compared to the control group (NS).	NA	Short term follow-up: Nutrients from school menus: A significant difference between the intervention and control group in % total fat calories (Δ-8.00, p=0.004); and % calories saturated fat (Δ-4.08, p=0.002). No significant difference between the intervention and control group in kilocalories (Δ-37.3, p=0.691) **ES -0.0007**; carbohydrate (g, Δ+11.5, p=0.487) **ES 1.4**; protein (g, Δ-0.26, p=0.933) **ES -0.13**; fat (g, Δ-7.81, p=0.085) **ES -2.22**; iron (mg, -0.16, p=0.877) **ES -0.33**; magnesium (mg, Δ+3.9, p=0.740) **ES -0.79**; calcium (mg, Δ+64, p=0.827) **ES 0.39**; sodium (mg, Δ-96, p=0.624) **ES -0.84**; vitamin A (RAE, Δ=+36.6, p=0.643) **ES 1.01**; vitamin D IU (Δ=+0.28, p=0.505) **ES 1.33**; folate (mg, Δ=+13.6, p=0.581) **ES 1.01**; and sugar added (g, Δ-2.66, p=0.763) **ES -0.36** Food intake reported by parents: Significant difference in intake times per day of sweetened beverages (Δ-0.28, p=0.024); whole milk (Δ-0.22, p=0.011); and chocolate milk (Δ-0.17, p=0.025) between the intervention and control group. No significant difference in intake times per day of vegetables (Δ+0.02, p=0.788); fruits (Δ+0.07, p=0.269); skim milk (Δ+0.12, p=0.138); 100% juice (Δ-0.03, p=0.689); bottled water (Δ+0.09, p=0.413); and fast food (Δ+0.04, p=0.374.

Wasenius et al. (2018) [123]	NR	Short term follow-up: Significant difference in locomotor skills between intervention and control group (Δ+2.4, p<0.001) **ES 1.31**. No significant difference between intervention and control group on object control skills (Δ+0.5, p=1.0) **ES 0.53**, sum of raw scores (Δ+2.8, p=0.333) **ES 1.48** or Gross Motor Quotient (Δ+3.2, p=0.498) **ES 1.30**. TPA: NR	NA	NA
Williams et al. (2014) [120]	NA	NA	NA	Short term follow-up: Significant difference between the intervention and control group in proportion of children that used low fat/fat-free milk at home (OR1.39, p<0.05) **ES 0.19**; and cups of vegetables child consumed at home (Δ+0.12, p<0.05) **ES 0.12**. No significant difference in cups of fruit child consumed at home (Δ+0.06, NS) **ES 0.04**; and cups of fruits and vegetables child consumed at home (Δ+0.19, NS) **ES 0.10** between the intervention and control group. Significant difference between the intervention and control group in no. of days the child helped self/requested vegetable as snack (Δ0.34, p<0.05) **ES 0.14**. No significant difference between intervention and control group in no. of days the child helped self/requested fruit as snack (Δ+0.24, NS) **ES 0.09**; no. of days parent offered vegetable as snack (Δ+0.25, NS) **ES 0.11**; and no. of days parent offered fruit as snack (Δ0.00, NS) **ES 0**.
Yin et al. (2014) [124]	Short term follow-up: No significant difference between intervention group and control group in BMI z-score (Δ-0.09, p<0.09) **ES -0.04**.	Short term follow-up: Significant difference between the intervention and control group in gross motor development (Δ1.15, p<0.001) **ES 0.03** A significantly higher level of active play in the intervention group compared to the control group (data not available).	NA	Short term follow-up: Significantly more fruit and vegetables consumption in the intervention group (0.19 serving, p<0.05) and low-fat milk (0.06 serving, p<0.006) than in the control group. No reporting on grain products. No significant change in meat consumption.

Table 2.4. Continued

Study	BMI/BMI z-score	Physical activity	Sedentary behaviour	Nutrition behaviour
Zhou et al. (2014) [125]	Short term follow-up: No significant difference between intervention and control group for BMI (kg/m2, Δ0.19, NS) **ES 0.10**; and BMI z-score (Δ0.15, NS) **ES 0.10**. Significant difference between intervention and control group for % body fat (Δ-1.2, p=0.0001) **ES -0.34**; fat mass (kg, Δ-0.55, p=0.0001) **ES -0.61**; and muscle mass (kg, Δ+0.48, p=0.0001) **ES 0.32**.	Short term follow-up: Significant difference between the intervention and control group in 20m agility run (seconds, Δ-0.74, p=0.0001) **ES -0.39**; broad jump (cm, Δ8.09, p=0.0001) **ES 0.46**; tennis ball throw (m, Δ+0.52, p=0.006); sit-and-reach (cm, Δ+0.88, p=0.03) **ES 0.35**; balance beam walk (seconds, Δ-2.02, p=0.0001) **ES -0.15**; 20m crawl (seconds, Δ-3.36, p=0.0001) **ES -0.55**; and 30m sprint (seconds, Δ-0.45, p=0.02) **ES -0.21**	NA	NA

BMI= Body Mass Index; CPM= Counts Per Minute; HS+POPS= Head Start + Preschool Obesity Prevention Series; IYS = Incredible Years Series; KiMo= Kindergarten Mobile; LPA= Light Physical Activity; MVPA= Moderato-to-Vigorous-Physical-Activity; NA= Not Applicable; NF-P= Nursery Fit-Participated; NF-NP=Nursery Fit-Not Participated; NR= Not Reported; PA= physical activity; TPA= total Physical activity
Effect sizes are only provided for studies and outcomes for which effect sizes could be calculated. The positive or negative indicator shows the direction of effect. Depending on the outcome this favours the intervention group or the control group.

Effects on physical activity and sedentary behaviour outcomes

With regard to PA outcomes, eleven out of fifteen studies (73.3%) found favourable effects on at least one of the outcomes [107, 108, 111, 112, 117-119, 123-126] (Table 2.4). Of these studies, three found positive effects on all PA outcomes measured [111, 124, 125], and six found mixed effects [107, 108, 117, 118, 123, 126]. The majority (66.7%) of the significant effects were found for motor development outcomes [117, 118, 123-126]. The effects found by Lumeng et al. (2017) and Story et al. (2012) were all non-significant [112, 119]. The effect sizes of the favourable results were large [123], moderate [123, 125, 126], and small [108, 111, 112, 117, 124-126]. For two studies [107, 119] effect sizes could not be determined. Two studies found effects that were unfavourable for the intervention group [115, 116]. These results had small effect sizes (non-significant), except for Nyberg et al. (2015) on 'child taken to activity in the last week', which had a moderate effect size [116] and was non-significant. One study found no effect on all PA outcomes [105]. One study reported no significant differences for PA outcomes but did not show data [113].

Three studies had a long-term follow-up of PA outcomes [115, 116, 118]. Roth et al. (2015) found mixed long-term effects of PA outcomes. Some of their outcomes were also unfavourable for the intervention group, but not significant [118]. The two other studies had non-significant unfavourable results, except for MVPA in the study of Nyberg et al. (2015), which was favourable for the intervention group [115, 116]. All long-term effect sizes were small.

Sedentary behaviour was operationalised as time spent in SB or as screen time/media use. Eight out of nine (88.9%) studies found favourable effects of the intervention on at least one SB outcome [108, 111-117]. Five of them found positive effects on all SB outcomes [108, 111, 113, 114, 117]. Of the effective studies, three found effects on screen time/media use [111, 113, 117] and two on time in SB [108, 114]. The available effect sizes of the effective studies were moderate [111] or small [108, 117]. Three studies also reported unfavourable effects for the intervention group on SB outcomes [112, 115, 116]. These results all had small effect sizes and were not significant. One study did not show any effect of the intervention on SB [105].

Two studies performed an additional long-term follow-up [115, 116]. Nyberg et al. (2016) found mixed effects in the long-term with a significant difference in time in SB, with a small effect size [115]. Nyberg et al. (2015) found favourable effects for the intervention group on both SB outcomes in the long-term [116]. These results had a small effect size and were not significant.

Effects on nutrition behaviour outcomes

All studies reporting on NB outcomes reported favourable results for the intervention group for at least one of the NB outcomes [109-117, 119, 120, 122, 124] (Table 2.4). Three studies found positive effects on all NB-related outcomes [109, 114, 117]. One study described positive effects, but no conclusions on significance could be made based on the available information [113]. Eight studies found mixed effects [110-112, 115, 116, 119, 120, 124]. Effects were seen in a great variety of NB outcomes, such as fruit and vegetable consumption, junk food consumption, sugar sweetened beverages (SSB) intake, breakfast patterns [109, 111, 112, 114, 119], nutrients in school menus [119], or percentage of healthy eaters [117]. Within these mixed effects, some studies found unfavourable results for the intervention group for some outcomes [111, 112, 115, 116, 119, 122]. They were all non-significant. Effect sizes were available for five studies (38.5%) [112, 115, 116, 119, 120]. One study found large and moderate effect sizes in changes in nutrients from school menus [119]. The studies by Nyberg et al. (2015, 2016) showed large, moderate, and small effect sizes [115, 116]. All other effects on the NB-related outcomes were small [112, 119, 120].

Three studies had an additional long-term follow-up measurement of NB [111, 115, 116]. They all showed favourable results for the intervention group for at least one of the outcomes. One study showed mixed effects [111], and the other two studies showed no significant long-term effects [115, 116]. Some of these non-significant effects were unfavourable for the intervention group. Long-term effect sizes of these two studies on the different NB outcomes were large, moderate and small.

Synthesizing intervention components with effects

From a narrative synthesis of the effects with the intervention components, two types of patterns emerged. First, better integrated interventions (targeting multiple types of environments) seemed to be related to intervention effectiveness. In particular,

incorporating policy changes in addition to changes in the physical and sociocultural environments appeared to increase the likelihood of effects occurring [113, 114, 120, 125]. For example, Zhou et al. (2014) formulated PA policy as part of the intervention and found significant differences in the PA outcomes [125]. In the interventions of Natale, Lopez-Mitnik et al. (2014) and Natale, Messiah et al. (2014), policy was formulated on various EBRB, and they found significant differences between the intervention and control groups for SB and NB [113, 114]. One intervention focused on policy on NB, but did not report on this outcome and did not find effects on PA [107, 121].

The second pattern that emerged concerned the level of parental involvement, which seemed to be positively related to the intervention effectiveness. For example, an intervention adopting a participatory design, i.e., actively involving parents in the intervention development, showed effects on PA and SB [108]. An intervention using parent-delivered activities found effects on PA [124], and interventions using family activities for both parents and children found effects on various EBRB [109-111, 125]. These interventions were found to be more effective than interventions focusing predominantly on parental education [105, 112, 115, 116, 123].

Discussion

The aim of this systematic review was to evaluate the effectiveness of childcare-based interventions with direct parental involvement on weight status and EBRB in children aged 2 - 5 years old. A total of 22 studies describing 17 interventions was included. These studies showed promising effectiveness with predominantly favourable results for the intervention group on at least one of the measured outcomes. However, there were studies that also showed unfavourable results. The effect sizes related to these results were for a great majority small, with a few moderate and large effect sizes. Only a small number of studies showed statistically significant differences between the intervention and control group, in particular on weight-related outcomes. Figure 2.2 shows the key recommendations that emerged from this review and that will be explained further here.

Practice:

- Childcare interventions should aim to actively involve parents. This may need a shift from educational intervention strategies, to strategies focused on active involvement of parents in intervention development and implementation and activities for parent and child together.
- Different types of environments should be taken into account in the development of childcare interventions (i.e. not only the physical and/or sociocultural environment, but also the political environment in particular), to ensure that each type of environment is supportive for healthy child EBRBs.
- Local and/or national initiatives to support healthy EBRBs of young children should involve the childcare setting.

Research:

- The research community should aim for agreement on the operationalization and measurement of outcomes of childcare interventions, to increase comparability of the results of the interventions.
- Complete reporting of the results of analysis is advised, including means and standard deviations at the different measurement time points to aid summarizing of results through meta-analyses and systematic reviews.
- Systematic evaluation of the synergistic value of active parental involvement and integration of environmental types is needed in childcare interventions.

Figure 2.2. Key recommendations from this systematic review.

The level of parental involvement appeared to positively impact the intervention effectiveness. Interventions that used strategies to actively involve parents through participatory intervention designs, parent-delivered activities, or family activities including both parents and children appeared to have a higher likelihood of success in influencing the children's EBRB. A recent qualitative study emphasised the preference of parents to spend quality family time and have fun with the family through participating in such interventions [127]. Some studies indicated possible ceiling effects on health-related beliefs (parents usually know what is healthy), indicating there may be little to be gained from solely educational interventions [127, 128]. This may explain the limited effectiveness of the interventions in this systematic review that focused mainly on health education for parents. An important consideration in interventions using parental involvement may be selection bias. Some parental characteristics are associated with participation in interventions, such as high SES and two-parent families [129]. Cognitive beliefs may influence participation, for example, realising that their child is at risk for a certain behaviour [129, 130]. These factors may also be applicable to health-promoting childcare interventions, resulting in the participation

of parents who may be more engaged with the topic. This may influence the effectiveness of these interventions. Reaching and involving parents is a major challenge in interventions aimed at involving parents [131]. Many practical considerations exert important influences on the parents' ability to participate in interventions [127, 131]. Nevertheless, the high reach of parents may be a precondition to increase intervention effectiveness. In this systematic review it appeared that studies reporting high reach (>80%) were more likely to have positive results [111, 116, 117, 124, 125]. Three of them used active parental involvement strategies [111, 124, 125]. This might be an indication that parents are more willing to participate in these types of interventions. As the data in this review are not conclusive on reach, there is still a lot to be learned about how to reach parents, what strategies to use in interventions, and how to increase the level of parental involvement, in order to improve health-promoting interventions for young children.

Better integrated interventions, including the political environment, appeared to be related to increased effectiveness. Policies may function as the basis or backbone of intervention strategies and be an important enabler for determinants related to behaviour [132, 133]. For example, promoting water consumption in the childcare setting can be arranged by educating childcare workers and parents and providing a water tap. However, it may become part of common practice and result in more sustainable change if a supporting policy is formulated. This may entail, for example, stating that the serving of SSB is no longer allowed and parents are no longer allowed to bring SSB from home. The findings related to the level of parental involvement and the integration of the types of environment should be interpreted with caution, since they are based on a narrative synthesis of the interventions. A systematic assessment of effective intervention elements is needed to confirm these results.

Factors in all types of environments influence children's EBRB [74, 133-135]. It is thus important to take into account the different environmental types. As the political and economic environments have been underrepresented in the interventions included in this systematic review, increased attention should be paid to them by intervention developers. Improving our understanding of the interdependence between the environmental types (e.g., how is the sociocultural environment influenced by the political environment) may help in designing interventions that fit best within their real-life setting and can have a greater impact.

In line with previous reviews, limited evidence was found for effectiveness on weight status outcomes, while more indications were found for effectiveness on behavioural outcomes [79, 99, 100]. Interventions thus appear to be more effective in changing behaviour which they directly target. Weight status is changed through the child's behaviour and therefore more distal and more difficult to change. Time may be an important factor in determining intervention effectiveness on weight status outcomes because behavioural changes need time to manifest as weight changes. In line with this, longer interventions and longer follow-

up time resulted in increased odds of effectiveness on weight status [117, 119, 122]. Moreover, interventions showing an effect on weight status also showed effects on one or more behaviour-related outcomes [111, 114, 117, 119, 122, 126]. These effective interventions on weight status all aimed at multiple EBRB. This emphasizes the importance of not targeting single EBRB in isolation but combining them in interventions. This is also supported by research showing the clustering of EBRB in young children [136] and a recent intervention study showing stronger effects of a comprehensive intervention approach compared to the promotion of physical activity in isolation [137].

Regarding the PA outcomes, most effects were seen on motor skill development. Fundamental motor skills (FMS) are the basis for an active life as children become able to perform activities and enjoy being physically active. This can help them to maintain an active lifestyle throughout their lives [138, 139]. It may be more important to aim interventions at FMS rather than physical intensity measures at this age. A majority of the interventions showing this positive effect on FMS provided play materials as part of the changes in the physical environment [117, 123-125]. This may suggest that this intervention strategy fits better with effects on FMS.

The NB outcomes were operationalised in many different ways: varying from intake at school and at home, to intake on product level and on nutrient level. Most of the outcomes were subjectively measured by parental self-report. These factors made it difficult to draw conclusions on the effectiveness on NB outcomes. The magnitude of the effects for all outcomes was moderate or small, with some exceptions. However, in the end, all the small effect sizes on different behavioural outcomes, day in and day out, may add up to substantial behavioural change.

Although intervention effectiveness on behavioural outcomes was promising, it may still be considered limited, for example when compared with primary school-based interventions (except for NB outcomes) [101]. Context-related factors may explain this difference in effectiveness. Attention paid to healthy EBRB in young children has only recently started to grow. This lack of tradition and culture of health promotion in the childcare setting is reflected in the studies included in this review, with the oldest intervention dating from 2001. A longer tradition of promoting healthy EBRB may facilitate a more positive tendency and greater readiness for intervention implementation, which may result in increased effectiveness. In addition, context-related factors such as local and national health-promoting initiatives have focused mainly on primary school-aged children and older up till now, while these new initiatives aimed at younger children may be very supportive of change [140, 141]. It is important to take into account such context-related factors in intervention development and implementation, as they may be crucial in understanding effectiveness [43].

Limitations of the included studies

There was great heterogeneity between the included studies regarding operationalisation and measurement of outcome measures. This hindered our ability to perform a meta-analysis of the effects. In addition, comparability of the effects of individual interventions included in this review is limited. Another limitation is the methodological quality of the included studies, as only three studies were rated as strong. However, those three studies were not more effective compared to the other studies. This may be explained by the focus of the quality instrument on internal validity (e.g., study design and randomization, blinding, and dropout rates). These may be aspects that cannot always be taken into account in 'real-life' intervention studies.

Strengths and limitations of the review

This review adds to our knowledge on intervention effectiveness in the childcare setting by specifically looking at direct parental involvement. We tried to explain intervention effects by looking at the different types of environments targeted using the ANGELO framework [42]. The strengths of this review are the use of the EPHPP tool, which is a validated instrument to assess study quality, and thus reflect the risk of bias, for intervention studies [104]; the use of the PRISMA statement for reporting of the systematic review [142]; and calculation of the effect sizes to increase comparability between the studies.

There are some limitations to this systematic review. Although four databases were used to conduct the literature search, only studies written in English were included, which may have resulted in selection bias. We did not extend our literature search to find unpublished work, which may have resulted in publication bias. Results and conclusions of this review may need to be considered with caution due to the mostly weak methodological quality of the included studies. Further, the synthesis of intervention components and effects was based on narrative synthesis and needs further research.

Recommendations

There is a sound theoretical foundation to incorporate parental involvement in childcare-based interventions [79, 99]. Behavioural outcomes such as children's EBRB and intermediaries' behaviours are more likely to be changed by these types of interventions. Increased attention paid to operationalization and continuity in these outcomes between studies will improve the comparability of intervention programs.

Knowledge also needs to be gained on how to reach parents, what type of strategies to use for parental involvement, and the optimal level of parental involvement. This knowledge could be essential in improving the effectiveness of childcare-based intervention programs. With regard to reporting on intervention results, improvements could be made in the detail of reporting on study design and results (e.g., means and standard deviations). This

will enable a better judgement of the study quality and calculation of the effect sizes. A systematic evaluation to determine effective intervention elements may be needed.

We recommend that intervention developers take into account all different types of environments and look beyond the physical and sociocultural environment when designing health-promoting programmes in the childcare setting. In particular, policy changes may function as a necessary additional element in order to achieve sustained effects. We also recommend taking a comprehensive approach (including different EBRB) and taking into account the clustering of EBRB. Recognizing the complexity of childhood overweight and obesity in intervention development may be indispensable for intervention effectiveness. We recommend looking for alternative ways of involving parents besides just educational strategies. Formative research may support intervention development by shedding light on influential factors from different types of environments and their interdependence and will aid in increasing intervention fit with the setting.

Conclusion

Childcare-based interventions with direct parental involvement show promising effects on improving young children's EBRB. However, the evidence is limited, especially for weight-related outcomes. More integration of different types of environment, as well as a more active level of parental involvement, might be factors that influence intervention effects on children's EBRB. Taking these factors into account in intervention development may advance the field of childcare-based health promotion towards more effectively and sustainably changing children's EBRB.

Appendix

Table S2.1. Search strategy PubMed.

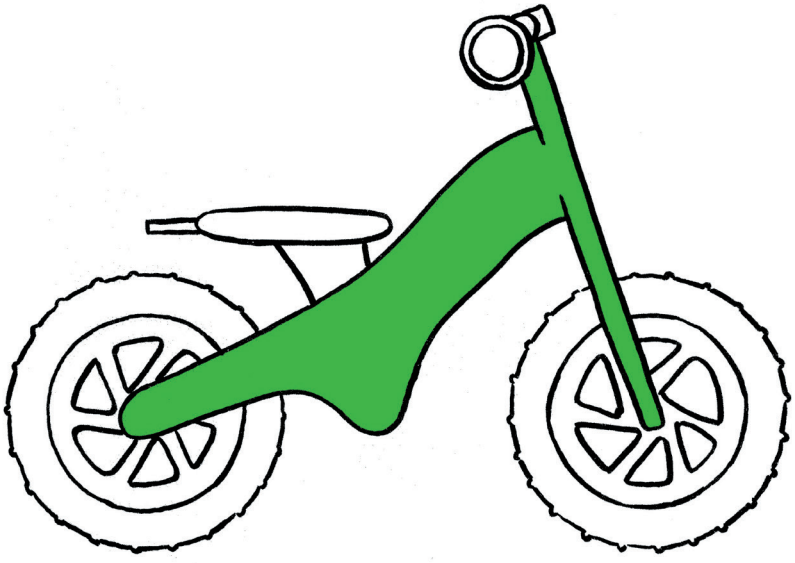
Category	Search terms
Child	(Child [Mesh] OR Child [Title/Abstract]) OR Children [Title/Abstract] OR (Child, preschool [Mesh] OR Child, preschool [Title/Abstract]) OR Children, preschool [Title/Abstract] OR Minors [Mesh] OR Minor [Title/Abstract] OR Minors [Title/Abstract] OR (Pre-schoolers [Title/Abstract] OR Preschoolers [Title/Abstract]) OR Preschooler [Title/Abstract] OR Toddler [Title/Abstract] OR Toddlers [Title/Abstract] OR (Infant [Mesh] OR Infant [Title/Abstract]) OR Infants [Title/Abstract])
Intervention components	((“Motor activity” [Mesh] OR physical activity [Title/Abstract] OR physical activities [Title/Abstract]) OR (“Life Style” [Mesh] OR “life style” [Title/Abstract] OR lifestyle [Title/Abstract] OR lifestyles [Title/Abstract]) OR “Energy balance” [Title/Abstract] OR (“Diet, Food and Nutrition” [Mesh] OR Food [Mesh] OR “healthy food” [Title/Abstract] OR “unhealthy food” [Title/Abstract] OR (Diet [Mesh] OR Diet [Title/Abstract] OR Dietary [Title/Abstract] OR Diets [Title/Abstract]) OR Nutrition [Title/Abstract] OR “Child Nutrition” [Mesh] OR (“healthy eating” [Title/Abstract] OR “unhealthy eating” [Title/Abstract]) OR (“energy intake” [Mesh] OR “energy intake” [Title/Abstract]) OR (“Sedentary Life Style” [Mesh] OR “Sedentary Life Style”[Title/Abstract] OR “Sedentary behaviour” [Title/Abstract] OR “Sedentary behaviour” [Title/Abstract])
Pre-School/ School	(“Schools, nursery” [Mesh] OR (“Child Day Care Centers” [Mesh] OR “Day Care” [Title/Abstract] OR “Daycare” [Title/Abstract] “Day Cares” [Title/Abstract] OR “Daycares” [Title/Abstract]) OR (Pre-school [Title/Abstract] OR Pre-schools [Title/Abstract] OR Preschool [Title/Abstract] OR Preschools [Title/Abstract]) OR (Kindergarten [Title/Abstract] OR Kindergartens [Title/Abstract]) OR (Nursery [Title/Abstract] OR Nurseries [Title/Abstract]) OR (Playgroup [Title/Abstract] OR Playgroups [Title/Abstract]) OR (Schools [Mesh] OR School [Title/Abstract] OR Schools [Title/Abstract] OR “Primary school” [Title/Abstract] OR “Primary schools” [Title/Abstract]) OR (“School based” [Title/Abstract] OR “School centered” [Title/Abstract]))
Family	(Parents [Mesh] OR Parent [Title/Abstract] OR Parents [Title/Abstract]) OR (Fathers [Mesh] OR Fathers [Title/Abstract] OR Father [Title/Abstract]) OR (Mothers [Mesh] OR Mothers [Title/Abstract] OR Mother [Title/Abstract]) OR (Caregiver [Title/Abstract] OR Caregivers [Title/Abstract]) OR (Family [Mesh] OR Family [Title/Abstract] OR Families [Title/Abstract]) OR (“Family based” [Title/Abstract] OR Home [Title/Abstract] OR “Home based” [Title/Abstract]) OR Parental [Title/Abstract])
Intervention	(Intervention [Title/Abstract] OR Interventions [Title/Abstract])
Effectiveness	((Evaluation [Title/Abstract] OR evaluations [Title/Abstract]) OR (“evaluation studies” [Publication type] OR “evaluation studies as topic” [Mesh]) OR (effects [Title/Abstract] OR effectiveness [Title/Abstract] OR effectivity [Title/Abstract] OR effective [Title/Abstract] OR effect [Title/Abstract]) OR “pre post test” [Title/Abstract] OR “pre post tests” [Title/Abstract])

Table S2.2. PRISMA checklist.

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	15
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	16
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	17-18
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	18
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N.A.
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	18
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	18
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary material S2.1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	18-19
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	19-20
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	19-20
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	20
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	20
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis.	n.a.
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n.a.
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n.a.

Table S2.2. Continued

Section/topic	#	Checklist item	Reported on page #
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	20, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	22, Table 2.1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	26, Table 2.2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	27-48, Table 2,3 & 2.4
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n.a.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n.a.
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n.a.
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	48
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	52
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	48-51, Figure 2.2
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	



Chapter 3

Healthy Nutrition and Physical Activity in Childcare: Views from Childcare Managers, Childcare Workers and Parents on Influential Factors

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Abstract

Childhood obesity is an important public health issue influenced by both personal and environmental factors. The childcare setting plays an important role in children's energy balance-related behaviours (EBRB), such as physical activity, sedentary behaviour and healthy nutrition. This study aimed to explore facilitators and barriers of healthy EBRB in childcare in a comprehensive way, from the perspective of three crucial stakeholders: childcare managers, childcare workers and parents. A qualitative study was performed using semi-structured interviews. Content analysis was performed using the 'Environmental Research framework for weight Gain prevention' (EnRG framework) to guide the analysis. Forty-eight interviews were held with a total of 65 participants (9 childcare managers, 23 childcare workers and 33 parents). Influential factors in all types of environment (physical, sociocultural, economic and political) were mentioned. Although a need for change was not always expressed, the interviews revealed opportunities for improvement of healthy EBRB in childcare. These opportunities were related to the sociocultural, physical and political environment. Childcare workers and managers expressed an influence of the home setting on the childcare setting, resulting in a need for more congruence between these settings. There are opportunities for improvement in the childcare setting to promote healthy EBRB in young children in the Netherlands. It appears important to align intervention components between the childcare and home setting.

Introduction

Many children are growing up in an obesogenic environment, resulting in a high intake of energy-dense foods, low levels of physical activity and high levels of sedentary behaviour [3, 11, 143, 144]. These unfavourable energy balance-related behaviours (EBRB) have resulted in an increase in the prevalence of childhood overweight and obesity [5, 88]. In the Netherlands, 8.0% of 2-year-old boys and 8.3% of 2-year-old girls are overweight including 0.7% obesity in both boys and girls, and these numbers increase to 9.1% (boys, overweight), 16.3 % (girls, overweight), 1.1% (boys, obese) and 2.6% (girls, obese) for 4-year-old children [5]. These numbers are comparable to the prevalence of overweight and obesity in other Northern European countries but are fairly favourable compared to the prevalence in other Western countries [145, 146]. As the prevalence of childhood overweight and obesity is expected to keep rising, the prevention of childhood overweight and obesity is still an important public health issue [146]. Lifestyle behaviours are developed early in life and are known to track into adulthood [14]. Furthermore, weight status between two and six years of age is most predictive for adult weight status and overweight and obesity-related diseases [7, 147]. In practice and research, increased attention has been paid to the prevention of childhood overweight and obesity and the promotion of a healthy lifestyle in young children [79, 81, 148].

The home environment, in particular parents, exerts an important influence on child EBRB [50, 53, 96, 149]. Many children are also cared for in formal childcare such as day care or preschool [60]. In the Netherlands, 41% of children under the age of three attend formal childcare, ranking childcare use in the Netherlands among one of the highest in Europe [61]. This percentage doubles to 82% for children between three and five years old [61]. On average, children attend formal childcare for about seventeen hours per week [150]. Studies have shown that childcare use could result in an increased risk for overweight and obesity in children [62-64, 93]. Potential factors influencing this increased risk include foods consumed during childcare [151]; limited opportunities to be physically active [62]; and staff behaviours [152]. There is also evidence for a protective role [62]. The use of favourable nutrition- and physical activity-related practices by childcare staff, such as prompting children to be physically active and using non-food rewards for trying new foods, have been shown to be positively associated with the related behaviours in children [75]. Along with these results from quantitative research, a number of studies have examined perceived facilitators and barriers in the childcare setting. A recent review describes more general themes in which barriers and facilitators for physical activity and sedentary behaviour are perceived [153]. They include the child, the home, the out-of-home childcare, parent-childcare provider interactions, environmental factors, safety and weather [153]. More specifically, perceived barriers and facilitators in the case of physical activity are lack of indoor or outdoor play space or materials, safety rules, and support of colleagues [74]. Regarding healthy nutrition, lack of policy, lack of training of staff, and budget and time constraints were perceived barriers [78, 154]. Thus, various factors within the

childcare setting play an important role in the healthy development of young children's EBRB and weight status.

The improved understanding of the complexity of childhood overweight and obesity has directed researchers to adopt a socio-ecological perspective, acknowledging the importance of the multi-level (e.g. intrapersonal, interpersonal and community level) influence of determinants [43]. As Sallis et al. described, 'ecological models are believed to provide comprehensive frameworks for understanding the multiple and interacting determinants of health behaviours' [38]. The Environmental Research framework for weight Gain prevention (EnRG) adopts the socio-ecological research paradigm and proposes that the environment influences EBRB directly, as well as through the mediation of cognitive variables (attitude, subjective norm and perceived behavioural control) [39]. Further, it proposes the moderating influence of personal and behavioural factors on environment–behaviour relationships [39]. The EnRG framework describes different types of environment, namely sociocultural, physical, economic and political [39, 42]. For this study, the EnRG framework was used as a theoretical framework to explore facilitators and barriers in childcare to promote healthy nutrition and physical activity. In order to explore factors in all the different types of environments, as well as their mediating and moderating factors, different stakeholders (i.e., childcare managers, childcare workers and parents) were included in the study.

Materials and Methods

Setting

The study was conducted in the south of the Netherlands. In the Netherlands, there are several different types of formal childcare: centre-based childcare for infants and pre-schoolers (including preschool and centre-based day care), family-based childcare for infants and pre-schoolers, and after-school care for children in primary school [155]. The current study focuses on the first type: formal centre-based childcare, with a specific focus on pre-schoolers. Pre-schools provide half-day childcare with a focus on playful learning to prepare children for primary school. In this type of childcare, there is only one moment during which children consume food (snack time), and they often bring their own food. Children between 2 and 4 years old can attend preschool [155]. Centre-based childcare provides whole-day childcare and usually focuses less on educational goals [155]. In this type of childcare, there are several moments during which children consume food, and the childcare institutions mostly provide the food products. Children 0–4 years old are able to attend centre-based childcare [155] Parents can receive a general childcare benefit for formal childcare from the government, based on their working hours and income [156].

Study sample and recruitment

In-depth interviews were held with centre-based childcare managers, pre-school childcare workers, and parents of children attending pre-school. All childcare managers had

supervisory and policy-making responsibilities. Childcare workers were responsible for the daily supervision of the children and provision of the educational activities at preschool. Childcare workers should be minimally trained with a lower vocational pedagogical education [157]. All interviews were limited to those working with children aged 2-4 years old. A combination of purposive (childcare workers) and convenience sampling (childcare managers and parents) was used. Childcare managers of fifteen childcare facilities were approached by telephone and asked to participate in an interview; nine managers (from eight facilities, 53.3%) were willing to participate. Reasons for non-participation were lack of time (N = 1) and inability to reach the manager (N = 6).

Childcare workers of ten pre-schools were asked to participate in the interviews, and all pre-schools participated (100%). They received brief written information about the interview by e-mail, before an appointment was made by telephone. The interviews with the childcare workers were held with those who were present at the time of the interview, mostly two and occasionally three childcare workers per pre-school. A total of twenty-three childcare workers participated in the interviews. To inform the parents, a pamphlet announcing the presence of the researcher was distributed among the pre-schools that agreed to participate. Parents were asked to participate in a short interview during or directly after drop-off and picking-up times at the pre-school. Thirty-three parents agreed to participate. Verbal informed consent from all participants was obtained before conducting the interviews. The Maastricht University Medical Centre+ Medical Ethics Committee reviewed and approved this study as part of a larger research project (METC163022).

Data collection methods

A qualitative research design with semi-structured interviews was used. A comprehensive theoretical framework (EnRG framework [39]) was used to guide the development of the topic list for the interviews. Questions asked during the interviews included: 'How do you feel about healthy nutrition/physical activity in young children?' and 'How do you feel about the space and play materials at this facility?' Interviews with the childcare managers were conducted by AG, and all other interviews were conducted by IK. Almost all interviews with the childcare managers and workers took place in a quiet environment. Most interviews with the parents took place in a public area near the pre-school and, therefore, were not always quiet places. All interviews were held in Dutch and were audio-recorded (Olympus VN-2100 PC, digital voice recorder or Android Application Smart Voice Recorder). The interviews were held between March 2015 and June 2016.

Data processing and analysis

All interviews were transcribed verbatim. If words or sentences were unclear, a second researcher was consulted to complete the transcript. All transcripts were anonymized by removing names and locations. A directed content analysis approach was adopted [158]. The EnRG framework [39] was used as the theoretical framework for the analysis. The constructs

of this framework (e.g., the types of environments and cognitive determinants) formed the basis of the content analysis. Additionally, codes were used to increase specificity, such as 'nutrition or physical activity', 'indoor- or outdoor- play area', or 'influence of other pre-schools or other pre-school teachers' that arose from the data. For the construct 'political environment' content describing rules, regulations, policies regarding nutrition or physical activity in the childcare setting are considered shaping the political environment. Initial analysis was done by AG (childcare managers) and RM (all other interviews). The analysis was checked by IK for consistency of coding with the theoretical framework, and an additional analysis of cognitive variables was done for the interviews with the childcare workers and parents. Data analysis was performed using QSR International's NVivo 11 qualitative data analysis software (QSR International, Doncaster, Victoria, Australia).

Results

Respondents

Forty-eight interviews were held with a total of 65 participants (9 childcare managers, 23 childcare workers and 33 parents). The interviews with childcare managers lasted on average 42 minutes (range: 32–50), lasted 34 minutes (range: 21–60) on average with childcare workers, and almost 10 minutes (range: 4–23) on average with parents. All childcare managers were female, with an average age of 40.1 years, an average working experience as manager of 6.3 years, and 55.5% of the managers had experience as a childcare worker (Table 2.1). All childcare workers were female, with an average age of 49.8 years and a working experience in childcare of 17.6 years (Table 3.1). Of the parents, 22.9% was male, 25.0% had low education, 48.4% was employed, and 87.1% was in a relationship (Table 3.2).

Table 3.1: Demographics of childcare managers and childcare workers.

	Childcare Managers (N = 9)	Childcare Workers (N = 23)
Mean age in years (range)	40.1 (29–69)	49.8 (19–65)
Gender		
Female (%)	9 (100)	23 (100)
Male (%)	n.a.	n.a.
Educational level[a]		
Lower vocational pedagogical education	0	7 (30.4)
Lower vocational social work	2 (22.2)	2 (8.7)
Higher vocational pedagogical education	2 (22.2)	9 (39.1)
Higher vocational social work	0	1 (4.3)
Other	4 (44.4)[b]	4 (17.4)[c]
Average working years (SD)	6.3 (6.1)	17.6 (8.4)
Previous or current experience as childcare worker (%)	5 (55.5)	n.a.

[a] Education of one manager was unknown; [b] All four childcare managers had a higher vocational education, but not pedagogical; [c] One childcare worker had a higher vocational education not pedagogical, two had a lower vocational education not pedagogical and one was still in training.

Table 3.2: Demographics of parents.

	Parents (N = 31 [a])
Mean age in years (range)	31.7 (22–41)
Gender [b]	
Female (%)	26 (81.3
Male (%)	7 (18.7)
Educational level [c]	
Low (%)	8 (25.0)
Medium (%)	11 (34.4)
High (%)	12 (37.5)
Employment status	
Unemployed (%)	16 (51.6)
Employed [d] (%)	15 (48.4)
Full-time (%)	10 (66.7)
Part-time (%)	4 (26.7)
Relational status	
In a relationship (%)	27 (87.1)
Not in a relationship (%)	4 (12.9)
Average number of children (range)	1.8 (1–4)

[a] Characteristics of two parents were unavailable; [b] Gender was based on tone of voice, and therefore available for all participating parents; [c] Based on ISCED-97 classification: low equals levels 0, 1 and 2; medium equals levels 3 and 4; and high equals levels 5 and 6 [159]; d Working hours of one parent were unknown.

Cognitive mediators

Attitude

All respondents (managers, childcare workers and parents) had a positive attitude towards healthy nutrition and physical activity in young children. There were various beliefs underlying this positive attitude. All respondents mentioned the belief that healthy nutrition and physical activity are important for the health of the children. For childcare workers, an important belief regarding physical activity was to give the children the opportunity to go outside when they do not have this opportunity at home. *'We find it especially important because we know a lot of the children live in flats, do not have a garden and do not go outside often' (CW3.2)*. The respondents believed that being active made children happy and that children enjoyed being physically active (see Supplementary Materials: Table S3.1 for additional quotes).

With regard to healthy nutrition, childcare managers believed that it was very important to encourage children to eat as healthily as possible. However, some childcare managers did not think that this meant that all unhealthy foods should be banned. *'I hear in some organisations that they ban juice completely, and then I think: Come on! … I think it is important for children to learn to drink water, but to not give juice at all..., that is not what puts on weight' (CM1).* Childcare workers and parents both mentioned this belief as well, in particular with regard to sugar-sweetened beverages. Parents believed that it was important

to keep a balance. It was often mentioned that they did not really mind their children eating sweets or snacks or drinking sugar-sweetened beverages, as long as it was limited to a little bit and balanced with healthy products. *'I do not think lemonade is really necessary … but I do not mind it for one time a day' (P16).*

Social Norm

Childcare workers and managers did not mention many social influences on how they handle nutrition and physical activity. One childcare manager even said, *'If you do not see the value of what we are doing here, then you may not be a parent that fits here' (CM4).* On the other hand, parents were often mentioned as an important influence. In particular, in relation to birthday treats, they experienced that there is still a widespread preference of parents to provide sweets or snacks instead of a healthy treat, because it is a festive occasion. *'Well, we could try it, but then I think if the switch to fruit as a snack is so difficult, then the birthday treat will be… I think for most families you will really step on their toes' (CW2.1)*. Childcare workers found it difficult to address this belief with parents, and often capitulated by allowing unhealthy treats. Childcare managers also talked about the more general focus of society on healthy nutrition and physical activity. They experienced that this also forced them to be conscious about it. *'You indeed notice that more and more parents ask questions or say, "I do not want them to participate with birthday treats." Parents are very, very occupied with it and, therefore, we are also very occupied with it' (CM5)*.

Perceived Behavioural Control

All respondents commonly expressed that it is 'in the nature' of children to be physically active, and therefore, they did not perceive it as difficult to ensure that the children would be physically active. However, some childcare workers expressed that they felt incapable and insecure about having the children in a physical education room. *'That's just not for me, my nerves were in tatters, they were climbing in everything and they are so little, so you think oh if they fall out of it! … and then with just the two of us, that was impossible' (CW10.2)*. With regard to healthy nutrition, all respondents felt they were capable of promoting healthy nutrition in children. Child preferences or dislike of certain foods were often mentioned, but none of the childcare workers expressed that this hindered their ability to promote healthy nutrition for these children.

Environmental Facilitators and Barriers in Childcare

Physical Environment

The respondents emphasized the importance of the availability of healthy food products in childcare, such as fruit and vegetables, healthy spreads for sandwiches, and drinks without sugar or low in sugar. All facilities, except for two day-care centres, served lemonade to the children, and although this may not be regarded as a healthy choice, almost all respondents

approved or tolerated the serving of lemonade in childcare. *'I don't think it's necessary to switch to water, they only get a little to drink, and we use a small amount of lemonade' (CW6.1)*. This was sometimes also the result of not knowing a healthier alternative than lemonade. *'Yes, lemonade we are aware of it, but what do you give them otherwise? Juice mixed with water?' (CW4.1)*. In pre-schools, most respondents were very positive about the availability and variety of the fruits brought by parents. However, there were childcare workers who experienced that parents would often bring fruits that are on sale or no fruits at all, and vegetables were only sporadically available, reducing variability. In centre-based day care centres, the availability of food products was predominantly determined by rules and regulations. All childcare managers took them into account to ensure a healthy food environment for the children. However, energy-dense snacks such as cookies were more often available in these childcare institutions compared to pre-schools.

With regard to physical activity, parents and managers in particular were satisfied with the possibilities. In most facilities there was an outdoor playing area, which was suitable for children of that age group. Often an indoor play area was also present. Parents and childcare managers were positive about the availability of play materials, both indoors and outdoors, found them age-appropriate and also stimulating for motoric development. *'They have big playing areas, also inside … They can climb, they can slide, they can bike, and they can run … all that a child should be able to do, they can do here' (P8)*. With regard to play materials, parents often referred positively to puzzles, painting materials and building blocks, which may be more related to sedentary activities. Childcare workers were more critical about the physical environment with regard to physical activity, compared to the other respondents. In particular, they experienced lack of safety, lack of challenging play materials and, more generally, the appearance and accessibility of the outdoor playground as barriers to be physically active with the children. *'There is an outdoor playing area with a sandpit and 'rolling materials', so that's what we have. But the sandpit is small with a high border, which isn't safe … there is totally nothing green or grass … They can't climb, all they can do is ride a bike or scooter, that's it' (CW8.2)*. Furthermore, a lack of availability of an indoor physical education room and time, especially the high demands on the available time that they have with the children, were important barriers mentioned by the childcare workers. Several of them expressed a need for greater variety in play equipment to be able to promote different locomotor skills (e.g., climbing and balancing). They felt that with their current offer, they were unable to stimulate the development of these skills in children. Many childcare workers mentioned that they would like to have more natural elements in the outdoor playground, such as grass, a little garden or hills to climb on, *'… I would say: make something with grass there, then you also have something hillier they* [the children] *can climb on' (CW3.1)*.

Sociocultural Environment

Childcare workers believed that snack-time should be a social moment spent together at the table. The fruit was chopped and divided, so that all children got some variety in the pieces of fruit on their plate. Usually, one plate was provided for two children. Childcare workers explained that this was a way to teach the children to share, but it could also help in letting children be role models to each other. The childcare workers also modelled behaviour themselves by using this moment to eat a piece of fruit with the children and trying to encourage them to try new food products. However, some less favourable practices were also described by the childcare workers. They were mostly related to pressuring children to finish their plate or take another bite, *'we provide all children with a basic bowl* [with fruit] *which they are supposed to finish' (CW5.1)*. Some childcare workers also mentioned that they used food as a reward: '*So, we say, "If you eat your fruit, then you get your cookie." In this way we stimulate them to eat some fruit' (CW3.2).* Influences in the social environment that were mentioned were predominantly parents and sometimes the community health service. *'Then the community health service remarked that too much lemonade was served, and then we started thinking about why we actually do that' (CM4).*

An important belief for childcare managers and workers to facilitate physical activity was providing a moment for the children to release their energy. They found it very important that the children go outside at least once a day. However, it was unclear whether this also happened in practice. It was mentioned that going outside was often skipped when there were time constraints. *'You have to do certain activities in a certain planning, and these often take up some time, making that you are not able to also go outside with the whole bunch' (CM3)*. Other barriers to providing opportunities for physical activity were mentioned by the childcare workers. Some facilities had to share their outdoor playground with a primary school, and older children would be present on the playground at the same time as the young children, resulting in perceived unsafe situations. Parents did not always take into account that the childcare workers want to go outside with the children, despite various weather conditions. Therefore, children were not always suitably dressed. *'Parents also find it too cold too soon … "Did you go outside to play?!" is what they say, and not all parents are always happy about that' (CW2.1).* Both childcare managers and childcare staff expressed the need for an increased awareness of healthy nutrition and physical activity in the home setting. They believed that this would help them in stimulating healthy nutrition and physical activity in the childcare setting. *'Teach parents what is healthy. There is a large group that thinks they know what is healthy, but maybe they can learn more, so that the child also better knows what is healthy' (CM1)*.

Economic Environment

The economic childcare environment was primarily discussed with the childcare managers and workers. Almost all managers mentioned that they did not work with a pre-specified

budget in regard to nutrition or physical activity. For example, if there was a need for new play materials, they evaluated whether this fit in the budget and then purchased it. *'If I think it is worth the money, then it may cost something, and I do not really care that much about the costs' (CM4)*. Some managers mentioned that financial cuts in childcare were something that influenced how much they could spend on healthy nutrition and physical activity. Many childcare workers at the pre-schools experienced a great monetary barrier regarding increasing the variety in fruits or vegetables or getting new play materials. They did not expect their organization to be able to provide fruit and vegetables for financial reasons. Furthermore, they felt that they could not expect parents to bring more unusual fruits due to the costs. *'You cannot force parents to bring a pineapple if that puts someone to great expense' (CW6.1)*. As fixed play materials often have to comply with strict safety regulations, they are too expensive to purchase, and thus childcare workers often did not ask for them. *'Often there is no money to purchase new materials such as a slide, because they have to comply with all those safety rules. So, we cannot just go to IKEA to buy things that are cheaper' (CW5.1)*. On the other hand, it was stated that budgets were sufficient to purchase small materials that can stimulate physical activity such as chalk pieces and bottles for blowing bubbles.

Political Environment

There was some variation between the locations regarding whether a nutrition-related policy was available. In centre-based childcare, food is provided by the organisation. Therefore, there was an elaborate policy around food products and drinks that are available, food safety, and permitted nutritional supervising practices. For pre-schools, where parents bring the majority of the food products for snack-time, the only policy was that the food products were supposed to be fruits.

The majority of all childcare locations had a policy aimed at stimulating a healthy treat for birthday celebrations. There was great variance in the adherence by parents to this policy and its implementation by childcare workers. This was partly due to the influence of the parents' beliefs (perceived or real), and partly because the policy was formulated ambiguously and was not enforced, which makes it more a guideline. Some childcare workers expressed the need for a clear, strongly worded policy around birthday treats. They expected that this would help them in communicating it to the parents. *'The policy does not prohibit sweets as a treat, it is only advised* [to provide something healthy]. *So, you cannot make parents accountable' (CW9.3)*.

In general, no formal policy was formulated around physical activity. In particular, managers said that providing enough opportunities for physical activity is common practice for childcare workers and therefore does not need to be written down in formal policy. *'At childcare we work a lot according to policies, protocols and rules and then I think: is it necessary for*

physical activity? We think some things do not need to be put down in policy and are part of the professionalism of our childcare workers' (CM1). The rules and regulations imposed by the community health services were perceived as an important barrier to physical activity. *'Well, a lot of things are bound to norms, a lot more than in educational institutions, and that limits the children's physical activity. And we actually went over the top: watch out, look out, don't do this, don't do that, and that's actually a very wrong development, just because the community health service tests us on it'(CM6).*

Cross-setting Influence of Childcare and Home Setting

The childcare managers and workers first talked about the responsibility of the parents to create a healthy home environment for their children. *'So many things are being made our responsibility, but they come here only two or four mornings, yeah I think some things have to be for the parents. I do not think we have to do everything' (CW5.1).* One childcare manager said that to promote a healthy lifestyle in young children, you need to involve the parents. *'If you only do things here* [at childcare], *of course you achieve something, but not everything so I think that is very important* [to involve parents in healthy lifestyle changes]*'(CM7).* There were several ways in which an influence of the home setting was experienced. Many comments related to dietary habits in the home environment. For example, children were not used to eating at the table, arrived at childcare without having had breakfast, or lacked skills to bite pieces of fruit due to still being bottle-fed. Childcare managers explained that they got requests from parents for special treatment of their child with regard to nutrition. Interestingly, this was often related to healthier nutritional choices, such as parents not wanting their children to drink sugar-sweetened beverages or eat sweet bread toppings. *'There is a group of children of which the parents say, "They cannot have milk, they really cannot have sweets, they do not participate in birthday treats, they drink just water," (CM5).* Mostly, the childcare managers did not go along with such individual requests and stuck to their own nutrition policies.

With regard to physical activity, a common remark was that children often arrive at childcare with unsuitable clothing for playing outside. *'We really have to promote that children wear a jacket when it is cold weather, many do not bring a coat' (CW8.1).* Some childcare workers mentioned that children at their facility lacked the locomotor skills to be able to join in all activities. They explained this as due to a less challenging home environment with regard to physical activity (e.g., lack of availability of certain play materials or space).

Although it was not the focus of this paper, the interviews with the parents also revealed an influence of the childcare setting on the home setting. Parents mentioned that they noticed that their child ate more fruit and a greater variety of fruit, due to the fact that it is encouraged at childcare. *'First at home he would not eat grapes, but now he comes*

here [at the pre-school] *and he says 'yum' when he sees grapes' (P15)*. However, it was also mentioned that going to childcare increased the intake of sugar-sweetened beverages. *'They get lemonade too at my home, although I limit it to one glass a day … so I actually think then you have already got that here* [at the pre-school]. *But then I give him one extra at home' (P25).* Some parents stated that they would rather see their child not drinking any sugar-sweetened beverages but took for granted what was served at the childcare facility.

Moderators

The interviewees mentioned several moderating factors, as described by the EnRG framework. Predominantly, demographic factors, personality factors, habit strength and awareness were discussed in the interviews. Ethnicity or cultural background was often mentioned. *'You see that children with a different cultural background, they prefer something sweet instead of fruit, they are not too crazy about it, no' (CW6.2).* Age was also mentioned, more often in relation to physical activity. Childcare workers experienced that younger children were more hesitant in joining in activities. *'If those little ones go outside, the size* [of the playground] *is already overwhelming, then you have the older children running around, they just do not get to playing' (CW6.1)*. Socio-economic status was mentioned as a moderator, such as the opportunities children have at home to be physically active and develop motor skills or the availability of healthy food products. Regarding personality, some child characteristics were mentioned such as allergies and preferences. They were mostly only related to nutrition. *'Sometimes with little children it is quite difficult, because they are fussy with vegetables, for example' (CM7)*. In relation to birthday treats, habit strength was mentioned. Childcare workers often thought that children, but even more so their parents, were used to a certain routine and would therefore want to stick to it. They mentioned that getting used to a new routine was important in accepting change. *'Now they are used to it. They all know, the children too: "We do not have to bring anything. It is my birthday, and I can treat with those cookies* [provided by the childcare facility]*"' (CW1.1).* The last moderating factor that appeared during the interviews was awareness. Firstly, this was generally seen in the lack of need for change, while some factors that were described can be considered unhealthy. Secondly, some participants described that being aware of, for example, the content of certain food products helped them in making healthier decisions.

Discussion

This study aimed to explore facilitators and barriers to healthy nutrition and physical activity in childcare from different perspectives (childcare managers, childcare workers and parents). The EnRG framework was used to identify intrapersonal and environmental factors influencing childcare. All respondents expressed a positive attitude towards healthy nutrition and physical activity in childcare. However, less healthy aspects not always

required attention in the respondents' opinion. For example, the serving of sugar-sweetened beverages at the childcare location was approved or tolerated by all respondents. In the Netherlands, over half of the children consume more than two sugar-sweetened beverages per day [160], and schools can be an important venue for reducing sugar-sweetened beverage intake [161]. The majority of the respondents thought that being active is in the nature of young children and thus they need little encouragement to be sufficiently physically active. This perception may well be inaccurate, because research has shown that young children often do not meet physical activity guidelines, in particular for sedentariness [162-164]. Actively promoting physical activity by increasing awareness about low activity levels can be an important factor in decreasing the sedentariness of young children.

Factors mentioned regarding the physical environment were most often related to the availability and variety of healthy food products and the availability of play materials and indoor and outdoor play space. This is comparable to other research that explored factors influencing nutrition and physical activity at the childcare centre [72, 73, 134, 153]. Providing more, particularly portable, play materials has been part of intervention studies and had a positive effect on children's moderate-to-vigorous physical activity (MVPA) [95, 165]. A need for more natural elements in the playground was expressed to enhance its appeal to be more physically active. Previous research has shown the positive effects of natural elements on children's physical activity, making this an important consideration for childcare interventions [166-168]. Exposure to new food products has been shown to be an effective strategy in helping children eat and like these products [169]. Changing the physical environment through providing healthy food products and play materials could be an effective measure to overcome the perceived barriers in childcare. However, there was an apparent difference in the influences perceived in the physical environment between the childcare managers and parents on the one hand and the childcare workers on the other. The childcare managers and parents were more positive and described the opportunities that the physical environment offered for healthy EBRB, while the childcare workers were more negative and described barriers, they felt needed to be overcome for healthy EBRB. One explanation could be that the managers worked at different childcare facilities where indeed the physical environment was more facilitating for healthy EBRB. Another explanation could be that there is a discrepancy in the expected role of the childcare worker regarding healthy EBRB. Studies have described that for physical activity childcare workers often see their role as supervising and guarding safety, but not actively participating in activities and that this may differ from the expected role from childcare managers [170, 171]. As a result, childcare workers might tend to attribute influences on children's behaviour more externally, in this case the physical environment, while a childcare manager might rely more on the childcare worker's behaviour (i.e., sociocultural environment) in relation to the opportunities in the physical environment. As one is not more important than the other, this underlines the combined influence of different types of environments as suggested by socio-ecological models. Therefore, this is something

important to take into account in intervention development and implementation. A last explanation could be that this difference exists because the childcare managers are too far distanced from daily practice and, therefore, cannot accurately estimate the influence of the physical environment. In our sample, though, more than half of the managers also had experience as a childcare worker and thus may be able to understand the influence of the physical environment in daily practice.

The sociocultural environment is predominantly formed by the behaviour of the childcare workers. Some favourable practices were described by the childcare workers (e.g. modelling of healthy eating), but also some unfavourable ones (e.g. using food as a reward) [75]. It appeared from the interviews that almost all participants agreed with how things are run at the childcare centre. This implies that childcare workers are not sufficiently aware of the practices they can use to influence the behaviour of the children, which is also supported by previous research [172]. This may be an important aspect to pay attention to in intervention development, for example when training childcare workers. Furthermore, some other influences on the sociocultural environment were mentioned. Parents were perceived as an important influence on the ability to promote healthy nutrition and physical activity in childcare. For example, through the clothes they let their children wear and healthy eating habits they teach their children at home. Aspects in the physical environment also influenced the behaviour of the childcare workers (e.g., available time, scheduling problems with the primary school), which indirectly influenced the sociocultural environment.

Factors in the economic environment mostly concerned financial means. The economic environment has not been extensively studied before in the childcare setting yet. A study of family childcare did mention financial considerations as an influence on food choices [78, 154]. The high cost of healthy food is something that is often mentioned by parents, especially ones with a low socio-economic background [134]. This is in line with the concern expressed by childcare workers in the current study that it would burden the parents of the children with high costs to bring more unusual fruits. There was a difference noted between the childcare workers and managers regarding perceived economic factors for physical activity. Many childcare workers expressed a barrier to purchasing new play equipment due to high costs. Childcare managers expressed that they found it more important to know whether new equipment was needed than the cost of this equipment. It could be that childcare managers gave more social-desirable answers and in reality, are more cautious in purchasing new equipment. Further, this might again point towards a combined influence of different types of environments (the economic and physical environment). In intervention development, this may mean that both environments should be taken into account in order to assure intervention effectiveness.

In the political environment, some distinct differences were seen. The different types of facilities (pre-school or centre-based day care) influenced whether an elaborate nutrition policy was in place. This was mostly related to whether food was provided by the facility or not. The lack of an institutional policy led to perceived ambiguity by the childcare workers, particularly relating to birthday treats. Most childcare workers felt that birthday treats needed to change, but they did not feel supported by their institutional policy. The Netherlands Nutrition Centre provides an example policy statement that many institutions use to formulate their own policies. The specification and translation of this example into institutional policy appear particularly important. Previous research confirms the positive influence that policies could have on EBRB of children in childcare [77]. It is important to note that even with policies in place, the translation of policies into childcare staff's practices is still very important for the promotion of healthy EBRB in young children [77, 172]. Another difference was seen between nutrition and physical activity. While a nutrition policy was often mentioned, this was not the case for physical activity. Providing sufficient opportunities for physical activity (e.g., by going outside) was mostly assumed to be something that is just done and does not require a formal policy. This lack of a formal PA policy, which is also seen in other studies, is explained by the common, mistaken notion that young children are inherently active [173]. Policies and guidelines have the potential to support physical activity through increasing the quality of play times; for example, by setting structured play times [174]; ensuring appropriate clothing [175]; or childcare staff behaviours during play time [176]. It is important to take into account the often-mentioned remark in this study not to overload the staff with regulations and policies. This could have adverse effects, as evident from the regulations of the community health services that are limiting instead of promoting physical activity.

Weather as a perceived barrier to physical activity is often described in the literature [69, 73, 177]. Interestingly, in this study, weather was not always seen as a barrier by the childcare workers and managers. The Dutch climate is quite moderate, with few extremes compared to other countries. This may explain the limited perceived influence of the weather itself. Some care should be taken with this finding because it is not clear whether childcare workers really went outside in all types of weather. Some childcare workers did express weather as a barrier, in particular hot and sunny weather in combination with lack of shade in the playground, which is also in line with previous research [166, 177]. Providing shade in order to promote physical activity is something that is often overlooked and not part of intervention research. This may be a factor to take into account in future research as it may eliminate a perceived barrier to going outside. The childcare workers did experience a barrier if the clothing of the children was not suitable for going outside. This is also something seen in other studies [74, 175].

The participants in the interviews talked about moderating factors that could influence the effect of the facilitators and barriers for children's EBRB. They were mostly in line with existing knowledge on moderating factors such as the child's age, socio-economic status, cultural background and characteristics [178-181]. An interesting finding involved the possible influence of awareness. Several unfavourable environmental factors were described for which a need for change was not always expressed. This could be greatly influenced by a lack of awareness, for example, in relation to the use of unfavourable practices by childcare staff. For intervention development, it is important to take this into account and focus not only on 'how' to promote healthy children's EBRB, but also on 'why'.

An important theme in the interviews was the influence of parents and the home setting on EBRB of children in the childcare setting. Important findings in this study were that childcare workers and managers both stressed the importance of involving parents and the home setting in the promotion of healthy behaviours in children. They felt they had limited opportunities (e.g., the amount of time children spent at preschool in comparison to the time they spent at home) to influence the lifestyle of young children. They also expressed perceived barriers in the childcare setting regarding nutrition behaviour and physical activity through the parents' practices or environmental factors in the home setting. These influences of the home setting might also elicit childcare workers to knowingly use unfavourable practices for fear of parental reactions [182]. On the other hand, the interviews with parents revealed both positive and negative influences of the childcare setting on the home setting. These findings indicate an interaction between the childcare and home settings, which is hypothesised in the ecological systems perspective as the mesosystem [47, 48, 183]. Such a mesosystem acknowledges not only the interaction between personal characteristics and environmental influences, but also the interaction between different types of environments and between environmental settings, like the childcare and home settings [48]. The interaction between determinants is often underrepresented in the current literature on children's EBRB [48]. Other qualitative studies have described this interaction between home and childcare settings [134, 135, 153], and a recent quantitative study was the first to show the existence of this mesosystem and its influence on child outcomes [49]. Recent reviews on the effectiveness of interventions do highlight the importance of this interaction by recommending a comprehensive, multi-component approach (i.e., combining home and childcare settings) in prevention interventions for childhood overweight and obesity [80, 99].

This study has some strengths and limitations that should be taken into account when interpreting its results. One limitation is the possibility of social desirability in the participants' answers. Due to the nature of the study, it is possible that the participants did not describe the situation as it was, but as they would want it to be or think it should be. The parents in this study might not want to criticise the childcare staff at their facility due to their personal relationship. They may have been overly positive. Another limitation is that

the interviews with the parents were quite short. Therefore, it was not always possible to explore in depth their views on nutrition and physical activity at the childcare centre. The economic and political aspects were not discussed with the parents. This may have resulted in an underrepresentation of the parents' opinion in this study. However, combining different stakeholders in this study enabled us to explore all types of environments from different viewpoints. The influential factors in the types of environment were also explored with those experiencing them directly. A last limitation is related to the generalizability of the results. Due to the qualitative study design and the recruitment methods, the results of this study may not be generalizable to other populations. Differences in childcare systems, nutritional and physical activity (cultural) habits, and local and national policies may influence the generalizability of these results. However, similar influential factors may be applicable in other regions as several factors found in this study overlap with previous research into determinants and facilitators and barriers to children's EBRB in childcare [74, 134, 170]. With this study, our qualitative knowledge on influential factors has increased on the influential factors in different types of environments. Quantitative studies are needed to evaluate the robustness of these results, in particular on the existence of an interaction between these environments. Nonetheless, as formative research for intervention development, it is important to explore influential factors specifically in the context in which the intervention will be implemented [184]. Adaptation of interventions to their context can be pivotal in their implementation and sustainability [185].

Conclusions

The current study gave us some insight in the obesogenity of the childcare and home environment. Several facilitating and hindering factors were identified in all types of environments. The promotion of healthy EBRB in young children in childcare is something that is considered important by the different stakeholders. Although a need for change was not always expressed, opportunities for improvements in childcare to promote healthy EBRB in young children were revealed. An interaction between the childcare and home settings was recognised. Therefore, a mesosystem approach seems necessary in intervention development in which intervention components are aligned in both the childcare and the home setting.

Appendices

Table S3.1: Concepts and quotes illustrating the concepts identified in the interviews.

Concepts	Quotations to illustrate the concepts identified
Intrapersonal factors - attitude	
Importance of healthy living	'Because it's healthier for your body, that you have more energy and I just think it is good to start with that at a young age.' (CW4.1) 'As an extra they can have something [juice], but rather only water … I think that's important for health reasons.' (P20) 'We often come and watch, and they love to play outside … they are so actively playing; it is nice to see.' (P33) 'What I particularly find important is that they go outside in nice weather, that a child can be a child.' (P18) 'So, we don't have the rule that everyone has to be seated at the table. They are only toddlers, right? It should not be that this is already school-like, that children grab a puzzle, sit at the table, clean up and go to the next one.' (CW8.2)
Balance	'You have to be able to sometimes eat something sweet and to snack a bit, you have to be honest in that.' (CW3.1) 'Well, my philosophy is that if you do not give it to children when they are young, do not let them experience it, they will not know how to control themselves.' (CM1) 'I do not think it is a problem. You see, he needs to get nice things, and he needs to get healthy things, there has to be a balance in it.' (P27)
Intrapersonal factors – Social norm	
	'Not all parents are so happy with that. That is something striking: if it is cold, you do not go outside.' (CW2.1) 'What I say with the candy, but we have been doing it for ages. And we already say it [that healthy treats are preferred] but it does not happen, so we actually have given up on it.' (CW6.2) 'You can see that an increasing number of people are being more conscious about nutrition and physical activity.' (CM6) 'You indeed notice that more and more parents ask questions or say, "I do not want them to participate with birthday treats". Parents are very, very occupied with it and, therefore, we are also very occupied with it.' (CM5)
Intrapersonal factors – Perceived behavioural control	
	'Besides the time constraints, you also have to comply with all sorts of guidelines. The Community Health Service says, "Before you eat fruit, the children have to wash their hands for at least 30 seconds."' (CW4.2) 'You can only do that if you have a smaller group, six, seven children, max eight … Most of the time the groups are totally full.' (CW8.1) 'I do think it is very important to get advice in it. I am not clumsy, and I know a lot about what they do at schools. But still, I find it difficult.' (P28) 'But we know how to make our way in that.' (P17) 'No, not at all. She [child] is used to drinking water, so she likes it.' (P16)
Environmental factors – Physical environment	
Availability	'If you see that big play area, you would think that it would fit some more [play materials], on the other hand you could also just organize an activity. So, it also provides opportunities.' (P23) 'We have specified timeslots and in the afternoon it is in consultation, mostly we can use it [indoor physical education room] … we have to adjust, and it does not always suit well with snack time for example.' (CW3.2) 'What we really encounter is challenge for the children. We can do a lot of games, but they also like to do something for themselves, and then you have five crappy bikes and a sandpit in which the sand does not get replaced and two balls. So, we do come short in relation to play materials.' (CW6.1) 'They have bikes and a sandpit what I saw. Some small play materials, and inside it is a paradise anyway. So, they learn with puzzles, drawings, painting, all sorts of things.' (P13)

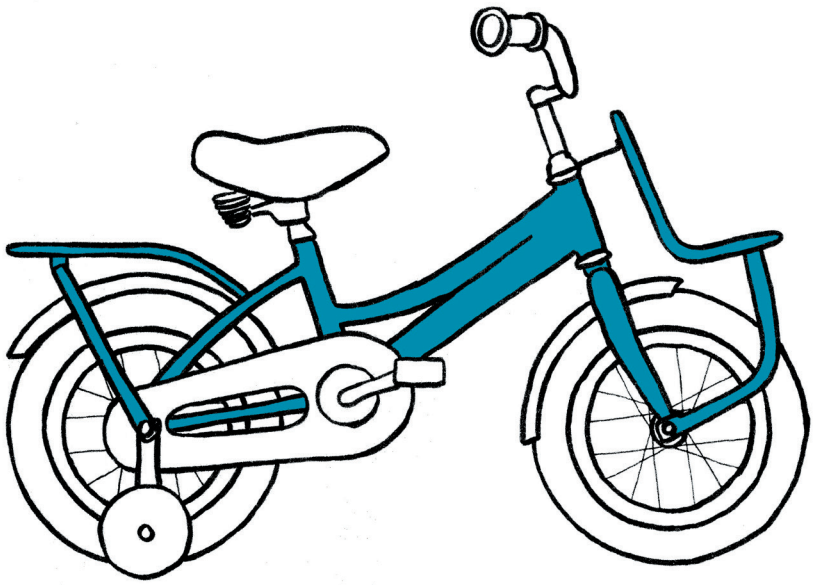
Table S3.1: Continued

Concepts	Quotations to illustrate the concepts identified
Variety	'Well, they take a piece of fruit with them, but you see that they are very selective in what they take. The most things that they eat are bananas and apples, with kiwifruit it is already more difficult, tomatoes, oranges, tangerines. Some find it nice, and others do not, so you notice that there is not much variety they can choose from.' (CW4.1) 'They get the usual pieces, pear, apple, banana and oranges and tangerines, so this is quite varied already.' (CW7.2) 'I think that there is great variety in what they get offered from what others bring.' (P22)
Space	'But that is also just not possible here, because if they start running, you already have to warn them "be careful with the tables."' (CW1.1) 'We adjusted the outside play areas, so that they [children] can be outside independently and play outside. Everything is fenced and safe in order to let them be outside as much as possible.' (CM3) 'I think there is enough physical activity, but I do not think there is enough space. I find it quite small outside, certainly for a group of sixteen children. Yes, I find it quite tight.' (P13)
Environmental factors – Sociocultural environment	
Nutrition and physical activity related practices	'What we do occasionally, when we have a lot of tangerines, we let the children peel the tangerines.' (CW4.1) 'We also give a good example. If fruit is eaten, then we also eat a piece of fruit.'(CW8.2) 'Most of the activities that we do [during circle time] is not only sitting. This morning we did something with colours and placed all colourful papers throughout the classroom … and then the children have to walk around and search for all the yellow cards.' (CW9.2) 'If they do not like tangerine, then I also take a piece of tangerine, and then we do it together. And sometimes I see that the child has it in their mouth, although he might not eat it. But he did chew on it and, well, then he did taste it already.' (CW9.2)
Influences on practices	'I see and I hear that we also have some childcare workers, if there is a team with some that just do not want to go outside, then it also does not happen.' (CM4) 'Indeed, they [childcare workers] like to go outside to let the children play, but with more structured activities, you see that particularly the older childcare workers find that more difficult, for example, to come up with a game.' (CM5) 'What we do see with playing outside is that sometimes a child is not used to it … that they kind of have to learn here to play outside.' (CW2.2) 'For example, a child enters with a sandwich in the hand, because he does not want to eat at home. Yes, what is not wanting to eat, he is asleep longer right? Well, that is a choice made, so he gets a sandwich shoved in his hand, and he is supposed to eat that here.' (CW4.1) 'Some parents ask, "Do they eat at the table?" Yes, they all sit at the table, for some parents that is unimaginable.' (CW8.2)
Environmental factors – Economic environment	
Childcare budget	'We just do what we think is important, look if bikes are worn out, then we make sure that there will be new bikes.' (CM1) 'We just buy something if we want to have it. If we think it is a nice offer and we can really use it, we buy it. We do not really think in percentages and budgets.' (CM2) 'There is no money for a lot of things, that is the standard reply.' (CW8.2) 'But that is just because of the money and not because of safety.' (CW9.2) 'It depends, if it is not too costly, otherwise we have to request it… but if it is just something like that balance beam, I just get it myself.' (CW10.1) 'I think parents pay enough tuition, so we could provide fruit. If I look at my son who is at day care, he gets his food all day, and I think this should also be the case for us, honestly.' (CW2.1)
Financial situation of parents	'You cannot force parents to bring a pineapple if that puts someone to great expense.' (CW6.1) 'Like strawberries or mangos, that is more expensive fruit, and I cannot expect that from parents, and I will not ask for it.' (CW10.1)

Environmental factors – Political environment	
Childcare policies	'But from our organization there is actually only the advice to always give fruit and nothing about drinks.' (CW8.1) 'I talked about it with my manager, and I would appreciate having a policy from the organisation that birthday treats are no longer necessary instead of one half does it and the other half does not.' (CW3.2) 'Although it is written in the rules and although we say to parents try to think of something else, we do not send anyone home who still brings sweets.' (CW4.2) 'It is something that goes automatically if you find it important. Yes, we do not really have that in a policy, it is just we know … in the regular schedule there are at least two moments of physical activity and play. Often it is much more.' (CM1) 'We looked consciously at our nutrition policy, what is and is not bought at the facilities and ensuring the same things are done at the facilities, that birthdays are celebrated in the same way. That parents do not bring the treats, but that we do that ourselves.' (CM2)
Rules and regulations of the Community Health Service	'Because it has to be durable, it has to comply with all regulations. It cannot cause splinters, it has to be fixed, be closed and around it, it has to be safe.' (CW5.2) 'It [safety] has to be covered from all sides. That you start to notice, also for myself that you are sometimes afraid to do something like what if one of them slips or…' (CW8.1)
Cross-setting influence between childcare – home setting	
	'You can pick out the children who did not have breakfast immediately… that is really stuffing, and I think yeah this is probably the first thing you get today.' (CW2.1) 'Do you remember that we, when there was snow, we actually wanted to go outside with the children. But many do not wear shoes that are suitable or wear a winter coat … we really have to promote to make sure children wear a coat.' (CW8.1) 'We do make exceptions for parents with certain wishes… there is a group of children of which the parents say, "They cannot have milk, they really cannot have sweets, they do not participate in birthday treats, they drink just water," and then we go with that… yes, those children are an exception to the rest of the group.' (CM5) 'It has grown in the past years, also with parents and I do it too myself at home. Then I hear myself talking, because we are now so aware of it, "Be careful, watch out, that makes you dirty."' (CM6)
Moderators	
Demographics	'We have some families that are in debt restructuring, and they get a limited budget. You could eat healthily, but it will definitely have an influence.' (CW4.2) 'Yeah, that depends also [healthy treats or not], not to be judgemental, but it depends on the background.' (P18) 'What we do come across is that foreign parents, who do not speak Dutch well, so you cannot communicate well, that they have their own customs.' (CW5.2) 'There are children who eat more couscous than potatoes and, well, the couscous may be equally healthy, but it influences what you eat.' (CW4.2) 'If you have a more multi-cultural day care, then things are different with nutrition.' (CM1) 'It is safer to have babies and toddlers alone outside, than when there are also three- and four-year-olds with balls and all materials. So, that was a barrier, and we arranged our spaces around it.' (CM3)
Child characteristics	'That many children have problems eating, do not like everything and that because of that there is little variety in what is offered, that is something you clearly notice.' (CW1.1) 'Children do have a preference for certain things. We have those periods that we leave the skin on the apples, but you notice that they do not like that.' (CW6.2) 'We have bikes and a sandpit and then you see that children who are a little bigger or do not like being active that much, that they sit in the sandpit and you will say, "Come on, on these bikes", but it does not happen.' (CW5.1) 'We actually thought that it would be one big playground, but the fence was kept in place. And well, you can divide it between children who are quicker and children who want to play more carefully.' (CW7.1) 'Well, they say not to bring strawberries or kiwi fruit because of allergies.' (P28)

Table S3.1: Continued

Concepts	Quotations to illustrate the concepts identified
Habit strength	'I would not know what should be done differently, we have been doing it for years.' (CW5.1) 'Something that is also nice is to just give something, a little toy or something. Children always like that too… but it [treating with sweets] is just what they're used to.' (P11) 'That is the whole lifestyle at home, they are used to it like that from growing up. That is something that you should change.' (CW2.2)
Awareness	'Sometimes I even think was that really that bad? That I only now start to realise how much [sugar] it actually contains.' (CW3.2) 'You can be proud that you are allowed to help them grow and being aware of physical activity and healthy nutrition is part of that.' (CM1)



Chapter 4

Study Protocol for the Evaluation of "SuperFIT", a Multicomponent Nutrition and Physical Activity Intervention Approach for Preschools and Families

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Abstract

The promotion of healthy energy balance-related behaviours (EBRB) is already important for children at a young age. Different settings, for example childcare and home, play an important role in the EBRB of young children. Further, factors in different types of environment (e.g., physical, sociocultural and political) influence their behaviours. SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial) is a comprehensive, integrated intervention approach for 2–4-year-old children. This paper describes the development and design of the evaluation of SuperFIT. The SuperFIT intervention approach consists of preschool-based, family-based, and community-based components. Intervention activities aimed at changing the physical, sociocultural and political environments in each setting and establishing an increased alignment between the settings. A quasi-experimental design was adopted with twelve intervention and nine control preschools to evaluate effectiveness. The primary outcomes were Body Mass Index (BMI) z-scores (objectively assessed height and weight), dietary intake (24 h recall), and physical activity (accelerometer) of the children. Further, the effects on the nutrition- and physical activity-related practices of preschool teachers and parents were evaluated (questionnaires). Intervention effectiveness was evaluated using linear mixed models. Process evaluation was performed using mixed methods; both quantitative (questionnaires) and qualitative (observations and in-depth interviews) measures were used. The comprehensive, integrated approach of SuperFIT is expected to support healthy EBRB in young children.

Introduction

Childhood overweight and obesity remain an important public health problem, with a continued expected rise in prevalence in the coming years [146]. In the Netherlands, around 8% of 2-year olds are overweight, and this increases for 4-year olds to 9.1% for boys and 16.3% for girls [5]. It is known that childhood overweight and obesity are likely to track into adulthood [8]. Furthermore, changes in weight status between the age of 2 and 6 years appear to be most predictive for adult overweight [7]. Overweight and obesity are associated with chronic diseases such as diabetes type 2 and cardiovascular diseases, and psychosocial problems that can occur already during childhood [2, 3]. This is predominantly the result of unfavourable energy balance-related behaviours (EBRB), such as a high intake of energy-dense food and drinks, low levels of physical activity (PA), and high levels of sedentary behaviour (SB) [11]. Family socioeconomic status and neighbourhood deprivation are important determinants of overweight and obesity [179, 186]. In order to prevent childhood overweight and obesity, the promotion of healthy nutrition and PA in young children is essential, particularly in high-risk groups [13, 187].

SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial) was developed as a comprehensive, integrated intervention approach to promote healthy EBRB in young children (2–4 years old). It is based on three main principles. The first one involves a combined focus on nutrition and PA. Childhood obesity, as well as EBRB, are often the result of a complex interplay between nutrition and PA behaviour [11]. Furthermore, unhealthy nutrition and PA habits often cluster within the same children [91, 136]. Young children are often highly sedentary, with limited physical activity [20, 22, 167]. They already show unhealthy dietary patterns, and even those with healthier dietary patterns do not always comply with nutritional guidelines [28, 188]. In general, adherence to dietary guidelines is low, especially for vegetable and fruit intake, sugar intake and total energy intake [29-31]. Therefore, SuperFIT primarily focusses on increasing fruit and vegetable consumption, decreasing unhealthy snack consumption, increasing water consumption, increasing PA, and decreasing sedentary behaviour.

The second principle highlights the multi-setting approach, as it targets the childcare, home, and community settings. Children's EBRB are influenced within different (micro-)systems [86]. In countries belonging to the Organization for Economic Co-operation and Development (OECD), a majority of young children are partially cared for in formal childcare [60]. The childcare setting is therefore an important micro-setting related to children's EBRB, along with the home setting [62, 73, 189, 190]. From a systems perspective, it is important to ensure the alignment of these different micro-settings, in order to induce synergetic effects [47, 48].

The childcare setting is regarded as promising for the implementation of interventions to promote healthy child EBRB [13]. Evaluations of these interventions have shown their potential to affect EBRB and weight-related outcomes positively [79, 81, 95, 99]. Interventions have been implemented in the home setting with positive effects on the children's EBRB [55, 191]. While the integration of childcare and home settings has been increasingly recognized as supporting intervention effectiveness [58, 99], the results of integrating childcare-based and family-based interventions have been inconclusive [80, 191]. This may mainly be attributed to the type of parental involvement, with direct (or active) involvement (e.g., parents' attendance at training or educational sessions) being more supportive of changes in their children's behaviour [58]. The intensity of parental involvement may be influential, with more intensity being supportive of intervention effectiveness [58]. The inclusion of a community setting has also been shown to be supportive of the prevention of childhood overweight and obesity, particularly when combined in a multi-setting approach [192]. The community can contribute by, for example, increasing access to PA opportunities [125]. Establishing connections and cooperation with community partners increases the sustainability of changes [193].

The third principle focuses on the integration of different types of environments in the SuperFIT approach. Socio-ecological models underline the influence of determinants of EBRB in the environment [39, 86]. Crucial determinants of excessive weight gain in toddlers can be identified in the sociocultural environment (e.g., parenting style and nutritional and PA-related parenting practices [50, 75, 194]), physical environment (e.g., availability of play materials, play space and healthy food products [72, 167, 169]), economic environment (e.g., costs of food products [133, 134]), and political environment (e.g., formulating clear policies in childcare [77]) [42]. In addition, socio-ecological models suggest an interaction between these different types of environments [48, 86]. For example, the effects of changes in the physical environment may be moderated by changes in the sociocultural environment, and similarly for any other combination of environments [48, 86]. Therefore, it is important to take into account the different types of environments in intervention development. The SuperFIT approach aims to integrate changes in specifically the physical, sociocultural and political environments, because they are the most changeable types of environments within the three settings (childcare, home, community) [42].

The SuperFIT approach assumes that the incorporation of these principles within intervention strategies will result in greater effects to prevent overweight and obesity in young children [48]. The childcare setting is considered the primary one, particularly due to its possible point of entry. The SuperFIT approach is not a pre-specified intervention programme but is adaptable to the individual situations of childcare organizations. Intervention efforts are therefore focused on the aspects requiring change. The aim of the SuperFIT approach is to improve the EBRB of 2–4-year-old children and prevent overweight and obesity. It is expected that the SuperFIT approach will increase physical activity and decrease sedentary

behaviour. Further, it is expected that the SuperFIT approach will increase the intake of fruit and vegetables, and water, and decrease the intake of unhealthy snacks and sugar-sweetened beverages. For Body Mass Index (BMI) z-score, it is expected that the SuperFIT approach will help young children to maintain or achieve a healthy BMI z-score.

The SuperFIT approach, as implemented in a pilot region, will be evaluated through an effect and process evaluation. The aim of the effect evaluation is to assess its effectiveness on the BMI z-score, PA, sedentary behaviour and dietary intake (primary outcomes) of children aged 2–4 years old from disadvantaged families in the Netherlands. In order to do so, a quasi-experimental design will be adopted, and the intervention group will be compared to a control group that does not receive the SuperFIT intervention approach. Changes in the sociocultural environment (i.e., nutritional and PA-related practices of preschool teachers and parents) and the physical environment will also be assessed. The aim of the process evaluation will be to gain insight into the processes supporting the development and implementation of SuperFIT. This will be used to better understand the results of the effect evaluation and support their interpretation. The current paper describes the content of the SuperFIT approach in the pilot region and the research protocol concerning the evaluation.

Materials and Methods

Study Design

For the evaluation of SuperFIT, the RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework will be used as a guide [195]. A mixed methods design will be used for the evaluation. In order to assess the effectiveness of SuperFIT, a quasi-experimental research design will be adopted. In addition, process evaluation using qualitative and quantitative research methods will be performed to evaluate Reach, Adoption, Implementation and Maintenance, in addition to Effectiveness. The SPIRIT (Standard Protocol Items: Recommendations for Intervention Trials) was used as guideline to draft the study protocol (see supplementary material) [196].

Study Setting

In the Netherlands, formal centre-based childcare takes two forms. First, day-care centres provide full-day childcare [155], which children aged 0–4 years old can attend. Second, preschools provide half-day childcare with the specific goal to prepare 2–4-year-old children in a playful way for primary school [155]. Parents can receive a general childcare benefit for formal childcare from the government, based on their working hours and income [156]. The SuperFIT approach was implemented at *preschools* in the pilot region because they have a broader reach compared to day-care centres. Children with language or socio-emotional developmental delays, for example, can be referred to preschools to undergo a program to alleviate these delays [197]. This results in the inclusion of vulnerable groups. Day-care centres

are mostly used by families with working parents and higher incomes, which would result in a restricted sample [198].

The Intervention

SuperFIT was developed in a partnership with the preschool organization in the pilot region, a local PA-providing organization, and health promotion experts. A steering committee of stakeholders, including the municipality, community health service and youth health care agency, were consulted during the process of development and implementation. As formative research for the intervention development, a needs assessment was performed among preschool teachers and parents of the target population [133]. The theory and evidence-based knowledge from the health promotion experts, practice-based knowledge of the partners, and the input of the formative research were used to develop the different intervention components and strategies. During the implementation, a continuous process of co-creation, feedback and adaptations was adopted to develop the SuperFIT approach. The focus was to select strategies that could be considered add-in as opposed to add-ons. In other words, SuperFIT was designed to be integrated into daily routines as much as possible, rather than demanding additional activities to daily routines (e.g., additional physical education classes). Furthermore, intervention strategies were developed in such a way that there was a high adaptability to the specific situation of preschool teachers in their daily work.

Preschool-Based Component

The preschool-based component of SuperFIT aimed at changes in its sociocultural, physical and political environments. The sociocultural environment was operationalised as the nutritional and PA-related practices of the preschool teachers. Different strategies were applied to promote healthy practices. First, an inspirational session was organized for the preschool teachers with a well-known Dutch professional in the field of school-based PA. Second, three 2 h, off-the-job training sessions were provided for the preschool teachers [199]. All training sessions consisted of three sub-sessions led by an expert on the following topics: PA and related practices at the preschool; nutrition and related practices at the preschool; and positive child-rearing style. Preschool teachers got the opportunity to choose which of the sub-sessions they would attend based on their personal learning goals. At least one teacher of each preschool was expected to attend each sub-session, so that all themes would be covered within one preschool. The sessions were highly interactive and promoted an exchange of experiences between the attendees. Third, an on-the-job coaching session was provided by a PA and health coach after all off-the-job training [200]. Lastly, to support the preschool teachers at the workplace, PA and nutrition cards were developed. They contain easy-to-perform PA games and nutrition-related activities that fit with the current learning methods used in the preschools. They were developed by the experts within the SuperFIT partnership.

The physical environment was defined as 'what is available at the preschool' [42]. For PA, the strategies focused on increasing the availability of play materials. All preschools received a box with general PA-promoting play materials. These materials were aligned with the PA cards to enable all preschools to perform the activities described on the cards. The box contained a variety of materials that could promote PA both indoors and outdoors, such as bean bags, hoops, balls, sidewalk chalk, and clothespins [201]. In addition, an assessment of preschool-specific needs for materials was performed in order to provide these additional materials (e.g., stepping-stones or foam blocks).

Regarding nutrition, the strategies focused on increasing the variety and availability of fruit and vegetables during snack time and providing general nutrition-related materials [28]. A local greengrocer supplied unfamiliar fruits or vegetables (e.g., cherries, raspberries, avocado, celery) to increase the variety of fruits and vegetables. This supplemented the fruits that the children would bring to the preschool from home and was available every day. The supplied fruits or vegetables were similar during the two weeks to increase repeated exposure of the children to each new product [169, 202]. The general nutrition-related materials were part of the general box, with play materials, and were matched with nutrition-related cards. Materials included a water tap, fruit and vegetable toys, nutrition-related story books, and materials to involve children in preparing foods. Preschool teachers could also express the need for specific nutrition-related materials (e.g., a blender) to supplement the general materials that were delivered.

The political environment was defined as 'the institutional policies related to nutrition and PA' [42]. The strategies of SuperFIT focused on updating the nutrition policy and initiating the development of a PA policy, as this was not yet in place. Particular subjects of interest for the nutrition policy were the availability of water and healthy treats and preschool teacher practices. The PA policy was formulated to provide recommendations on the amount of time at childcare that should be spent active. It was intended to provide guidelines around safe play, particularly in a physical education room.

Family-Based Component

For families of the children in the participating preschools, a family-based component was developed within the SuperFIT partnership. The formative research was used as a guide, but parents were not actively involved in its development. The aim was to use fun family activities to help families integrate healthy nutrition and PA into their normal life. Fathers, mothers, siblings, grandparents, uncles and aunts were all welcome to join. The family sessions were characterised by fun activities for the whole family that concerned PA and nutrition. This included, for example, activity games that could be easily translated to the home setting, tasting sessions of new fruits and vegetables, and making healthy treats. To be able to address the influences of the different types of environments on nutrition and PA (e.g., nutritional

and PA-related parenting practices, availability of (un)healthy food products, rules around screen time), caregiver-only sessions were held in addition to the family sessions. Lifestyle Triple P seminars [203] were given by a trained Triple P provider. The sessions were highly interactive, enabling caregivers to share their experiences, solutions and ideas. Three 1.5 h caregiver-only sessions were provided. Three rounds of the family-based component were organized. In the first round, four, one-hour family sessions were organized. Together with the caregiver-only sessions, a total of seven sessions were delivered. However, parents and implementers indicated that this was too demanding. Therefore, in the second and third rounds, a total of five sessions were organized, three caregiver-only sessions and two family sessions. During the caregiver-only sessions, the implementers organized activities relating to PA and nutrition for the children. For younger siblings who were unable to participate in the sessions, childcare was available.

Community Component

The community component was based on PA and healthy nutrition initiatives that were already available in the intervention region. The aim was to improve linkages between different organisations and increase publicity about PA opportunities available within the community. Therefore, a social map showing sports organizations, playgrounds and a petting zoo was developed and distributed within the community.

Planning

The intervention activities of the preschool component started in April 2017. The first off-the-job training took place in May 2017, followed by an on-the-job coaching. The second and third off-the-job trainings took place after the summer holidays in September 2017, each training followed by an on-the-job coaching. The box with general play materials was available for the preschools after the first off-the-job training. The delivery of supplementary fruits and vegetables was started in May 2017 and lasted until May 2018. The first round of the family-based component started in May 2017, the second round in September 2017, and the third round in January 2018.

Participants

A convenience sample of intervention preschools was recruited from a childcare organization in an urban municipality in Limburg (the Netherlands), based on the socio-economic status (SES) of their neighbourhood. Preschools could participate if they were located in the low-SES neighbourhoods of the pilot region. SES was based on the 2014 values of the Netherlands Institute for Social Research (SCP), with a negative score indicating a low SES [204]. Together with the management of the childcare organization, eligible preschools were selected. No other inclusion or exclusion criteria were applied. In total, twelve preschools participated in SuperFIT. Control preschools were selected in another urban area in Limburg in the south of the Netherlands. This area was comparable with regard to SES. One childcare organization

collaborated, and a total of nine preschools participated as a control group. Due to the nature of the project, no randomization was performed. The Maastricht University Medical Centre, Medical Ethics Committee reviewed and approved this study (METC163022/ NL 58061.068.16), and the trial was prospectively registered (Clinicaltrials.gov, NCT03021980).

Children attending the participating preschools were eligible for inclusion. Additional inclusion criteria were: (1) at least one parent had to be able to understand Dutch, and (2) both parents signed the informed consent. Written information about the SuperFIT project was sent to each preschool to hand out to all parents with children attending that preschool. This information leaflet also informed the parents of the family-based component. Two weeks later, a researcher visited the preschool to explain SuperFIT verbally, starting with a kick-off event organised by the SuperFIT partnership. During that time, the parents were able to ask for additional information and hand in their informed consent for participation in the preschool-based component research and, additionally, the family-based component. During the course of SuperFIT, additional recruitment efforts were made to increase participation in the family-based component. First, parents of the participating preschools were informed through newsletters of the new rounds starting the family-based components. Second, parents in other preschools in the pilot region were informed about the family-based component and invited to participate.

All preschool teachers working at the participating preschools were part of the target population of SuperFIT as intermediaries for child EBRB. They were informed about SuperFIT by the childcare organisation during the development phase. Written information about SuperFIT was also sent to them. Two weeks later, a researcher visited the preschool to explain SuperFIT verbally, and the preschool teachers were able to provide their informed consent at that time.

Data Collection

For the effect evaluation, baseline measurements were performed before the start of the intervention, from January until April 2017. In the control group, baseline measurements were performed from January until July 2017. Follow-up measurements took place in November/December 2017 (first follow-up) and May/June 2018 (final follow-up). In order to reduce the participant burden, the data collection was aligned with intervention participation. This means that more elaborate data were collected for participants in the family-based component compared to participants in the preschool-based component or control group.

For the process evaluation, data were collected continuously during the implementation period. Qualitative and quantitative data will be entered, cleaned, coded and analysed from

July 2018 until July 2020. Figure 4.1 shows the planning of the research and implementation of SuperFIT.

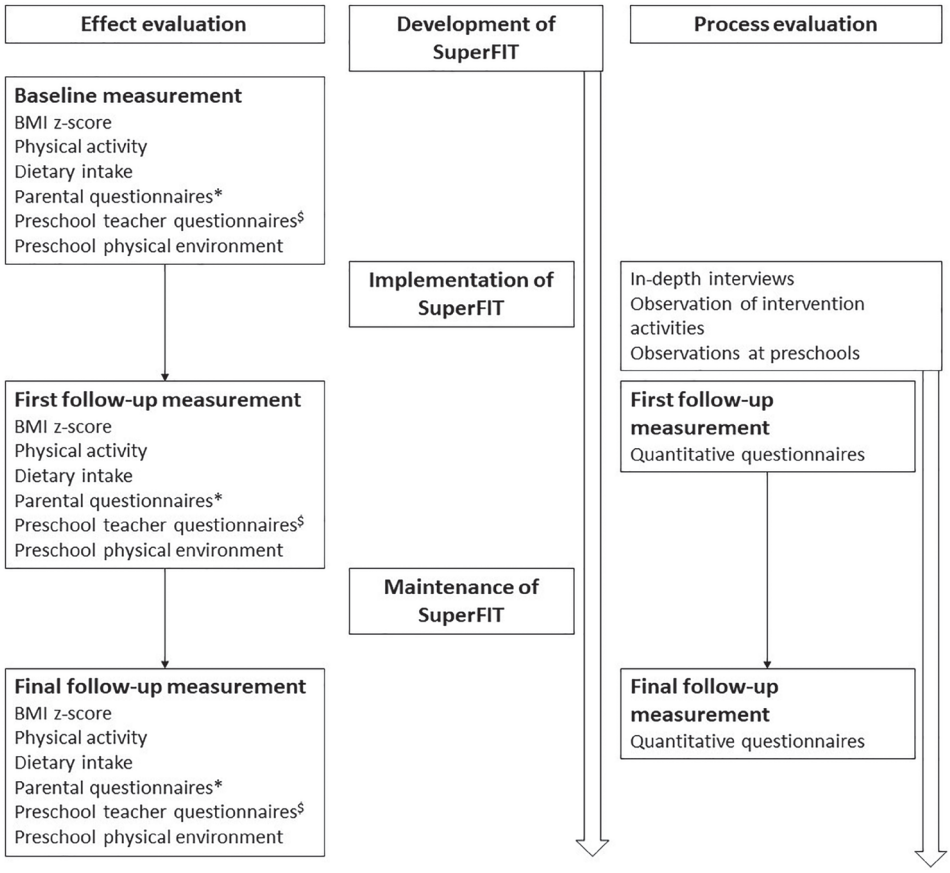


Figure 4.1. Planning of the implementation and evaluation of SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial). *Parental questionnaires measured demographics, nutritional and physical-activity-related practices, family health climate and physical home environment. $Preschool teacher questionnaires measured demographics and nutritional and physical-activity-related practices.

Effect Evaluation

BMI z-Score

A trained member of the research team will assess the weight, height and waist circumference of the children, using a standardized protocol. Standing height will be measured to the nearest decimal in centimetres (cm) using the Seca© 213 stadiometer (Seca, Hamburg, Germany), with light clothing and without shoes. Weight will be measured to the nearest decimal in kilograms (kg) using the Seca© Clara 803 (Seca, Hamburg, Germany), digital weighing scale. Heavy clothing and shoes will be removed before measurement. Waist circumference will

be measured using the Seca© 201 (Seca, Hamburg, Germany), measuring tape. Only a thin vest or t-shirt between the measuring tape and skin will be allowed. A single measurement will be performed to assess height, weight and waist circumference. Anything unusual occurring during the measurements, such as not wanting to take off shoes or wearing heavy clothing, will be recorded to adjust for it during analysis. Height and weight measurements will be used to calculate BMI, which will be converted to a BMI z-score, adjusted for age and gender using a Dutch reference population (the Fifth Growth Study) [5].

Similar anthropometric measurements will be performed on one of the parents of each family participating in the family-based component, using the same protocol and measurement instruments. Weight and height measurements will be used to calculate BMI.

Dietary Intake

The children's dietary intake will be measured both at home and at the preschool. A 24 h dietary telephone recall will be conducted to assess dietary intake at home. Researchers and research assistants will be trained in following a dietary recall protocol and entering data in the Blaise© software (version 4.8.4.1767 (Statistics Netherlands (CBS), The Hague, the Netherlands)). Phone calls will be done in the evening adopting a structured protocol that divides a day into seven chronological eating moments: yesterday's evening snack(s), today's breakfast, morning snack(s), lunch, afternoon snack(s), dinner and evening snack(s). Parents will be asked to report food products consumed, starting with yesterday's evening snack(s). Fruit, vegetables and snacks will be the major focus of the dietary recall. This meant that snacking moments were explored in detail, while the questions about main meals focused on fruits, vegetables and beverages only.

Details of each product will be requested, such as the kind, portion size, amount and preparation technique. Probing questions (e.g., did he/she drink something during dinner? Was this regular soda or diet soda?) will be used as memory cues to help parents record all products, including product details. Blaise© (version 4.8.4.1767 (Statistics Netherlands (CBS), The Hague, the Netherlands)), a system used to administer computer-controlled questionnaires, will serve as the data entry software and contain child products (e.g., candy, fruit drinks) and child portion sizes (e.g., segments of fruit and a sippy cup) to match a child's diet. It also will provide an 'unknown' option, an 'other' option and a comment section whenever the existing codes will not match. These will be recoded into existing or new product codes later in the process. Blaise was connected to The Dutch Food Composition Database, version 2016/5.0 (National Institute for Public Health and the Environment (RIVM), Bilthoven, the Netherlands) to assess nutrient composition.

At the preschool, the children's dietary intake will be assessed using a dietary journal [28]. The teachers will record the intake of each child on a predefined list of the most commonly

consumed food products and beverages at the preschool. Additional blank spaces will be available for any other food products consumed. Consumption will be recorded in number of units most common for the food product (e.g., parts for fruits/vegetables, pieces for sweets, cups for beverages).

For families participating in the family-based component, a short food frequency questionnaire on fruits/vegetables, sweets and snacks, and beverages will be part of the measurement diary, which will be provided with the accelerometer, to assess parental dietary intake.

Physical Activity and Sedentary Behaviour

Children's PA and sedentary behaviour (SB) will be assessed using Actigraph GT3X+ (Actigraph, Pensacola, FL, USA) accelerometers, applying an adjusted wearing protocol [205]. Accelerometers will be placed on the right hip using an elastic belt. Children will wear the accelerometers for eight consecutive days during waking hours. Instructions will be given to remove the accelerometer for activities involving water such as bathing, showering and swimming. Parents will be provided with a measurements diary to record wear-time particularities, preschool attendance, and attendance at other childcare facilities.

PA and SB of one parent of the families participating in the family-based component will be assessed using Actigraph GT3X+ (Actigraph, Pensacola, FL, USA) accelerometers. The measurement protocol for the children also will apply to their parents.

Questionnaires

The preschool teachers will be asked to complete a questionnaire on demographic variables and nutritional and PA-related practices (Child-care Food and Activity Practices Questionnaire, CFAPQ) [206]. All parents will be asked to fill out a questionnaire on demographics and other background variables. The parents of children in the family component will be additionally asked to fill out a questionnaire on nutritional and PA-related practices (Pre-schooler Physical Activity Parenting Practices questionnaire (PPAPP) [207], and Comprehensive Feeding Practices Questionnaire (CFPQ) [208]), family health climate (Family Health Climate Scale [209]), and physical home environment, based on the Environment and Policy Assessment and Observation-Self Report (EPAO_SR) [210]).

Preschool Physical Environment

Questions from the Environment and Policy Assessment and Observation instrument (EPAO) [211] related to the physical environment will be adapted to the Dutch setting and will be used to assess the physical preschool environment. A trained researcher will observe each location and will fill out the questionnaire at baseline and both follow-up measurements.

Process Evaluation

The process evaluation will be conducted to gain insight into the reach, adoption, implementation and maintenance of SuperFIT, using both quantitative and qualitative measurements. Preschool teachers and parents in the intervention group will be asked questions about their appreciation of SuperFIT in the follow-up questionnaires. Observations will be done at the preschool locations to assess implementation fidelity, change in daily activities, and the social and physical environment at the preschool. The observations were done in one morning, twice during implementation (September/October 2017 and April 2018) and once after implementation (September 2018).

In-depth semi-structured interviews were performed with the preschool teachers, parents, management, and implementers on several occasions during or following implementation. In June and July 2017, in-depth interviews were held with the preschool teachers, focusing on development and implementation. These interviews were also used to adapt the intervention strategies that were still to come.

In February and March 2018, in-depth interviews with the preschool teachers were held to gain insight into their experiences with SuperFIT, such as its strengths and limitations, and the facilitators and barriers of integrating SuperFIT into daily practice. Finally, in October and November 2018, in-depth interviews were held with preschool teachers, management and implementers that focused on the maintenance of SuperFIT within their organisation. After each round of the family-based component, in-depth interviews were held with the participating parents on their experiences, strengths and limitations, and changes that may have occurred as a result of their participation.

All intervention activities were observed using a free-form protocol to record any aspects occurring during the activities and give a general impression of the intervention activity. Attendance at the intervention activities was recorded in order to evaluate reach.

Data Analysis

Quantitative continuous variables will be presented as means and standard deviations. Categorical data will be presented by percentages of participants in each of the possible categories. Baseline characteristics and outcome values will be analysed for differences between the groups, using analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. The effects of SuperFIT will be analysed using linear mixed models with child and preschool levels in order to correct for repeated measurements and group effects. Known potentially relevant confounders will be taken into account based on the literature and/or differences in baseline characteristics. All analyses will be performed using SPSS version 25.0 (IBM Corp, Armonk, NY, USA).

Qualitative data of the interviews will be audio-recorded and transcribed verbatim. Interview transcripts will be coded by themes and concepts using NVivo version 11 (QSR International, Doncaster, Victoria, Australia).

Sample Size

An a priori sample size calculation was performed based on the BMI z-score. For the preschool-based component, the expected difference between the intervention and control condition was 0.10 BMI points [98]. Given a power of 0.90 and $\alpha < 0.05$, a sample of 115 children in each group was required to detect this difference. Correcting for the potential nesting of effects within a preschool, considering an intraclass correlation of 0.0006, which corresponds to a design effect of 1.23, a total of 142 children should be included. Taking into account an attrition rate of 20%, 171 children should be included in each study group, resulting in 342 children.

For the family-based component, the expected difference between the intervention and control group is 0.30 BMI z-points [98]. Taking into account a power of 0.90 and $\alpha < 0.05$, a sample of 38 families is required. Adjusting for an attrition rate of 30% a total of 50 families is the target for inclusion in the family-based component.

Recruitment for this study was done between January and April 2017 for the intervention group and between January and July 2017 for the control group. A flow diagram of participation is shown in Figure 4.2. Parents of 23.9% of the children attending intervention preschools agreed to participate in the preschool component, 41.0% of these parents also agreed to participate in the family-based component, and 26.7% of parents of children in the control preschools agreed to participate. Of the preschool teachers, 91.4% from the intervention preschools and 65.0% from the control preschools agreed to participate.

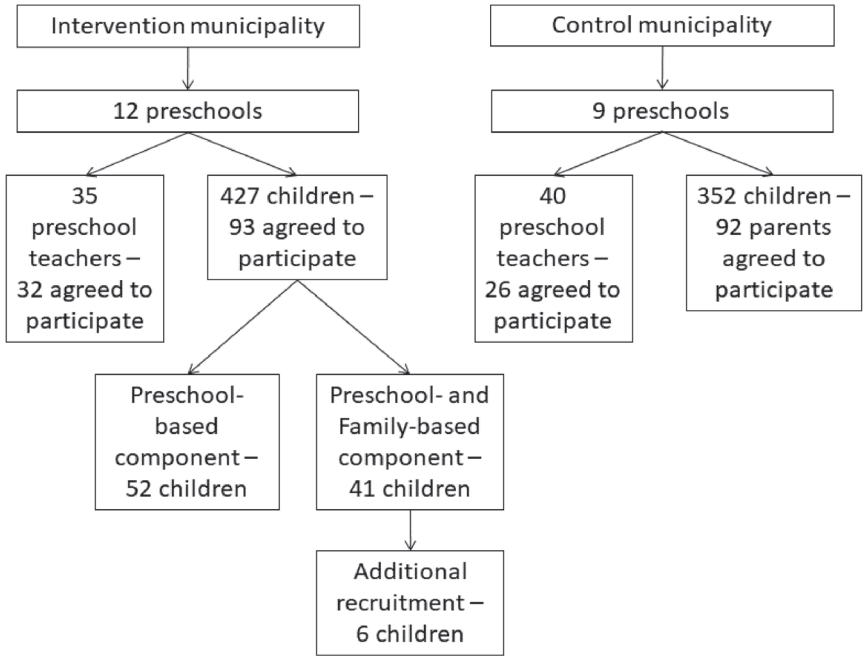


Figure 4.2. Flow diagram of the participants of SuperFIT.

As the a priori calculated sample size was not reached, an additional power calculation was conducted. Based on the sample size (intervention $N = 99$; control $N = 92$), a difference of 0.19 BMI z- points can be detected, which seems attainable based on the available evidence [80, 98]. The calculations are based on the same assumptions of the a priori sample size calculation. In addition, an increase of 1.44% of time in moderate-to-vigorous physical activity (MVPA) per day (corresponding to 8.91 min per day), 0.33 instances of fruit consumption per day, 0.26 instances of vegetable consumption per day, and 0.57 instances of water consumption per day can be detected. A decrease of 0.52 instances of sugar-sweetened beverages consumption per day and 0.61 instances of snack consumption per day can be detected. These differences also seem attainable based on the available evidence [201, 212].

Discussion

This study protocol describes the design of the effect and process evaluation of SuperFIT, a comprehensive, integrated intervention approach. It aims at affecting the children's EBRB through changes in multiple types of environments and aligning these changes in the preschool, home and community settings. In particular, targeting both the preschool and the home settings may be important for intervention effectiveness, as socio-ecological theories and research describe an interplay between them [47-49]. Intervention research has shown that incorporating a parental component in childcare-based interventions may be essential

for intervention effectiveness [79, 99]. Furthermore, not targeting single behaviours or types of environment in isolation, but rather taking into account the complexity of childhood overweight and obesity was expected to be supportive of effects on children's EBRB and weight-related outcomes [79].

SuperFIT was developed in close collaboration between practice professionals and health promotion experts, in co-creation with the target group. This enhanced its applicability and usability [185], and a rigid evaluation of the program was ensured [213]. The SuperFIT approach was developed to be adaptable to the specific situation of a childcare organization and location, which may foster sustainability [214]. It also contains elements (e.g., on-the-job coaching) that directly assist childcare workers in its application in the context of their daily practice, and therefore stimulates implementation [215]. The extensive process evaluation will study these factors and try to understand the changes that occur within the system that may or may not lead to effects from the SuperFIT approach [216, 217].

The effect evaluation was done using objective measurements where possible (i.e., accelerometer data, height and weight measures), valid measurement of dietary intake (24 h recall), and validated questionnaires (practices). One limitation of the study may be the quasi-experimental design, without randomisation. Convenience samples of the preschools were used, which may have introduced selection bias. However, in intervention research, it is important to find a balance between internal (i.e., rigorous research designs) and external (i.e., generalizability) validity [218]. For the evaluation of the SuperFIT approach, the current study design was considered most appropriate for achieving this balance.

Conclusion

SuperFIT is a multi-component, integrated intervention that aims to promote healthy EBRB in young children through aligning the childcare and home settings with regard to physical activity and healthy nutrition. A rigid effect and process evaluation will provide insight on the possible effectiveness of this type of intervention and factors that may have influenced this effectiveness.

Appendix

Supplementary Table S4.1. SPIRIT checklist.

Section/item	Item No	Description	Addressed on page
Administrative information			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	83
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	91
	2b	All items from the World Health Organization Trial Registration Data Set	n.a.
Protocol version	3	Date and version identifier	n.a.
Funding	4	Sources and types of financial, material, and other support	
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	83
	5b	Name and contact information for the trial sponsor	
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities	
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)	n.a.
Introduction			
Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention	85-87
	6b	Explanation for choice of comparators	87
Objectives	7	Specific objectives or hypotheses	86-87
Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory)	87
Methods: Participants, interventions, and outcomes			
Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained	87-88
Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists)	90-91
Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered	88-90
	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease)	n.a.
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests)	n.a.
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial	n.a.

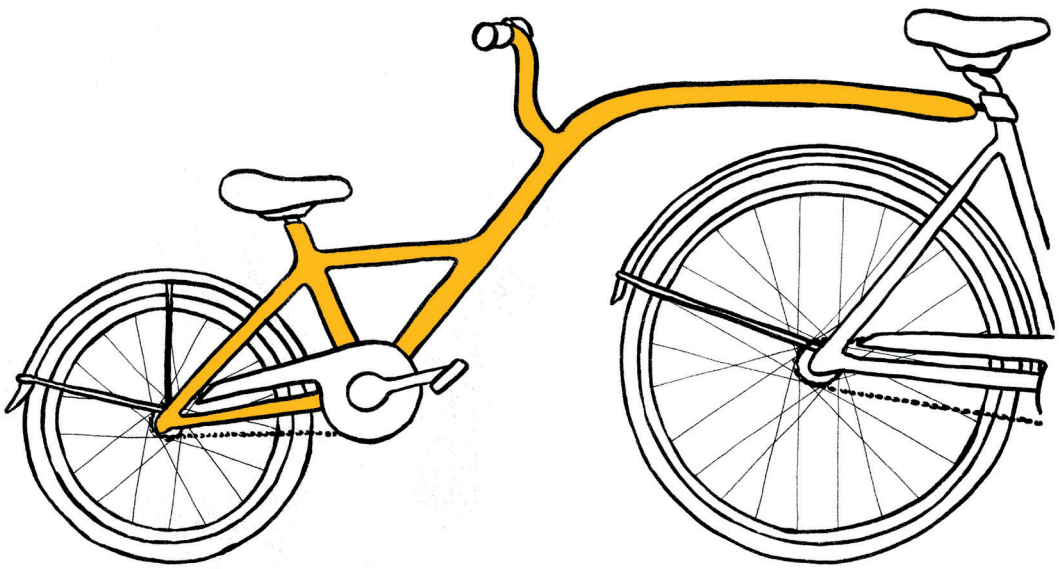
Supplementary Table S4.1. Continued

Section/item	Item No	Description	Addressed on page
Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended	92-95
Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure)	90-92, Figure 4.1
Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations	96-97
Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size	90-91
Methods: Assignment of interventions (for controlled trials)			
Allocation:			
Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions	n.a.
Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned	n.a.
Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions	n.a.
Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how	n.a.
	17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial	n.a.
Methods: Data collection, management, and analysis			
Data collection methods	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data	91-96
	18b	collection forms can be found, if not in the protocol Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols	n.a.
Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol	91-92

Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol	95-96
	20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	95-96
	20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)	n.a.
Methods: Monitoring			
Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not needed	n.a.
	21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial	n.a.
Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct	n.a.
Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor	n.a.
Ethics and dissemination			
Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval	91
Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)	n.a.
Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)	90-91
	26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	n.a.
Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	n.a.
Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	
Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	n.a.
Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	n.a.
Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	n.a.
	31b	Authorship eligibility guidelines and any intended use of professional writers	n.a.
	31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	n.a.

Supplementary Table S4.1. Continued

Section/item	Item No	Description	Addressed on page
Appendices			
Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	n.a.
Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	n.a.



Chapter 5

The Effects of a Comprehensive, Integrated Obesity Prevention Intervention Approach (SuperFIT) on Children's Physical Activity, Sedentary Behaviour, and BMI Z-Score

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Abstract

SuperFIT is a comprehensive, integrated intervention approach aimed at promoting healthy energy balance-related behaviours in 2- to 4-year-old children in the preschool and home settings. A quasi-experimental research design was adopted to evaluate the effects of SuperFIT on physical activity (PA), sedentary behaviour (SB) and Body Mass Index (BMI) z-score. Children could participate in the preschool-based and family-based component (full intervention) or only in the preschool-based component (partial intervention). Children's PA levels and SB were assessed with accelerometers and observations, and height and weight were measured for the BMI z-score. Measurements were performed at baseline and two follow-up time points. Effectiveness was evaluated using linear mixed-model analyses, correcting for relevant covariates. Healthy changes in PA levels occurred within all study groups over time. No significant differences were found in overall PA levels between the intervention groups and control group at both follow-ups. Nevertheless, sedentary behaviour decreased more in the full intervention group (effect size (ES): −0.62), and moderate-to-vigorous PA (ES: 0.85) and counts per minute (ES: 0.45) increased more compared to the control group on preschool days at the first follow-up. No effects were found for BMI z-score. The integrated approach of SuperFIT may induce changes in PA of young children, although the effects were small.

Introduction

Regular and sufficient physical activity (PA) is an important contributor to the physical health and psychosocial well-being of children [15, 219]. Early childhood is an important period for developing healthy habits, such as participating in PA, and PA habits are known to track from childhood into adulthood [13, 14]. PA at a young age is also essential for the development of fundamental motor skills, which in turn is predictive for PA at an older age [139]. However, research has shown that young children are not getting enough daily PA, plus their daily movement patterns are characterized by large amounts of sedentariness [20-22, 220].

A lack of PA in combination with high sedentariness and unhealthy nutrition is associated with childhood overweight and obesity [3, 11]. These are continuing important public health problems with a prevalence that is expected to rise even further [146]. In the Netherlands, around 8% of 2-year-old children are overweight or obese and this prevalence increases with age [5]. Overweight and obesity are related to various health issues in both childhood and adulthood [1, 2]. Promoting PA in young children is therefore crucial to supporting children's healthy lifestyles and health.

The home setting exerts an important influence on the behaviour of young children. Not only is parental PA behaviour related to child PA [221], parental support and family characteristics are also related to PA [222]. The use of supportive parenting practices may promote PA among children [223]. In addition, many young children are enrolled in Early Care and Education (ECE), which increases with age (from ~33% for 0–2-year-olds to ~80% for 3-year-olds) [60]. The ECE setting has been both positively and negatively associated with PA in young children in different studies [69, 70]. In general, children spend much time sedentary and little time in PA in the ECE setting [68]. Educator-related factors (e.g., activity-related practices and presence), physical environment-related factors (e.g., outdoor play area and larger play spaces), and organization-related factors (e.g., provision of active opportunities) influence PA within the ECE setting [71]. Other factors are thought to be related to children's PA, although the evidence is less conclusive, such as the availability of portable or fixed play materials, educator training, and indoor play space [71]. The ECE setting is considered an essential and promising one for interventions in order to improve children's PA [224].

Systems theory suggests that it is important to take into account both the ECE and home settings when intervening to promote healthy behaviour [47, 86]. Furthermore, aligning important micro-settings towards more supportive environments for healthy behaviour may result in synergistic effects [48]. Research has already shown that this combination of ECE and home is more effective in preventing childhood overweight and obesity than targeting just one setting, although the relationship with behaviour is less clear [79, 99]. On the other hand, it has been found that inconsistencies between the ECE and home settings are related

to less physical activity in young children [49]. Including the community setting and creating a health-supporting community may also support intervention effectiveness as this may foster sustainable change [193].

Interventions tend to focus on single settings or single aspects of childhood overweight and obesity and as a result may lack comprehensiveness. Therefore, SuperFIT was developed as a comprehensive, integrated intervention approach in the ECE and home settings in the Netherlands. It takes into account the interaction between settings and the complexity of the childhood overweight and obesity problem. It primarily aims to increase physical activity levels, decrease sedentary behaviour and increase healthy nutrition behaviour (e.g., drinking water and eating fruits and vegetables) of young children through changes in the sociocultural environment (i.e., use of supportive physical activity and nutrition-related practices by preschool teachers and parents) and physical environment (i.e., availability of space, play materials, healthy foods). Through these behavioural changes, SuperFIT also aims to prevent childhood overweight and obesity. The current study evaluated the effectiveness of SuperFIT on child physical activity, sedentary behaviour and Body Mass Index (BMI) z-score. We hypothesize that SuperFIT will increase the levels of physical activity and decrease the levels of sedentary behaviour in young children compared to the control group. In addition, we hypothesize that SuperFIT will help children maintain or achieve a healthy BMI z-score. Finally, we hypothesize that the combination of the preschool and home setting will lead to synergy, increasing intervention effectiveness.

Materials and Methods

A protocol with a detailed description of the SuperFIT intervention and evaluation can be found elsewhere [225].

Study Design

In the Netherlands, ECE consists of two forms. In one, day-care centres provide full-day childcare [155], which children aged 0- to 4-years old can attend. In another, preschools provide half-day childcare with a specific goal to prepare children in a playful way for primary school [155]. Children aged 2- to 4-years-old can attend preschools. Parents can receive a general childcare benefit for both of these forms of ECE from the government, based on their working hours and income [156]. ECE centres have a large reach as children with, for example, language or socio-emotional developmental delays can be referred to ECE to enter a program to catch up on these delays [197]. SuperFIT was implemented at preschools and was evaluated using a quasi-experimental research design.

The Intervention

SuperFIT is a comprehensive, integrated intervention approach based on socio-ecological models of behaviour and systems theory [47, 48]. In particular, it aims to align intervention strategies between different micro-settings (i.e., preschool and home) to enhance intervention effectiveness. SuperFIT was developed in partnership with the intervention preschool organization, a local PA providing organization, and health promotion experts. Formative research [133], practice-based knowledge of cooperating partners, and theory- and evidence-based knowledge [86, 226-229] were used to develop it. Further, a continuous process of co-creation, feedback and adaptations was adopted during development to increase suitability and applicability in the settings. The intervention consisted of preschool-based, family-based, and community components.

Within the preschool-based component, several strategies were implemented that targeted the sociocultural and physical environment [42]. The sociocultural environment was operationalized as the physical activity- and nutrition-related practices of the preschool teachers. The intervention strategies involved the preschool teachers and included (1) an inspirational session with a school-based PA expert, (2) three off-the-job interactive training sessions on PA, nutrition, and positive child rearing, led by an expert on the specific topic (3) on-the-job coaching sessions following each the off-the-job training (three in total), on PA or nutrition led by the same experts, and (4) cards with easy-to-perform PA games and nutrition-related activities to support preschool teachers to integrate PA and healthy nutrition in the curriculum. The physical environment was operationalized as all that is tangibly available for the children at the preschool. Intervention strategies were (1) provision of a box of general play materials aligned with the PA-related cards that could promote PA both indoors and outdoors (e.g., bean bags, hoops, balls); (2) general nutrition-related materials aligned with the nutrition-related cards (e.g., water tap, fruit and vegetable toys, nutrition-related story books); and (3) complementary fruit and vegetables delivery. A local greengrocer supplied less-familiar fruits or vegetables (e.g., avocado, raspberries, carrots in different colours) to increase variety. These supplemental fruit and vegetables were available every day and were similar every two weeks to ensure repeated exposure. Intervention strategies were mostly designed to serve as add-in rather than add-on activities, which were highly adaptable to the specific situation of a preschool, to support implementation and sustainability.

The family-based component was developed to provide fun activities to help families integrate PA and healthy nutrition in their daily life [59]. All possible caregivers were invited to participate in these sessions. Caregiver-only sessions were organized in order to address the influences of the different types of environments (i.e., sociocultural, physical, political and economic [42]) on nutrition and PA. These sessions were based on Lifestyle Triple P seminars and were given by a trained Triple P implementer [203]. Three Triple P seminars were provided (one on PA, one on nutrition and one on general parenting), which lasted around

1.5 h. During the caregiver-only sessions PA or nutrition-related activities were organized for the children and childcare was available for the youngest siblings. In addition, family sessions were organized. They were characterized by fun activities for the whole family. The PA-related family sessions aimed at co-physical activity, performing active games that are easily translated to the home setting. The nutrition-related family sessions consisted of, for example, taste sessions, and making healthy treats.

The community component aimed to increase linkages between different organizations involved in young children's physical activity and nutrition behaviour. A social map was distributed that indicated PA opportunities suitable for young children within the community. Intervention activities in both the preschool-based and family-based components took place between April 2017 and May 2018. Activities in the community component started during the same period, but the social map was distributed in June 2018.

Study Population and Recruitment

A convenience sample of intervention preschools was recruited by a childcare organization in an urban municipality in Limburg (the Netherlands). Preschools were selected based on the socio-economic status (SES) of their neighbourhood as determined by the 2014 values of the Netherlands Institute for Social Research (SCP) [204]. A negative neighbourhood SES score indicated low SES, and preschools in these neighbourhoods were eligible. In consultation with the childcare manager a selection of eligible preschools was determined. In total, twelve intervention preschools participated. Control preschools were selected in another urban municipality in Limburg (the Netherlands) by one childcare organization. Preschools in neighbourhoods with comparable SES scores were eligible [204]. Nine preschools participated. Due to the nature of the project, no randomization or blinding was performed. Children attending the participating preschools were eligible for participation in the research of SuperFIT. Additional inclusion criteria for the children were: (1) At least one parent had to be able to understand Dutch; and (2) both parents signed informed consent forms. Parents were provided with the choice to participate in either just the preschool-based component (partial intervention) or both the preschool-based and family-based components (full intervention). All preschool teachers working at the participating preschools were eligible to participate in the research after providing informed consent. All children attending the participating preschools were exposed to SuperFIT, although not all children participated in the research. All preschool teachers were expected to participate in the intervention training and coaching sessions by the childcare organization as part of their professional development. The Maastricht University Medical Centre+ Medical Ethics Committee reviewed and approved this study (METC163022/NL 58061.068.16), and the trial was prospectively registered (Clinicaltrials.gov, NCT03021980).

Measurements

Baseline measurements were performed from January until July 2017. Follow-up measurements took place in November/December 2017 (first follow-up) and May/June 2018 (final follow-up). In order to reduce the participant burden, data collection was aligned with intervention participation. This means that more extensive data collection was done for participants in the family-based component compared to those in the preschool-based component or control group. Measurements were performed on anthropometry, physical activity, dietary intake and preschool teacher and parent nutritional and physical activity-related practices. The current paper presents the effects on BMI z-score and physical activity. The effects of SuperFIT on dietary intake will be presented elsewhere [87].

Physical Activity

Children's PA was assessed using Actigraph GT3X+ (Actigraph, Pensacola, FL, USA) accelerometers, applying an adjusted wearing protocol [205]. Accelerometers were placed on the right hip using an elastic belt. Children wore the accelerometers for eight consecutive days during waking hours, excluding activities involving water such as bathing/showering and swimming. Data were derived using a 10-s epoch. Wear time validation by Troiano (2007) was used [230]. Minimal wear time was set at 360 min per day. For children whose wear time indicated the accelerometer was worn during night sleep, data were extracted from 6.00 am to 9.00 pm to exclude sleep time. Children who had one day of sufficient wear time were included in the analysis. Uniaxial cut-off points of Pate et al. (2006) for PA intensity were used [231]. In addition, time spent in the different PA categories (sedentary behaviour (SB), light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA)) was divided by total wear time to calculate the percentage of time spent in each category. Counts per minute (CPM) based on vector magnitude were extracted. Data were extracted for overall PA and PA on preschool days.

Observations at Preschools during Implementation

Observations were performed at a random selection of the intervention preschools (9 out of 12 preschools, 10 groups) to assess change in daily activities and the preschool environment, among other things. The observations took place during morning opening hours on one day. They were performed twice during implementation (September/October 2017 and April 2017) and once after implementation (September/October 2018). The observations were performed using an observation form based on the Environment and Policy Assessment and Observation form (EPAO) [211]. The observation form consisted of the parts related to daily activities, the social and physical environments, and was adjusted to the Dutch preschool setting. The form followed the structure of a regular preschool day, starting with activities before snack time (indoor and outdoor), snack time, and activities after snack time (indoor and outdoor). For each activity, duration was measured by recording start and finish time. Activities outside, activities initiated by preschool staff both inside and outside (e.g.,

throwing over a ball), sedentary activities both inside and outside (e.g., doing handcrafts or playing seated in the sandpit), and circle time could be recorded separately. Observations were performed on a group level, indicating that activities should involve the majority of the children present to be recorded.

Anthropometrics

A trained member of the research team assessed the children's weight and length, using a standardized protocol. Standing height was measured using the Seca © 213 stadiometer (Seca, Hamburg, Germany), without shoes, to the nearest decimal in centimetres (cm). Weight was measured using the Seca © Clara 803 digital weighing scale to the nearest decimal in kilograms (kg). Heavy clothing and shoes were removed before measurement. Particular events occurring during the measurements, such as not wanting to take shoes off or wearing heavy clothing, were recorded to aid data cleaning. Further data cleaning was done on data entry errors and outliers. Height and weight measurements were used to calculate BMI, which was converted to a BMI z-score, adjusted for age, gender, and ethnicity, using a Dutch reference population (The Fifth Dutch Growth Study) [5].

Covariates

A baseline parental questionnaire was used to measure a range of demographics. For the children, these included birthdate and gender. Child birthdate was used to calculate the child's age at baseline. Parental demographics included parental birthdate, education level and country of birth. Parental birthdate was used to calculate parental age at baseline. Education level was recoded into low, medium and high using the International Standard Classification of Education (ISCED) 2011 classification [232]. Country of birth was recoded into 'the Netherlands' or 'other'. The questionnaire was also used to measure parental weight and length in order to calculate BMI.

To be able to correct for weather influences, data on weather conditions between 6 a.m. and 11 p.m. were collected from the Royal Dutch Meteorological Institute (KNMI) [233]. Data were gathered on temperature (average degree Celsius), sunshine (total hours) and precipitation (total hours).

Statistical Analyses

Baseline characteristics and outcome values were analysed for differences between the groups using ANOVA for continuous variables and chi-square tests for categorical variables. Effects of SuperFIT on overall PA, PA on preschool days, and BMI z-score were analysed using multiple linear mixed models with child and preschool levels in order to correct for repeated measurements and group effects. Linear mixed models handle missing outcome values by imputing them with a likelihood-based method. The fixed part of the model consisted of condition, time and the interaction term of condition and time. A random intercept was

included when this significantly improved the model based on the likelihood ratio. Sensitivity analysis was performed using only those cases that provided data for all measurements. PA outcomes were corrected for child age at baseline, child gender and weather conditions (temperature, sunshine, and precipitation). BMI z-score was adjusted for parental BMI at baseline, parental education level, parental country of birth. Manual backwards analysis was applied to correct for possible covariates.

Descriptive analyses were performed on the data from the observations. Total minutes spent in each activity were calculated. All analyses were performed using SPSS version 25.0 (IBM Corp, Armonk, NY, USA), and *p*-values < 0.05 were considered statistically significant. For all PA outcomes and BMI z-scores, effect sizes were calculated based on the estimated mean difference between measurements and the standard errors of the estimated means. Cohen's classification was used to determine the level of effect size [234].

Results

Participants

A total of 191 children participated in the study at baseline. Forty-seven children were included in the full intervention, 52 in the partial intervention and 92 in the control group. The children were 3.1 years old on average, and 46.1% were boys (see Table 5.1). At baseline, the groups differed significantly by parental country of birth, parent education level, and partner education level.

Table 5.1. Baseline characteristics of the participants.

Characteristic	Full Intervention (N = 47)		Partial Intervention (N = 52)		Control (N = 92)	
	N (%) *	Mean± SD	N (%) *	Mean± SD	N (%) *	Mean± SD
Child age (years)		3.2 ± 0.5		3.0 ± 0.4		3.1 ± 0.6
Child gender						
Boy	20 (42.6)		24 (46.2)		44 (47.8)	
Girl	27 (57.4)		28 (53.8)		48 (52.2)	
Child BMI z-score		0.25± 1.02		0.16 ± 0.88		0.13± 0.96
Parent age (years)		34.5 ± 4.1		35.6 ± 4.3		33.2 ± 4.3
Partner yes/no	26 (86.7)/4 (13.3)		35 (94.6)/2 (5.4)		37 (80.4)/9 (19.6)	
Parent birth country [$]						
Netherlands	38 (92.7)		39 (90.7)		45 (68.2)	
Other	3 (7.3)		4 (9.3)		21 (31.8)	
Partner birth country						
Netherlands	33 (89.2)		34 (82.9)		43 (81.1)	
Other	4 (10.8)		7 (17.1)		10 (18.9)	

Table 5.1. Continued

Characteristic	Full Intervention (N = 47)		Partial Intervention (N = 52)		Control (N = 92)	
	N (%) *	Mean± SD	N (%) *	Mean± SD	N (%) *	Mean± SD
Parent education level $						
Low	5 (12.2)		7 (16.3)		20 (30.8)	
Middle	12 (29.3)		15 (34.9)		27 (41.5)	
High	24 (58.5)		21 (48.8)		18 (27.7)	
Partner education level $						
Low	5 (13.9)		5 (12.8)		18 (32.7)	
Middle	20 (55.6)		15 (38.5)		23 (41.8)	
High	11 (30.6)		19 (36.5)		14 (25.5)	
Parent BMI		24.7 ± 3.1		25.5 ± 3.5		24.4 ± 3.4

* Due to missing data N can vary, percentages are based on available data; $ Significant difference between the groups. SD = standard deviation.

Valid accelerometer data for at least one measurement were available for 175 children (91.6%). Valid accelerometer data were available for 143 children (74.9%) at baseline, 129 children (67.5%) at the first follow-up, and 120 children (62.8%) at the final follow-up. Anthropometric measurements were available for 180 children (94.2%) for at least one measurement (baseline 164 children (85.9%), first follow-up measurement 146 children (76.4%), and final follow-up measurement 136 children (71.2%)). At baseline, parents of 127 children (66.5%) filled out the parental questionnaires.

Table 5.2. Changes in time spent in sedentary or physical activity (PA) activities at intervention preschools.

PA or sedentary activity	1st Obs.			2nd Obs.			3rd Obs.		
	Loc.	Min./ Max.	Mean (SD)	Loc.	Min./ Max.	Mean (SD)	Loc.	Min./ Max.	Mean (SD)
Outside play (minutes)	7	10/28	20.1 (7.7)	7	10/33	23.1 (8.2)	7	13/60	29.1 (17.8)
Inside active play* (minutes)	8	3/24	11.4 (6.9)	7	6/28	18.0 (8.1)	9	1/69	18.3 (21.8)
Total active ** (minutes)	10	3/41	23.2 (14.9)	10	22/36	28.8 (4.7)	10	11/74	36.9 (20.9)
Inside sedentary (minutes)	9	13/68	33.8 (17.7)	8	15/47	29.1 (11.0)	10	5/45	22.5 (12.3)
Circle time (minutes)	9	11/47	22.9 (12.0)	9	8/33	18.8 (7.5)	9	12/29	19.8 (5.1)
Snack time (minutes)	10	20/32	25.8 (3.6)	10	15/33	24.2 (5.7)	10	15/31	23.5 (5.0)
Total sedentary $ (minutes)	10	27/106	76.8 (25.7)	10	38/100	64.4 (21.1)	10	48/85	63.8 (13.0)

* Based on time spent in teacher-initiated activities ** Sum of outside play and inside active play $ Sum of inside sedentary time, circle time, and snack time. PA = physical activity, Loc. = locations, obs. = observation, min. = minimum, max. = maximum, SD = standard deviation.

Physical Activity at Preschools

The observation data showed that during the implementation period of SuperFIT, preschools reduced time spent sedentary, increased time spent active, and increased time spent outdoors (Table 5.2). Although average time spent outdoors increased, some preschools did not go outside at all during the observation days. Furthermore, the average duration of circle time and snack time appeared rather consistent. However, the maximum time spent in circle time decreased substantially.

Effects on Children's Physical Activity Outcomes

There were no significant differences for the PA outcomes between the groups at baseline. Regarding children's PA on preschool days, the results are shown in Table 5.3. Children in the full intervention showed significant within-group differences at both the first (SB and MVPA) and the final follow-up (all PA outcomes). In addition, compared to the control group, the full intervention showed significant differences for SB (effect size: −0.62), MVPA (effect size: 0.85), and CPM (effect size: 0.45). These significant differences were not present at the final follow-up.

Children in the partial intervention and the control group showed significant within-group differences between baseline and final follow-up, but not for the first follow-up. No significant differences were seen between the partial intervention and control group for both the first and final follow-up for PA outcomes on preschool days. Based on the effect sizes, the control group improved more on the PA outcomes than the partial intervention group, except for CPM at the first follow-up and MVPA at the final follow-up. However, all effect sizes were small or very small.

Table 5.4 shows the effects of SuperFIT on overall PA outcomes for the three study groups. All groups improved in the PA outcomes at the follow-up measurements. Significant within-group differences were seen between baseline and the final follow-up measurement in all groups. Only light PA was borderline significant (p = 0.051) in the full intervention group. At the first follow-up, the full intervention improved more on SB and MVPA compared to the control group. The partial intervention group improved more on MVPA compared to the control group. However, the effect sizes were small or very small and not significant. For the remaining outcomes, the control group improved more than both the full intervention and partial intervention group. These effect sizes were also small or very small and not significant. The sensitivity analyses showed different results, but comparable conclusions (supplementary material, Table S5.1). Effect sizes were small or very small, and no significant differences were found.

Table 5.3. Effects of SuperFIT on physical activity outcomes on preschool days for each study group.

PA outcome		Full Intervention *		Partial Intervention *		Control		Full vs. Control			Partial vs. Control		
		N	Mean ± SD **	N	Mean ± SD **	N	Mean ± SD **	B [a] (95% CI)	P	ES	B [a] (95% CI)	P	ES
SB (%)	T0	33	82.61 ± 5.44	41	81.57 ± 5.96	63	81.69 ± 5.50						
	T1	18	79.34 ± 6.34 [$]	26	82.13 ± 4.62	46	81.83 ± 4.62	−3.99 (−7.11; −0.87)	0.01	−0.62	0.78 (−1.97; 3.53)	0.57	0.07
	T2	7	80.31 ± 3.90 [$]	11	79.85 ± 6.55 [$]	24	79.13 ± 4.94 [$]	0.19 (−4.12; 4.50)	0.93	0.05	0.94 (−2.61; 4.50)	0.59	0.15
LPA (%)	T0	33	9.08 ± 2.10	41	9.45 ± 2.42	63	9.07 ± 2.33						
	T1	18	9.53 ± 2.27	26	9.24 ± 2.00	46	9.17 ± 1.97	0.38 (−0.90; 1.66)	0.56	0.16	−0.42 (−1.56; 0.72)	0.47	−0.13
	T2	7	10.81 ± 1.67 [$]	11	9.72 ± 2.98 [$]	24	10.47 ± 2.57 [$]	0.38 (−1.82; 2.58)	0.73	0.15	−1.11 (−3.00; 0.76)	0.24	−0.48
MVPA (%)	T0	33	8.31 ± 3.57	41	8.98 ± 3.79	63	9.24 ± 3.60						
	T1	18	11.13 ± 4.54 [$]	26	8.63 ± 2.95	46	9.00 ± 3.11	3.47 (1.39; 5.55)	0.00	0.85	-0.44 (−2.27; 1.39)	0.63	−0.03
	T2	7	8.89 ± 2.56 [$]	11	10.43 ± 4.23 [$]	24	10.40 ± 3.09 [$]	−0.26 (−2.78; 2.25)	0.83	−0.16	-0.09 (−2.18; 1.99)	0.93	0.08
CPM	T0	33	1095.55 ± 315.17	41	1113.27 ± 274.91	63	1135.15 ± 296.62						
	T1	18	1197.48 ± 356.17	26	1095.27 ± 216.55	46	1100.77 ± 242.51	170.94 (8.86; 333.01)	0.04	0.45	−11.68 (−154.77; 131.41)	0.87	0.06
	T2	7	1230.54 ± 158.07 [$]	11	1217.36 ± 361.45 [$]	24	1281.17 ± 260.20 [$]	24.01 (−218.55; 266.58)	0.84	−0.04	−69.05 (−268.17; 130.07	0.49	−0.15

*Full intervention = exposed to both preschool-based and family-based component, partial intervention = exposed to only preschool-based component **Observed scores for each measurement [a]Linear mixed-model analysis, based on imputed estimated means, corrected for baseline, child age, child gender, and weather (temperature, precipitation, and sunshine), [$]Significantly different from baseline score, analysed with paired t-tests. CI = confidence interval, CPM = counts per minute, ES = effect size, LPA = light physical activity, MVPA = moderate-to-vigorous physical activity, SB = sedentary behaviour, SD = standard deviation.

Table 5.4. Effects of SuperFIT on overall physical activity for each study group.

PA outcome		Full Intervention *		Partial Intervention *		Control		Full vs. Control			Partial vs. Control		
		N	Mean ± SD **	N	Mean ± SD **	N	Mean ± SD **	B [a] (95% CI)	P	ES	B [a] (95% CI)	P	ES
SB (%)	T0	33	81.95 ± 5.30	41	81.34 ± 4.53	69	81.76 ± 5.58						
	T1	29	80.14 ± 6.39	31	80.00 ± 4.16	69	80.31 ± 5.31	0.65 (−1.66; 2.95)	0.58	−0.07	0.63 (−1.57; 2.83)	0.57	0.02
	T2	24	78.64 ± 4.20 [$]	31	78.64 ± 4.59 [$]	65	77.32 ± 5.42 [$]	1.64 (−0.51; 3.79)	0.14	0.21	1.34 (−0.59; 3.27)	0.17	0.33
LPA (%)	T0	33	9.42 ± 2.04	41	9.80 ± 1.91	69	9.14 ± 2.25						
	T1	29	9.41 ± 2.49	31	9.96 ± 1.71	69	9.60 ± 2.13	−0.73 (−1.76; 0.30)	0.17	−0.22	−0.40 (−1.39; 0.59)	0.42	−0.14
	T2	24	10.50 ± 1.56	31	10.40 ± 2.23 [$]	65	10.66 ± 1.73 [$]	−0.66 (−1.61; 0.29)	0.17	0.01	−0.74 (−1.60; 0.12)	0.09	−0.22
MVPA (%)	T0	33	8.63 ± 3.46	41	8.86 ± 2.90	69	9.10 ± 3.71						
	T1	29	10.45 ± 4.20	31	10.05 ± 2.72	69	10.09 ± 3.56	0.17 (−1.28; 1.62)	0.82	0.23	−0.17 (−1.55; 1.21)	0.81	0.06
	T2	24	10.86 ± 3.67 [$]	31	10.96 ± 2.94 [$]	65	12.02 ± 4.22 [$]	−0.81 (−2.27; 0.65)	0.27	−0.19	−0.65 (−1.96; 0.66)	0.33	−0.24
CPM	T0	33	1111.23 ± 271.86	41	1138.15 ± 230.96	69	1132.32 ± 313.80						
	T1	29	1143.83 ± 348.79	31	1189.96 ± 201.46	69	1172.41 ± 284.56	−68.84 (−194.65; 56.99)	0.28	−0.02	−29.92 (−149.85; 90.02)	0.62	0.04
	T2	24	1300.09 ± 248.31 [$]	31	1297.31 ± 241.94 [$]	65	1383.19 ± 328.47 [$]	−95.96 (−225.88; 33.95)	0.15	−0.21	−81.14 (−197.96; 35.67)	0.17	−0.32

* Full intervention = exposed to both preschool-based and family-based component, partial intervention = exposed to only preschool-based component ** Observed scores for each measurement [a] Linear mixed-model analysis, based on imputed estimated means, corrected for baseline, child age, child gender, and weather (temperature, precipitation, and sunshine) [$] Significantly different from baseline score, analysed with paired t-tests. CI = confidence interval, CPM = counts per minute, ES = effect size, LPA = light physical activity, MVPA = moderate-to-vigorous physical activity, SB = sedentary behaviour, SD = standard deviation.

Effects on BMI Z-Score

No significant differences in BMI z-score were seen, with very small effect sizes between the full intervention and control group at the first follow-up (observed mean ± SD 0.20 ± 0.98 and 0.13 ± 1.00 resp.; B = −0.09, 95% CI −0.31; 0.13, p = 0.44, ES −0.09) and the final follow-up (observed mean ± SD 0.28 ± 0.90 and 0.08 ± 0.94 resp.; B = 0.00, 95% CI −0.25; 0.25, p = 0.99 ES 0.01). In addition, no significant differences were seen between the partial intervention and control group on BMI z-score at the first follow-up (observed mean ± SD 0.20 ± 0.81 and 0.13 ± 1.00 resp.; B = 0.05, 95% CI −0.17; 0.26, p = 0.66, ES 0.06) and the final follow-up (observed mean ± SD −0.01 ± 0.77 and 0.08 ± 0.90 resp.; B = −0.13, 95% CI −0.38; 0.11, p = 0.28, ES −0.14). Effect sizes were also very small. BMI z-score within the partial intervention group improved significantly between baseline and final follow-up measurement (p = 0.019). Sensitivity analysis showed similar results and conclusions (Supplementary material, Table S5.2).

Discussion

The aim of this study was to evaluate the effectiveness of SuperFIT on child PA and BMI z-scores. Observation data showed that time spent active (inside and outside) in the preschool setting increased during implementation, while time spent sedentary decreased. For PA on preschool days, significant differences were seen on SB, MVPA and CPM between the full intervention group and the control group at the first follow-up. No significant differences were seen between the partial intervention group and the control group, although the partial intervention group improved more on MVPA at the final follow-up. With regard to overall PA, all study groups improved significantly between baseline and final follow-up. Both intervention groups showed a greater improvement on MVPA at the first follow-up than the control group. The full intervention also improved more on SB at the first follow-up compared to the control group. However, these were small or very small effects, and there were no significant differences between the groups. For BMI z-score, no significant changes were seen between both intervention groups and the control group. The partial intervention group showed a significant decrease in BMI z-score between baseline and final follow-up. No significant changes in BMI z-score over time were seen in the full intervention group.

This limited effectiveness of SuperFIT may be explained by the long causal chain between the intervention and the outcomes assessed. The intervention aimed to change the sociocultural (i.e., the behaviour of intermediaries) and the physical environment at home and in the ECE setting. It was hypothesized that these changes would lead to changes in child behaviour, which would eventually lead to changes in BMI z-score. It may be that the changes caused by SuperFIT were not substantial enough or the follow-up time was not long enough to result in effects going up the causal chain. It would be interesting to look

at the effect of SuperFIT on the intermediate outcomes (e.g., teacher practices), which are closer to the intervention activities. Nonetheless, the observations showed that changes in daily activities occurred at the preschools. A reason why this was only reflected to a limited extent in overall PA outcomes could be that activity time in childcare may be compensated by increased sedentary time at home [69]. The small differences in activity time at the preschools may therefore not be enough to overcome such potential compensation. This may explain, in particular, the lack of effects in the partial intervention group. Although a clear beneficial relationship between PA and health outcomes is established, it remains uncertain what duration of PA is necessary to cause these health benefits, especially in young children, even though more PA may exert greater health benefits [15]. As a result of this lack of evidence, the Netherlands has not yet adopted a PA guideline for children under the age of four [235]. Therefore, it is also difficult to formulate recommendations on the minimum amount of physical activity that should be provided in both the ECE and home settings.

The limited effects found for SuperFIT reflect the outcomes in comparable studies [107, 123]. In general, the results of other interventions on PA outcomes have been mixed: some studies showed effects [124, 125], while others showed no effect [105]. In our study, the full intervention seemed to be beneficial for PA on preschool days. This may imply that children benefit more from changes in the preschool setting if there are also changes in the home setting. This underlines the importance of including a family component in preschool-based interventions, which has been suggested previously [99]. This supports the hypothesized synergistic effects of aligning both settings to be more health supportive, although this only occurred in the preschool setting [48]. For all groups, a within-group change of PA was seen. This may be explained by the natural development of PA throughout childhood, with PA levels generally rising until the age of five and then starting to decline [26, 27].

Studies have shown the importance of determinants in different types of environments on physical activity and sedentary behaviour [75, 133, 236]. Systematic reviews have also stressed the importance of integrated interventions, i.e., combining the physical and sociocultural environment [101, 237]. The integrated approach taken in SuperFIT, in which these different types of environments were taken into account was expected to be supportive for intervention effectiveness. The strategies that were implemented to change the different environments were evidence-based [72, 199, 200, 203]. In addition, a review has shown that environmental changes are most effective to stimulate pre-schoolers physical activity [224]. Due to the comprehensive, integrated approach of SuperFIT, it is difficult to identify which elements supported effectiveness. To increase our understanding, separate evaluations will be performed to study the effects of SuperFIT on the physical and social environment.

Only a few comparable interventions have been shown to be effective on weight-related outcomes [117, 119, 122, 126]. It appears unlikely to find changes (especially significant

ones) in weight-related outcomes within the relatively short follow-up periods usually applied in intervention studies. The small effect sizes found in this study, although not consistent over time, are comparable to ones mostly found in preschool-based or school-based interventions [80, 98, 238]. These small effects may be relevant, in particular, if they are sustained in the long-term as they can prevent overweight and obesity in adulthood [98]. Longer follow-up periods may be needed to be able to show effects on weight-related outcomes. Effectiveness studies are usually performed within time-limited projects; there are practical impossibilities to performing long-term follow-up measurements. Long-term (cohort) follow-up may also have practical constraints, such as participant burden and the transition of children from preschool to primary school, greatly affecting its feasibility. Researchers might have to critically consider whether weight-related outcomes should be included in relatively short-term effectiveness studies.

Strengths and Limitations

One strength of the current study is the comprehensive, integrated intervention approach, taking into account the complexity of childhood overweight and obesity. Therefore, children who may be at the highest risk for unhealthy lifestyles were exposed to the potential benefits of SuperFIT, as it was implemented in low-SES communities [186]. Other strengths included the objective assessment of BMI and PA outcomes. Changes in the preschool activities were assessed by observation and therefore evaluated more objectively compared to self-reporting. In addition, a long-term follow-up of approximately one and one-and-a-half years was used to evaluate effectiveness.

The methodology used may have some limitations. Not all participants adhered sufficiently to the accelerometer-wearing protocol to be included in the analyses (13.4% baseline, 12.2% first follow-up, and 9.1% final follow-up). Hip-worn accelerometers may overestimate sedentary behaviour, as they do not measure posture and, for example, classify standing as sedentary [26]. Other methodological limitations may be that no blinding could be employed due to the nature of the study and its measurements. This may have induced reactivity to the measurements, for example increased physical activity because of the awareness of wearing the accelerometer, which may partially explain the changes seen in the control group.

In addition, it is possible that similar interventions were carried out in the control group. A large, national, community-based approach was also being implemented in the control group [141]. Although the projects were predominantly aimed at primary schools, it is likely that spill-over occurred as most preschools are situated inside the buildings of primary schools. The participating children may have had older school-going brothers or sisters who may have contributed to this spill-over. However, evaluation studies in real-life settings are important to determine intervention effectiveness, including all influential factors present

in the real world, and decrease the gap in effects between efficacy and effectiveness studies [239].

Lastly, the sample size in this study was limited and, therefore, there was a lack of power to detect significant differences as the effect sizes were predominantly small or very small. To increase the power, analyses were performed comparing the complete intervention group with the control group. These analyses showed similar results and conclusions (data not shown).

Conclusion

Compared to the control group, no differences were detected between the groups to support the effectiveness of SuperFIT on weekly physical activity and weight. SuperFIT may nevertheless ultimately induce changes in the preschool setting regarding physical activity and sedentary behaviour. The combination of the preschool setting and home setting appears to be beneficial for improving the children's physical activity on preschool days. However, these effects are predominantly small and are not yet associated with changes in the BMI z-score.

Table S5.1. Sensitivity analysis of the effects of SuperFIT on physical activity using only cases with data on all measurements.

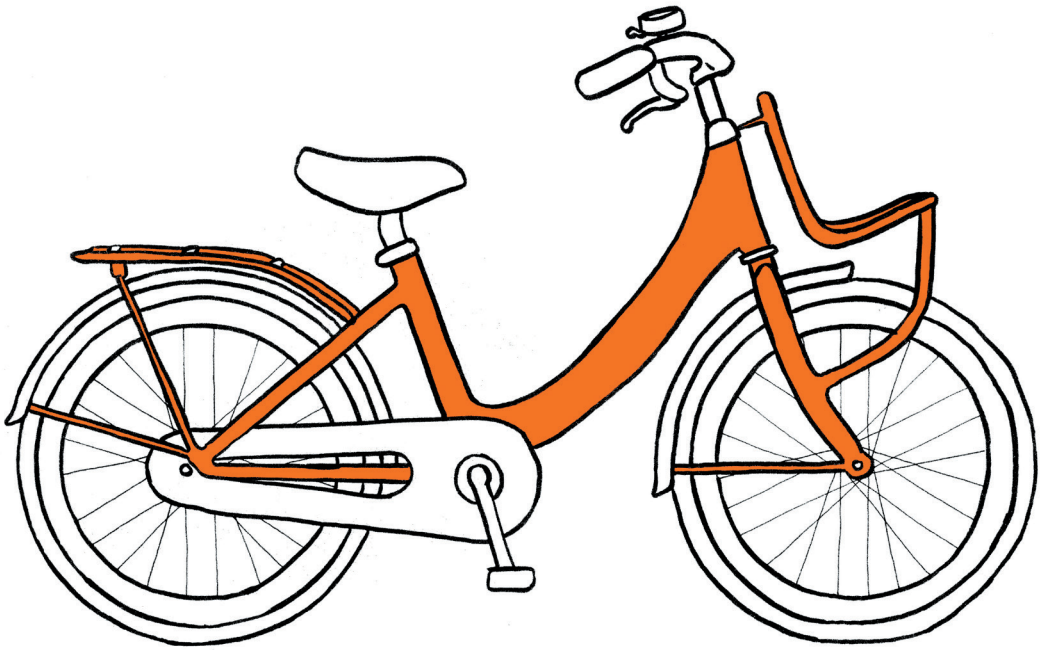
		Full intervention (N=17)*	Partial intervention (N=21)*	Control (N=43)	Full vs. control			Partial vs. control		
		Mean ±SD**	Mean ±SD**	Mean ±SD**	B[a] (95%CI)	P	ES	B[a] (95%CI)	P	ES
SB (%)	T0	81.39 ±5.42	81.15 ±3.74	81.09 ±5.98						
	T1	79.00 ±2.09	80.73 ±3.45	80.25 ±5.23	-1.54 (-3.93; 0.85)	0.21	-0.31	0.43 (-1.79; 2.65)	0.70	0.10
	T2	77.96 ±5.08[$]	77.64 ±4.27[$]	77.27 ±5.46[$]	0.40 (-2.08; 2.87)	0.75	0.08	0.33 (-1.97; 2.63)	0.76	0.07
LPA (%)	T0	9.65 ±2.06	10.03 ±1.32	9.31 ±2.43						
	T1	10.00 ±2.09	9.50 ±1.24	9.60 ±2.01	0.07 (-1.00; 1.14)	0.90	0.03	-0.82 (-1.81; 0.18)	0.11	-0.40
	T2	10.49 ±1.71	11.03 ±1.67[$]	10.62 ±1.70[$]	-0.46 (-1.58; 0.65)	0.41	-0.23	-0.31 (-1.34; 0.73)	0.56	-0.15
MVPA (%)	T0	8.97 ±3.51	8.82 ±2.66	9.59 ±3.96						
	T1	10.99 ±4.42[$]	9.77 ±2.43[$]	10.15 ±2.01	1.08 (-0.52; 2.69)	0,18	0.33	0.10 (-1.38; 1.58)	0.90	0.03
	T2	11.55 ±3.68[$]	11.31 ±3.17[$]	12.11 ±4.20[$]	-0.24 (-1.91; 1.43)	0.78	-0.07	-0.22 (-1.76; 1.32)	0.78	-0.07
CPM	T0	1111.35 ±284.12	1162.07 ±185.85	1169.62 ±329.18						
	T1	1206.63 ±321.45	1152.29 ±167.56	1190.83 ±279.39	74.07 (-52.83; 200.98)	0.25	0.28	-30.98 (-148.91; 86.94)	0.60	-0.12
	T2	1330.08 ±250.98[$]	1367.82 ±199.44[$]	1404.42 ±340.71[$]	-16.07 (-170.72; 138.58)	0.85	-0.17	-29.05 (-172.76; 114.66)	0.69	-0.11

*Full intervention= exposed to both preschool-based and family-based component, partial intervention= exposed to only preschool-based component **Observed scores [a]Linear mixed model analysis corrected for baseline, child age, child gender and weather (temperature, precipitation and sunshine) [$]Significantly different from baseline score, analysed with paired t-tests. CI= confidence interval, CPM= counts per minute, ES= effect size, LPA= light physical activity, MVPA= moderate-to-vigorous physical activity, SB= sedentary behaviour, SD= standard deviation.

Table S5.2. Sensitivity analysis of the effects of SuperFIT on BMI z-score including only cases with data on all measurements.

		Full intervention* (N=27)	Partial intervention* (N=26)	Control (N=58)	Full vs. control			Partial vs. control		
		Mean±SD**	Mean±SD**	Mean±SD**	B[a] (95%CI)[a]	P	ES	B[a] (95%CI)[a]	P	ES
BMI z-score	T0	0.34±1.06	0.19±0.86	0.19±1.03						
	T1	0.26±1.00	0.22±0.76	0.23±1.03	-0.11 (-0.37; 0.14)	0.37	-0.12	-0.00 (-0.26; 0.25)	0.99	0.00
	T2	0.26±0.90	-0.04±0.73[$]	0.17±0.92	-0.06 (-0.35; 0.22)	0.67	-0.06	-0.21 (-0.50; 0.08)	0.15	-0.22

*Full intervention= exposed to both preschool-based and family-based component, partial intervention= exposed to only preschool-based component **Observed scores aLinear mixed model analysis corrected for baseline, parental BMI, parental education and parental country of birth [$]Significantly different from baseline score, analysed with paired t-tests. BMI= body mass index, CI= confidence interval, ES= effect size, SD= standard deviation.



Chapter 6

Changing the preschool setting to promote healthy energy balance-related behaviours of pre-schoolers: a process and impact evaluation of the SuperFIT approach

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Based on:
Changing the preschool setting to promote healthy energy balance-related behaviours of pre-schoolers: a process and impact evaluation of the SuperFIT approach. Submitted

Abstract

Background:

The Early Care and Education (ECE) setting has an important role in the promotion of healthy lifestyle in young children. SuperFIT is a comprehensive, integrated intervention approach to promote healthy energy balance-related behaviours in pre-schoolers. Insight in the process of implementation and the context in which SuperFIT was implemented supports the understanding of the effectiveness of the intervention. This process evaluation studied factors that influenced the implementation and maintenance, as well as the (perceived) impact of SuperFIT in the ECE setting.

Methods:

A mixed-methods study was conducted. SuperFIT was implemented at twelve preschools in the south of the Netherlands. The process evaluation was performed among preschool teachers, managers of the preschool organization and implementers. Semi-structured in-depth interviews, quantitative process questionnaires, the Child-care Food and Activity Practices Questionnaire (CFAPQ) and observations were used to evaluate the implementation, maintenance, and impact of SuperFIT. The interviews were analysed using a theoretical framework based on the Implementation Framework and the Consolidated Framework for Implementation Research. Descriptive analyses were performed on the quantitative data.

Results:

Various SuperFIT activities were implemented in the preschool setting. Although, the intention to maintain SuperFIT was present, this was hindered by time and financial resources. Important factors that influenced implementation and maintenance were (in)congruence with current practice, limited perceived capabilities to integrate SuperFIT in daily practice, group composition, and the perceived top-down implementation. Organizational vision and societal attention towards healthy behaviour in general were perceived supportive for implementation and maintenance. Predominantly favourable changes were seen in the nutrition and physical activity-related practices and other aspects of the social environment. Limited changes were seen in the physical environment.

Conclusions:

Several factors influenced the implementation and maintenance of SuperFIT in the ECE setting. Some factors evolved over time from hindering to facilitating, emphasizing the importance of sufficient duration for intervention implementation. SuperFIT impacted mainly the social environment. A comprehensive approach was believed to be indispensable in order to change pre-schoolers energy balance-related behaviours.

Background

The Early Care and Education (ECE) setting has been recognized as an important setting to promote healthy energy balance-related behaviours (EBRB) in young children [13, 240]. Several aspects of the ECE setting can influence children's behaviour. Firstly, the use of supportive nutrition and physical activity (PA)-related practices by ECE staff may promote healthy EBRB in children [75, 241]. Secondly, the availability of (outdoor) play spaces and a variety of play materials may support children's PA [72, 242-244]. Thirdly, the availability of healthy food products, can support children's healthy dietary intake [76]. Lastly, policies in the ECE setting can support changes or activities within the ECE setting to promote healthy EBRB [125, 245]. In line with this, childcare use has been linked, both positively and negatively, to children's EBRB and consequently to childhood overweight and obesity [62, 65, 66, 246].

The past years, an increasing number of interventions in the ECE setting have been developed and evaluated (e.g., [201, 247-249]). Review studies of such interventions show their potential in changing young children's behaviour, although the available evidence is often limited [79, 99, 237, 240]. Taking a comprehensive approach (e.g., including a parental component within ECE-based interventions) has been recognized as important for the effectiveness of these interventions [99, 100, 237].

SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial) is a comprehensive, integrated intervention approach in the Netherlands [225]. SuperFIT aims to improve children's EBRB, through changes in the sociocultural (i.e., PA and nutrition-related practices), physical (i.e., availability of play materials and healthy food products), and political (i.e., nutrition and PA-related policies) environment in both the preschool and home settings. An effect evaluation study of SuperFIT showed no significant differences between the intervention groups and control group on BMI z-score and overall PA [250]. However, pre-schoolers who participated in the full intervention (preschool and family component) showed significant positive differences with the control group in PA on preschools days, supporting the need for a comprehensive intervention approach [250]. An effect evaluation study on nutrition related outcomes is currently in progress [87].

Insight in the processes that influence implementation may elucidate why interventions fail or succeed in changing behaviour [185]. Traditionally, process evaluations have focused on (relatively objective) measurable determinants, such as program reach, fidelity, and dose delivered/received [185]. Several frameworks explaining implementation processes are available [185, 251, 252]. Recently, attention has been given to the role of context in intervention implementation [43]. More emphasis is put on the unique characteristics of the implementation setting, for example preschools, and how the setting functions as a complex

system [43, 217]. Hereby, intervention implementation gets another dimension: to what extent was the intervention able to interact with the context of the system and able to 'saturate' the context of this specific setting [43]? A combination of quantitative and qualitative research methods is needed to provide insight in both the determinants for implementation as well as the interaction of the intervention with its context [215]. Few (published) process evaluations of interventions in the ECE setting are currently available, and these tend to focus on reporting of quantitative implementation measures (i.e., dose delivered, fidelity etc.), with limited attention for factors influencing these processes [247, 253-256]. Some factors influencing implementation negatively were, for example, lack of time, lack of support from the staff, interference with daily schedules, and low parental engagement [253, 256]. Support from the intervention provider was identified as a supportive factor for implementation [255, 256]. High implementation quality is important, as negative intervention effects compared to the control group have previously been shown for children in kindergartens with low quality implementation (i.e., low dose delivered/received, or satisfaction) [247]. Negative intervention effects were not shown with medium and high quality implementation [247]. This indicates that poor implementation may do more harm than good. Insight in the factors that influenced implementation of the SuperFIT approach is pivotal. The current study presents the process evaluation of the SuperFIT approach, specifically within the ECE setting. Several research questions will be addressed: 1) How was SuperFIT implemented and maintained in the ECE setting and how was this received by actors within this setting? 2) Which factors influenced implementation and maintenance? 3) What was the (perceived) impact of SuperFIT in the ECE setting?

Methods

Research design

A mixed-methods design was adopted, using both qualitative and quantitative research methods. This process evaluation is part of a larger evaluation study, which has been described in detail elsewhere [225] and was prospectively registered (Clinicaltrials.gov, NCT03021980). The current study focused specifically on the implementation and maintenance processes within the preschool setting.

The SuperFIT approach

The SuperFIT approach has been described in detail elsewhere [225]. However, a short description will be given here. SuperFIT was developed using socio-ecological models and systems theory on behaviour as a theoretical background [47, 48, 86]. SuperFIT was developed in cooperation of a local PA-providing organization, a preschool organization and health promotion experts. A continuous process of co-creation and adaptation was adopted to ensure intervention fit with the ECE setting. The SuperFIT approach consisted of three

components: a preschool-based component, family-based component, and community-based component.

Intervention strategies in the preschool-based component aimed to change the sociocultural, physical and political environment as defined in the ANGELO-framework [42]. Strategies to change the sociocultural environment focused on changing the PA and nutrition-related practices of the preschool teachers. Several off-the-job training sessions addressing PA, nutrition and positive child rearing were organized. Each off-the-job training session was accompanied by coaching on-the-job by a PA or nutrition coach to assist implementation in the workplace. PA and nutrition cards were developed, containing easy-to-perform PA activities or nutrition-related activities. To change the physical environment, a box with play materials to support active play (e.g., hoops, balls, beanbags, and trampoline) and nutrition-related materials (e.g., water tap, nutrition-related story books, and fruit and vegetables (F&V) toys) was provided. The materials were matched to the PA and nutrition cards, ensuring that all preschool teachers would have the materials needed to perform the activities on the cards. In addition, PA and nutrition-related materials matching specific needs of each preschool were provided. A complementary F&V delivery was done to increase the variety in the availability of fruits and vegetables with less common fruits and vegetables for the children (e.g., cherries, raspberries, beetroot, and radish). These complementary F&V were available every day, and the sort delivered was consistent for two weeks to ensure repeated exposure. In order to change the political environment, strategies aimed to update the nutrition policy (on provision of water instead of sugar-sweetened drinks and healthy treats) and develop a PA policy (including recommendations on time spent active and safe play) were initiated.

Further, SuperFIT included a family-based component (a combination of family sessions and caregiver-only sessions) and a community-based component (development and distribution of a social map of PA possibilities) component. They are, however, not the focus of the current paper.

Study setting and participants

SuperFIT was implemented at a convenience sample of twelve preschools from one preschool organisation in the south of the Netherlands. The preschools were all located in low socio-economic communities [204]. In the Netherlands, preschool consists of half-day, formal childcare in which children age 2-4-years-old are playfully prepared for primary school [155]. Parents can receive a general benefit from the Dutch government for formal childcare, depending on their working hours and income [156]. In addition, at the time of selection of preschools, children with mild developmental delays (e.g., language or socio-emotional) could be referred to preschools at low costs, to follow a specific program to alleviate these delays [197]. Therefore, preschools often reach a broader group of children

compared to day-care centres. The process evaluation was performed among preschool teachers, management of the preschool organization and implementers that were involved in the preschool-based component. Implementers were health brokers from the PA-providing organization, who provided the off-the-job training sessions and on-the-job coaching sessions. All participants provided (verbal) informed consent before participating in the study. The Maastricht University Medical Centre, Medical Ethics Committee reviewed and approved the evaluation study of SuperFIT (METC163022/NL58061.068.16).

Data collection

Both quantitative and qualitative measurements were conducted for this process evaluation. Data collection was performed between January 2017 and November 2018 on several occasions during the implementation and maintenance process. A timeline of the implementation and evaluation of SuperFIT is provided in Figure 6.1.

Interviews

Semi-structured in-depth interviews were performed to gain insight in the factors affecting implementation and maintenance. Two researchers performed the interviews. During the initial phase of implementation (June/July 2017), interviews were performed with preschool teachers and implementers. These interviews focused on development and implementation and partly served as input for the interventions activities that were still to come. At the end of the implementation phase (February/March 2018), in-depth interviews with preschool teachers were performed to evaluate the implementation process of SuperFIT. After the implementation phase (October/November 2018), interviews were performed with preschool teachers, managers of the preschool organisation (these included both general and unit management) and implementers to evaluate the maintenance of SuperFIT. For each round of interviews, topic lists were developed. Topics included for example strengths and weaknesses of SuperFIT, the perceived role of the interviewee in nutrition and physical activity in preschools, and the perceived change in the preschool setting. All interviews were held in Dutch and audio-recorded (Olympus VN-2100 PC, digital voice recorder). The participants provided verbal consent before the start of the interview.

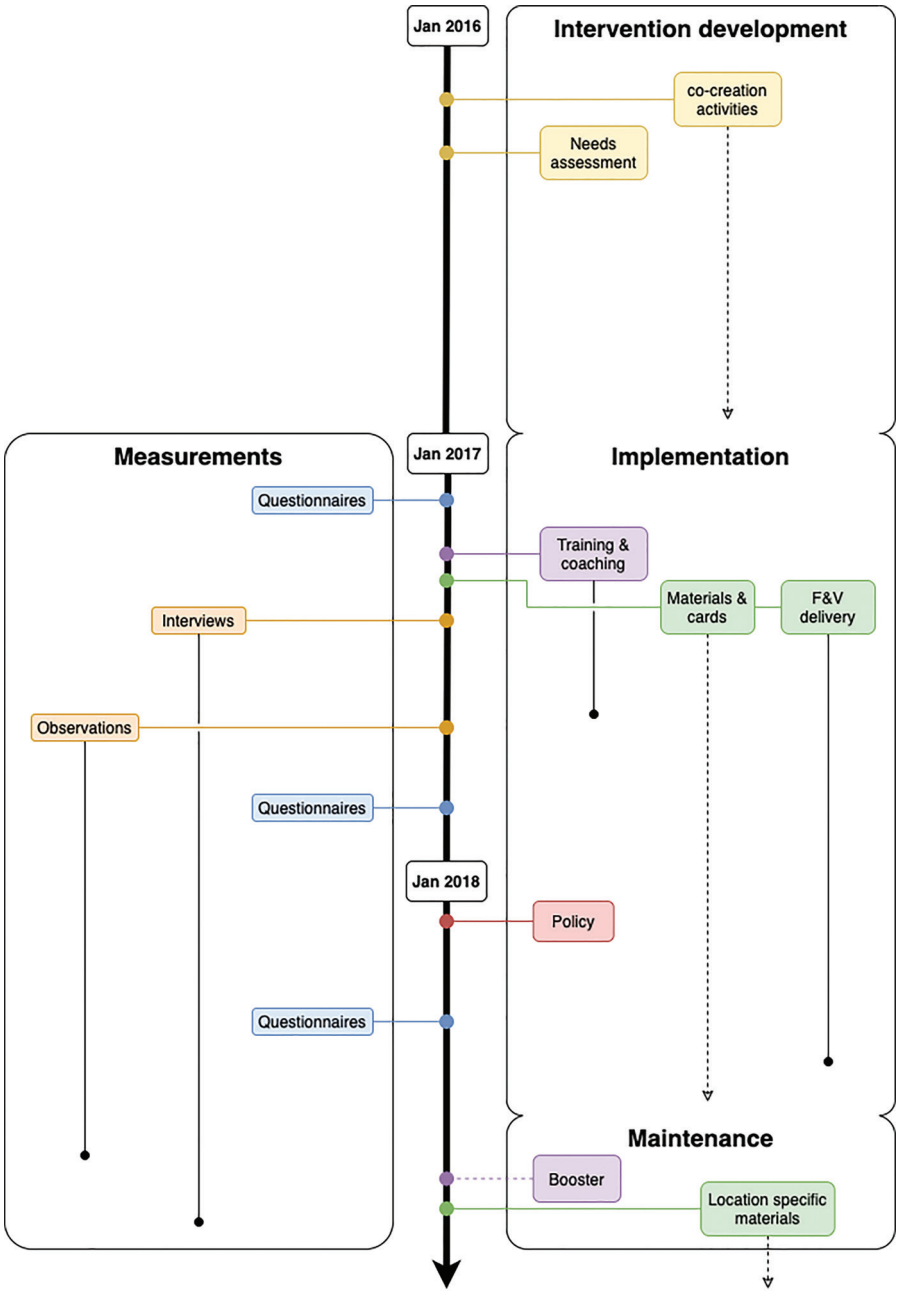


Figure 6.1. Timeline of the implementation of the preschool component of SuperFIT and the measurements of the process evaluation. Yellow= activities for the development of SuperFIT, purple= intervention activities aimed at the sociocultural environment, green= intervention activities aimed at the physical environment, red= intervention activities aimed at the political environment, blue= quantitative process measurements, orange= qualitative process measurements.

——● Indicates duration of an activity.

- - - -> Indicates continuous activities or availability

Questionnaires

The Child-care Food and Activity Practices Questionnaire (CFAPQ) was used to measure preschool teachers' use of nutrition and PA-related practices [206]. The CFAPQ was filled out by preschool teachers before the start of the implementation, once during and once after implementation. The CFAPQ was adjusted to fit the Dutch preschool setting. Some items were omitted because they were not applicable for the preschool setting. In addition, for some items the examples provided were adjusted to better fit the preschool setting. Items to measure the PA-related practices were, for example, *'How often do you play a sport or active game together with the children?'* or *'How often do you teach the children that being active is good for their health?'*. Items to measure the nutrition-related practices were, for example, *'I model healthy eating for the children by eating healthy foods myself'* or *'How often do you give a child something to eat or drink if s/he is upset, even if you s/he is not hungry?'*. All items were measured on a 5-point Likert scale. For some items the scale ranged from never to always and for some items the scale ranged from totally disagree to totally agree. Scale reliability was tested using Cronbach's alpha, according to the scales provided by the CFAPQ. A Cronbach's alpha of >0.50, although moderately low, was considered reliable [257]. The Cronbach's alpha of the scales ranged between 0.52 and 0.84. Items were deleted from the scales to reach reliability. Unreliable scales and deleted items were analysed as single items.

Preschool teachers were asked to fill out a quantitative questionnaire regarding implementation (November/December 2017) and maintenance (May/June 2018) of SuperFIT. The questionnaire regarding implementation was based on the Client Satisfaction Questionnaire [258] and included questions such as *'Did you find SuperFIT instructive?'* or *'How would you grade SuperFIT on a scale from 0-10?'*. In addition, specific questions on each intervention activity were asked. Factors influencing maintenance were measured with the Measurement Instrument for Determinants of Innovations (MIDI) adapted to fit the SuperFIT context [259].

Observations

Observations at the preschools were performed by trained researchers using an adjusted version of the Environmental and Policy Assessment and Observation instrument (EPAO) to assess the social preschool environment [211]. The parts that were applicable for the Dutch preschool setting were incorporated (e.g., pre-break inside play, break, and post-break outside play). Observations were performed on group-level, focused on preschool teachers' behaviour and did not involve observation of behaviour of individual children. Preschool teachers' behaviour was observed using questions such as 'Do the preschool staff take part in outside play activities?' or 'Do the preschool staff talk to the children about healthy nutrition?'. In addition, questions related to the implementation of SuperFIT were incorporated to assess integration of SuperFIT within the daily activities of the preschool

staff. Questions were, for example, 'Were fruit and/or vegetables from the delivery divided among all children?' or 'Did the preschool staff use materials from the general material box? If yes, which?' Observations were performed by the same researcher twice during implementation and once after implementation in a random selection of the participating preschools. Nine preschools were observed, of which one preschool had two groups who were both observed. The sample of preschools remained consistent over the three measurements. Items reflecting non-supportive preschool staff behaviour were recoded and sum scores reflecting a supportive social environment for various activities (e.g., outside play, inside play and snack time) were assessed.

In order to assess the physical preschool environment, separate observations were performed by a trained researcher or research assistant. The parts of the EPAO considering the physical environment were used [211], assessing, for example, inside play space, outside play space, the availability of fixed and portable play materials (inside and outside), and the presence of screens. The observations of the physical environment were performed once before implementation, once during and once after implementation. Where appropriate, sum scores were calculated to aggregate different questions into a summary variable, for example, total score of available portable play materials or total number of natural elements in the outdoor play area.

Analyses

Qualitative data

All interviews were transcribed verbatim. A second researcher was consulted when words or phrases were unclear. All transcripts were anonymised by removing names and locations. To develop the coding tree, two researchers (IK and AV) independently analysed 19% (6 of 32) of the interviews. Several consensus meetings were held to develop a final coding tree. The basis for the coding tree was the Implementation Framework of Fleuren et al. [252]. This framework was extended with the Consolidated Framework For Implementation Research (CFIR) to better reflect the contextual factors that influenced implementation and maintenance [251]. The main categories 'characteristics of the intervention' and 'characteristics of the user' from Fleuren et al. [252] were combined with the context-related factors 'the inner and outer setting' from Damschröder et al. [251] (Figure 6.2). As this process evaluation focused on the preschool setting, the innovation was regarded the preschool component of SuperFIT. The user considered the preschool teacher. The inner setting involved direct contextual factors for example, characteristics of the preschool organization, the preschool itself and the children attending the preschool. The outer setting includes the broader context, such as societal influences. Codes were extended with determinants from other implementation theories fitting the overall categories, following an abductive analysis strategy [260]. Codes used were, for example, "complexity" or "relevance" (characteristics

of the innovation), "self-efficacy" or "perceived advantages" (characteristics of the user), "formal reinforcement" or "time" (inner setting), and "society" or "cooperation with external parties" (outer setting). In addition, an "implementation" and "maintenance" code were used to code descriptions of what actually happened during these processes. Maintenance started after ending of the last SuperFIT activity (F&V delivery, May 2018). One of both researchers (IK and AV) then analysed the remainder of the interviews. After analysis of all interviews, a final meeting between the researchers was held to discuss any difficulties that arose during analysis. NVivo 12.0 (QSR International, Doncaster, Victoria, Australia) was used to support data analysis.

Quantitative data

The quantitative data (from questionnaires and observations) were entered and cleaned before analysis. The scores on the CFAPQ of preschool teachers from the same preschool were aggregated to achieve a preschool-level score. Descriptive analyses were performed per measurement time point. As the evaluations were performed on preschool level, the sample size (N=12) was not sufficient to allow for further statistical testing. Observed changes were quantified by calculating Cohen's d effect sizes: dividing the difference between the mean at follow-up and the baseline mean by the baseline standard deviation. Lipsey's cut-offs were used to define the effect sizes as small, moderate or large [261]. Descriptive analyses per measurement time point were used to describe the results of the observations. Analyses were performed using SPSS Version 25.0 (IBM, Armonk, NY, USA).

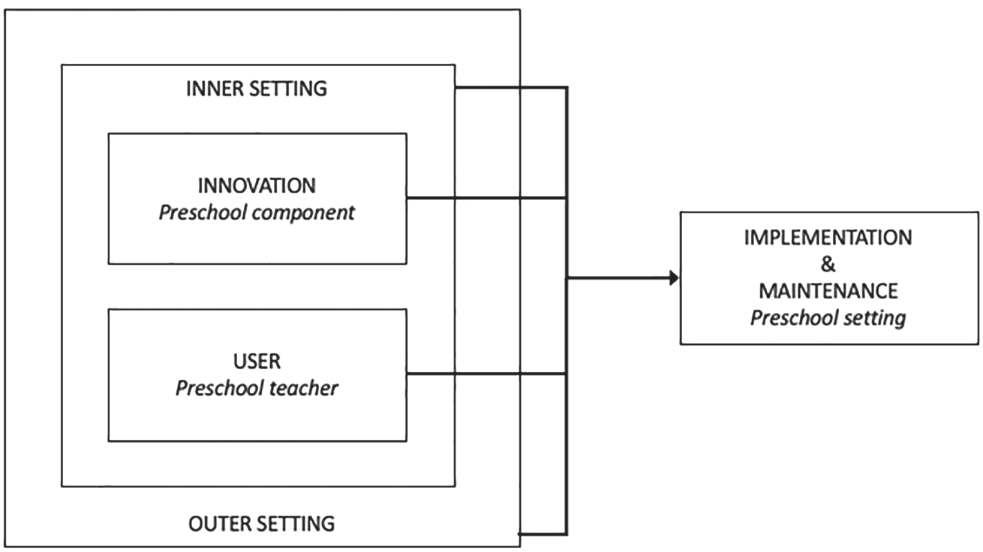


Figure 6.2. Theoretical framework for the process evaluation within the preschool setting; adapted from the Implementation Framework [252] and the Consolidated Framework For Implementation Research [251].

Results

Participants

Characteristics of the participants for the different measurements are presented in Table 6.1. A total of 32 interviews were held, which lasted 42 minutes on average. Thirty-one preschool teachers (response rate (RR)= 96.9%) filled in the CFAPQ at the first measurement, 24 (RR= 75.0%) at the second measurement, and 25 (RR= 78.1%) at the third measurement. Data was available for at least one teacher of each preschool at all measurement moments. At the first measurement 26 preschool teachers (RR=81.3%) filled in the process questionnaire, at the final measurement 25 preschool teachers (RR=78.1%) filled in the process questionnaire. Observations for the physical environment were done at all preschools on all measurement moments. For the social environment, observations were performed at 10 groups (76.9%).

Table 6.1. Participant characteristics for each measurement.

Participant characteristic	Interviews (N=49)	CFAPQ* (N=31)	Process questionnaire (N=28)
Age in years (mean)	45.1	46.8	45.7
Gender Female (%)	97.0	100.0	100.0
>10 years work experience (%)	55.6	61.3	59.2

*CFAPQ= Child-care Food and Activity Practices Questionnaire.

Implementation of SuperFIT

Various intervention activities were implemented during the implementation phase (April 2017 – May 2018). On average 89.0% of the preschool staff attended one or more of the off-the-job training sessions. A total of 42 different types of F&V were delivered, and all preschools received 20 different types of PA-related materials and 10 types of nutrition-related materials.

Differences were seen in how preschool staff started working with SuperFIT. It took time for preschool staff to start implementing activities and/or using materials (see also Supplementary Table S6.1). Nonetheless, a majority of the preschool teachers eventually used the materials. During the observations, on average around one SuperFIT PA-related material was used by staff and one to two PA materials were used by the pre-schoolers. If staff used SuperFIT nutrition-related materials, they always used the water tap. Pre-schoolers used on average around one nutrition material, which was most often the nutrition-related toys. Over time, more SuperFIT materials became visible in the preschools, and more staff were using PA-related cards. Nutrition-related cards were hardly used. Besides the use of the materials and cards, preschool staff also showed other initiatives to integrate SuperFIT elements into their daily practice. For example, they started thinking about how to increase PA in sedentary activities. Preschool staff also indicated that over time they became more

flexible in their daily structures to allow for more (short) active games, better fulfilling the children's needs.

Maintenance of SuperFIT

Maintenance was something that was explicitly addressed from the start of the project. Both the PA-providing organisation and the preschool organisation intended to continue SuperFIT after the initial implementation phase. All preschool teachers indicated that SuperFIT had become a way of working for them and continued using the materials and (limitedly) the cards. They continued to reflect on their routines and structures in order to increase PA (e.g., removing chairs from the tables to decrease sitting) or support healthy nutrition (e.g., preparing the food together with the children). The ending of the F&V delivery greatly decreased the variety of F&V offered, as preschools were depended again on the F&V children brought from home. It had become a habit to only serve water; the water tap remained a useful instrument to support water consumption.

For the preschool organisation, the maintenance phase also focussed on the dissemination of SuperFIT to its remaining ECE locations. The organisation formulated a vision regarding healthy behaviours in ECE and translated this in their policies. Although two managers were trained as so-called 'healthy childcare-coach' (part of a nationwide initiative 'Healthy Childcare' that is comparable to the 'Healthy School' initiative in the Netherlands [262]), dissemination was not centrally coordinated by the organization. Therefore, *how* SuperFIT was disseminated depended heavily on the motivation and efforts of individual managers. Dissemination was further influenced by available resources (time and monetary).

The innovation (preschool component)

The preschool staff considered the SuperFIT training and coaching on-the-job the most relevant parts of the approach (see Table 6.2 for all facilitating and hindering factors with supporting quotes). The training was appreciated because it provided the opportunity for staff to exchange experiences, for which they normally had no chance. The coaching on-the-job was found particularly relevant, because it helped in applying SuperFIT into practice. Further, preschool staff found it very important that the implementer experienced their daily struggles during the coaching, so that they would have a good idea of what would be realistic in practice. Preschool staff appreciated the training off-the-job with a 7.0 (scale 1-10) and the coaching on-the-job with a 7.4 (scale 1-10). Some managers and implementers stated that the more ready-made activities (e.g., the F&V delivery and materials) were the easiest to implement, as they did not necessarily require active behavioural change of the preschool staff.

During the implementation phase, preschool staff experienced incongruence between SuperFIT and their current practice. Due to time constraints, staff also felt they were forced

to make choices between activities. However, transferring into the maintenance phase staff increasingly recognized that SuperFIT was an add-in instead of an add-on program, facilitating its integration within practice. Barriers that were important during the implementation phase (e.g., time constraints or limitations in the physical environment), decreased and this supported staff to integrate SuperFIT into their daily practice. Staff indicated that time was needed to integrate SuperFIT into their daily practice. The duration of the program allowed for this, although time constraints remained important in the maintenance phase.

Another factor mentioned during the implementation phase, was the perceived inappropriateness for the pre-schoolers of the cards (too difficult) and the F&V delivery (too 'exotic'). In the maintenance phase, this factor changed to a supportive factor with the participants expressing SuperFIT as relevant for the pre-schoolers as it supported pre-schoolers in getting acquainted with new tastes and promoted PA (Supplementary Table S6.2).

Not all SuperFIT content was experienced as innovative or relevant, and often preschool teachers felt that *they* did not need to change. Some aspects were missed in SuperFIT, such as in-depth discussion of certain topics during the training (e.g., nutritional value of food produce) or changes to the outdoor play area.

It was suggested that a stronger bottom-up approach, i.e., involving preschool staff more from the start of the development, might have resulted in a better fit of the different preschool activities of SuperFIT. This factor was mentioned both for the implementation and maintenance phase. An important barrier seen for taking a bottom-up approach was that preschool staff was already heavily burdened with several tasks and were not always willing to participate in such bottom-up processes.

The preschool staff mentioned that the enthusiasm of the implementers was contagious and sparked their own enthusiasm for SuperFIT during the implementation phase. The quantitative process evaluation (Supplementary Table S6.1) showed that preschool teachers on average thought that SuperFIT was overall a good program, which they found interesting and instructive. The implementers were perceived as qualified.

The user: preschool staff

The majority of the preschool staff was very sceptical at the start of the implementation phase and initially lacked motivation to participate. However, during the implementation phase, an increased awareness among preschool staff about the goals and purposes of SuperFIT changed their attitudes towards SuperFIT. They became more enthusiastic about SuperFIT and willing to integrate it into their daily practice. In the maintenance phase, most participants expressed that they felt it is part of their job to promote healthy nutrition and

PA and were convinced that they could make a difference for the children. It was expressed that the ECE setting served as an example for parents, and that it was a place where children could at least get acquainted with healthy nutrition and PA. However, the influence of the home environment was also recognised as a hindering factor to change pre-schoolers behaviour.

All participants remained motivated to continue with SuperFIT in their work, although not all barriers were resolved (e.g., limited time and resources) or not all things were felt necessary to change (e.g., birthday or Christmas celebrations to warrant the celebratory character).

Preschool staff was surprised how easily the pre-schoolers switched to water, but they found it hard to get them to try the new F&V. This was further hampered by staff's low outcome expectation, as they considered the F&V not always to fit with the pre-schooler's preferences. They did not expect it to help pre-schoolers to eat more F&V. On the other hand, the F&V delivery was appreciated highest of all SuperFIT activities by the preschool staff (average appreciation 8.4, scale 0-10) and was reckoned the most successful aspect of SuperFIT.

Many of the preschool teachers described that they did not always feel capable of implementing SuperFIT. Reasons given were predominantly related to their other tasks, characteristics of their location (e.g., limited space to use the play materials), and safety concerns. In the maintenance phase, a different mind-set and increased awareness supported the integration of SuperFIT in the daily practice of preschool staff in the longer run. This was also reflected in the quantitative process evaluation (Supplementary Table S6.1). They increasingly felt that it was something they were able to incorporate in their daily practice. Overall, the preschool staff appreciated SuperFIT and often regarded all elements as important for the successes of SuperFIT.

The inner setting

SuperFIT fitted well with the vision of the organisation on healthy nutrition and PA in the preschool setting. Therefore, preschool staff felt that the organisation was committed to SuperFIT, which was reflected in the presence of management at the different activities during the implementation. In the maintenance phase, this vision supported the (re) formulation of policies and the initiation of several organisational processes to maintain SuperFIT, such as the training of two managers into 'Healthy Childcare Coach'. Managers had a preference for PA-related activities over nutrition. Nutrition was regarded more difficult to change, and healthy nutrition considered still ambiguous.

Several characteristics of the preschool groups were mentioned that influenced the implementation and maintenance phase. Age differences between the children, language

issues, (motoric) developmental delays in children, behavioural problems of children, and large number of children present were mentioned to influence the integration of SuperFIT in daily practice. These barriers appeared specifically important because the preschools were situated in low socioeconomic communities.

Information provision to the preschool staff was recognised as limiting factor for the implementation phase. Preschool staff felt they were insufficiently informed about what was exactly expected from them. They also mentioned that they would have liked to be better informed about the family component during implementation and felt that the preschool and family components were not one integrated program.

Several factors related to the availability of resources were mentioned for both the implementation and maintenance phase. For the implementation phase, the physical make-up of the room (i.e., available space or arrangement of the room), available time with the children, competing tasks and high workload were mentioned. Within the whole organisation high workload was experienced as a limiting factor for the integration of SuperFIT. With regard to resources in the maintenance phase, specifically the limited availability of funds influenced how SuperFIT could be maintained. Activities were terminated (e.g., the F&V delivery) and almost all activities needed an alternative way of delivery (e.g., training of the preschool staff). However, managers tried to find solutions to integrate SuperFIT given the limited resources.

The outer setting

For both the implementation and maintenance phase, collaboration with the primary school was an important influential factor, as most preschools were located within the same building as the primary school. This was experienced as hindering when agreements had to be made about the use of the physical education room or outside play area. On the other hand, it was facilitating if the primary school was also actively involved in health promotion. Continuity between the preschool and primary school (e.g., with regard to birthday treats and water drinking policy) was considered important for implementing changes, but also to achieve maintained healthy EBRB in children.

The current societal attention for healthy nutrition and PA in general, but also specific for the ECE setting, was experienced as a supportive factor. However, both preschool staff and managers felt that most parents did not occupy themselves with healthy nutrition or PA in the ECE setting. Managers thought that parents viewed the ECE setting particularly as a place to play and develop as a child.

Rules and regulations of Community Health Authority were considered a limiting factor. Preschool staff felt that rules related to for example, safety and hygiene that limited the possibilities for changes in PA or nutrition.

Table 6.2. Facilitating and hindering factors for the implementation and maintenance of SuperFIT in the preschool setting.

Domain	Facilitating	Example quotes	Hindering	Example quotes
Implementation				
Characteristics of the innovation: SuperFIT	• Training off-the-job for preschool staff, in particular to exchange experiences with other teachers and experts. • Coaching on-the-job. • Ready-made activities (e.g., delivery of materials/F&V). • Enthusiasm of the implementers. • Long overall duration of the program. • Supportive materials to implement changes within the preschool location (e.g., the water tap).	*'It is nice that you can share experiences like "how do you handle that" ... and it was nice that [the coach] came here to watch and give tips. That is something useful.' (PT)* *'I liked it a lot, that you can use the expertise of others who are enthusiastic about their profession and you also get a piece of the pie.' (PT)* *'We started with the tap. Let them tap water themselves... and not one child has asked for lemonade since.' (PT)*	• Incongruence with current practice. • No changes in the outdoor play area (e.g., provision of fixed outdoor play materials). • Limited appropriateness for pre-schoolers (e.g., difficult cards, too exotic F&V). • Lack of innovativeness (content of SuperFIT) for the preschool staff. • Predominantly top-down development of the intervention.	*'It is nice to hear, but then if you cannot apply it on your own preschool, I think that's a shame.' (PT)* *'I had hoped for more things for outside, the design... Our playgrounds are so boring.' (PT)* *'But passionfruit, with the seeds and all, and the papaya was also hardly eaten and then I think... this may be too much'. (PT)* *'I thought that it would have been good if a small group of preschool teachers thought about that together, some cooperation or consultation'. (M)*
Characteristics of the user: preschool teacher	• Preschool staff's previous experience with PA, by training or work experience. • Awareness among staff about purpose of the intervention.	*'You have to be creative with it, that is something that you learn with experience.' (PT)* *'Eventually, we learned that it is in the little things and then it is possible to integrate it.' (PT)*	• Preschool staff's initial negative attitude towards the program and lack of motivation to participate. • Low outcome expectations of the preschool staff to change children's EBRB due to lack of cooperation of the children. • Low self-efficacy of staff due to other tasks, and characteristics of their location or group.	*'I also thought that everyone was a bit hesitant, like, let's wait and see what is coming at us, does this fit us?' (PT)* *'I mean we try, but they will not even taste it and then I think: "what did we achieve?"' (PT)* *'At the beginning I thought "Do we get something extra to do again, we already have so little time..."' (PT)*
Characteristics of the inner setting: preschool organisation	• Health promotion (PA and healthy nutrition) was part of the organisational vision. • Support for SuperFIT within the organisation.	*'We wanted to promote healthy lifestyle within or organization before SuperFIT, but we had not turn it into action yet, so it [SuperFIT] did fit right up our alley.' (M)* *'It was always nice that some managers or even the director were present [at the training sessions for teachers] to see what was going on.' (PT)*	• Characteristics of the preschool location (e.g., limited space, full arrangement of the room, and limited availability of an outdoor play area). • Limited available time with the children (i.e., limited opening hours). • Group composition and characteristics of the children (e.g., language difficulties or age difference in the group). • Lack of information provision from the organization.	*'I need more time if I want to do everything and if I want to add this too, then I just need more time at the preschool.' (PT)* *'It really depends on the group. Sometimes you can do everything and sometimes you can do nothing, that's typical for pre-schoolers, right?' (M)*

Characteristics of the outer setting	• Preschool situated within primary school building that also supported health promotion. • Current attention for healthy nutrition and physical activity in society.	*'Because we are part of a primary school that is a "healthy school", we are also kind of obliged [to serve only water].' (PT)* *'Healthy lifestyle is increasingly put on the societal agenda, it is found increasingly important, also due to the increasing prevalence of overweight.'(I)*	• Limited access to physical education room, due to requirements of the primary school. • Low perceived support from parents for healthy nutrition and PA within the preschool setting. • Strict rules and regulations of the Community Health Authority, e.g., regarding safety or hygiene, limiting PA.	*'Look, it is a cooperation with the primary school, we used to use the physical education room more often… now it has become a larger school, the less we can do.'(PT)* *'Just this morning I was playing on the floor, but the floor is not that clean. And I started to think "What would the Community Health Service think about this?' (PT)*
Maintenance				
Characteristics of the innovation: SuperFIT	• Congruence with current practice. • Relevance for the pre-schools.	*'Sometimes you have so much to do for a day, that if you want to do an active game, you choose something simple or with less materials.' (PT)* *'I think that the things that the preschool teachers are thought about how to be physically active with the children, are concrete things that they can use.' (M)*	• Predominantly perceived top-down approach	*'The idea of SuperFIT was still thought of behind a desk … it does not result from a need from the staff, that they said, "we think that our community needs to be healthier". (M)*
Characteristics of the user: preschool teacher	• Positive attitude towards creating a healthy environment for pre-schoolers. • The promotion of healthy nutrition and PA was regarded as part of the job. • High motivation to work on healthy nutrition and PA for pre-schoolers. • Self-efficacy to be able to integrate SuperFIT activities into daily practice.	*'Then I think, at least they got that bit here … because we have a varied offer [of F&V], they can taste different things, that is what we can give them.' (PT)* *'There are other locations that cannot wait start working with it, who say "give me those cards and materials and I'll start with it!"' (M)* *'As I see it, now we just do it, because it became part of our daily schedule it has become routine.' (PT)*	• Low outcome expectations of only changing the preschool setting, particularly the home setting should also be addressed. • Some beliefs about not wanting to 'go over the top' with promoting healthy behaviour, in particular related to healthy nutrition (e.g., healthy treats or other celebrations).	*'To what extent can you influence it? If it does not address home, then things will not change.' (PT)* *'I do not belief it is good to withhold everything from the children … a child's birthday is a celebration and if you are not allowed to give some candy or small cooky… I think that should stay.' (PT)*

Table 6.2. Continued

Domain	Facilitating	Example quotes	Hindering	Example quotes
Characteristics of the inner setting: preschool organisation	• Organizational vision on healthy nutrition and PA. • (Re)formulation of organizational policies related to nutrition and PA. • Training of managers and 'Healthy Childcare Coach'.	*'What we formulated in our vision three years ago, is now in black and white in our policy: that we want to promote healthy lifestyle.' (M)* *'We have made it [healthy lifestyle] one of the spearheads of our organisation.' (M)* *'We talk about "healthy childcare" now, there is a plan of action regarding "healthy childcare", and there was some training regarding "healthy childcare". (M)*	• High workload and competition between the different tasks across the organization. • Availability of resources such as time and money. • Group composition and characteristics of the children (e.g., language difficulties or age difference in the group).	*'I think we can do much more with it [SuperFIT] if you get the time and space to work on it … now you have to do it in-between other things and then you cannot implement it properly.' (M)* *'Do we have money for it? That discussion is being held now.' (M)* *'It may influence the integration of SuperFIT: if everyone speaks the same language it is a lot easier, compared to a group of 16 children with 10 different nationalities.' (M)*
Characteristics of the outer setting	• Current societal views on healthy nutrition and PA. • Much attention towards healthy nutrition and PA within ECE setting. • Alignment of policies and activities between preschool and primary school.	*'If you look at the society, then everything is healthy this and healthy that.'(PT)* *'You just have to open a trade journal and it is about physical activity and healthy lifestyle, in that way it is in tune with the spirit of the times.' (M)*	• Low perceived support from parents for healthy nutrition and PA within the preschool setting. • Lack of cooperation between the primary school and the preschool in health promoting initiatives.	*'Parents do influence [implementation], if you want to do a lot and parents keep saying: "we do not want that", that has its influence.' (M)* *'Well, the primary school is renovating the playground, but they did not consult us … so I do not know what it is going to look like. It is a shame that they did not cooperate with [preschool organisation].' (PT)*

I= Implementer, M= Manager, PT= Preschool Teacher.

Impact of SuperFIT in the preschool setting

According to the participants, an increased awareness about the role of preschool staff in healthy nutrition and PA also led to changes in their behaviour, such as using different types of play materials, using more teacher-initiated play, and using different techniques to help pre-schoolers try new F&V. This was also reflected in nutrition and PA-related practices of the preschool teachers (Table 6.3). For most practices, a positive change was seen. Related to PA, the largest improvements were seen for 'Modelling' and 'Planning time for active play' at the first follow-up. Other improvements were predominantly moderate and some small (e.g., decrease in 'Telling children that they are not yet good enough at a game or sport'). Most changes were still visible at the final follow-up, although they decreased in size. At the first follow-up, a moderate, undesired increase was seen for 'Not letting the children play out of fear of them getting dirty', but this did not persist at the final follow-up. Related to nutrition, large improvements were seen for 'Modelling & Encourage balance and variety' and 'Emotion regulation & Food as reward', all other improvements were mainly moderate. The majority of the improvements persisted over time, some increased (e.g., 'Involvement & Environment'), while others decreased (e.g., 'I allow children to help prepare meals').

Other changes in the social preschool environment were also observed (Supplementary Table S6.3). The changes increased over time, which supports preschool staff's perception. Staff started using more play materials, both outdoors and indoors. During inside play, staff also increasingly initiated activities. However, this did not happen for outside play, where most staff did not initiate activities. Staff showed more supportive behaviours (e.g., encourage PA) for PA. Indoors, staff showed some limiting behaviours for PA (e.g., stimulating children to stay seated) and this did not change over time. Besides the materials that were provided as part of SuperFIT, no major changes were seen in the physical environment. Fixed (play) materials were increasingly available in the outdoor play area, while they decreased in the indoor play area (Supplementary Table S6.4). The availability of portable play materials increased over time in both the indoor and outdoor play areas. A decrease was seen in the availability of vegetables at the preschools over time, most likely due to ending of the F&V delivery (Supplementary Table S6.5). Eventually, all preschools switched to only serving water to the children.

Table 6.3. Changes in nutrition and physical activity related practices of preschool staff.

	Baseline Mean (SD)	T1 Mean (SD)	T2 Mean (SD)	T1 ES	T2 ES
Physical activity related practices					
Modelling	3.92 (0.25)	4.07 (0.35)	3.95 (0.19)	0.60	0.13
Teaching & Autonomy Support	3.89 (0.26)	3.82 (0.42)	3.85 (0.36)	-0.27	-0.16
Going Outdoors	4.35 (0.45)	4.22 (0.59)	4.43 (0.36)	-0.29	0.18
How often do you have outdoor toys for the children (for example skipping ropes, balls)?	3.95 (0.82)	4.31 (0.84)	4.26 (0.56)	0.44	0.38
How often do you keep the children occupied with inactive games?	3.58 (0.43)	3.44 (0.57)	3.37 (0.60)	-0.32	-0.48
How often do you not let children play actively for fear of them getting dirty?	1.09 (0.22)	1.15 (0.31)	1.09 (0.22)	0.35	0.02
How often do you tell children they are not (yet) good enough at sports of active games?	1.05 (0.11)	1.03 (0.10)	1.07 (0.17)	-0.18	0.18
How often do you tell the children that they will get hurt if they play actively?	2.19 (0.78)	2.19 (1.05)	1.94 (0.60)	0.00	-0.33
How often do you discipline children for being too active?	2.82 (0.46)	2.59 (0.66)	2.61 (0.49)	-0.50	-0.46
How often do you reward children for being calm?	2.16 (0.79)	2.10 (0.66)	2.25 (0.73)	-0.08	0.12
How often do you plan time for active play?	4.15 (0.54)	4.47 (0.45)	4.38 (0.33)	0.59	0.42
How often do you keep the children inside despite the weather?	2.29 (0.95)	1.94 (0.95)	1.80 (0.68)	-0.37	-0.51
Nutrition related practices					
Modelling and encouraging balance and variety	4.37 (0.44)	4.76 (0.25)	4.72 (0.39)	0.90	0.80
Involvement and environment	4.75 (0.24)	4.84 (0.29)	4.90 (0.13)	0.37	0.63
Teaching about nutrition	3.60 (0.91)	4.07 (0.64)	4.06 (0.82)	0.51	0.51
Pressure to eat	3.14 (0.66)	3.18 (0.68)	3.04 (0.90)	0.06	-0.16
Emotion regulation and food as reward	1.25 (0.22)	1.04 (0.08)	1.06 (0.12)	-0.91	-0.84
How often at meals, do you let the children choose the foods they want from what is served?	4.18 (0.94)	4.15 (0.97)	4.55 (0.72	-0.04	0.39
I want to be sure that the children do not eat too many sweets (for example, candy, ice cream, cookies or pastries).	4.45 (0.70)	3.86 (1.42)	4.38 (0.94)	-0.84	-0.10
I want to be sure that the children do not eat too many high-fat foods (for example, cheese, sausage, cookies).	4.48 (0.73)	4.56 (0.62)	4.10 (1.17)	0.10	-0.52
The children should always eat all the food on their plate.	2.53 (0.85)	2.26 (0.90)	2.02 (0.74)	-0.32	-0.60
I allow the children to help prepare meals (for example, set the table, prepare sandwiches etc.).	3.62 (1.11)	3.96 (1.00)	3.83 (0.93)	0.31	0.19
I tell the children what to eat and what not to eat without explanation.	1.54 (0.62)	1.22 (0.46)	1.68 (1.00)	-0.51	0.21

Note: [a]Items measured on 5-point Likert scale ranging from 1 (Never) to 5 (Always); [b]Items measured on a 5-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree); ES= Effect Size; SD= Standard Deviation.

Discussion

This process evaluation explored factors influencing implementation and maintenance of the SuperFIT approach and its impact in the preschool setting. At the start of the implementation phase, predominantly barriers were perceived for the implementation (e.g., incongruence with current practice, group composition, and the negative attitude of the preschool staff). These barriers are also described for other interventions in the ECE setting [253, 254, 256, 263]. Over the course of time, as staff got more acquainted with the approach, this negative tendency transformed into a more positive view. Duration of an intervention program is thus crucial for the level of implementation [264, 265]. Preschool staff participating in the SuperFIT intervention needed time to be ready to change and integrate SuperFIT elements in their daily practice. As a result, it may take a while for intervention effects to emerge, and sufficient program duration and follow-up is essential for detecting these effects [99]. Sequential implementation of intervention components over a longer period of time may assist in implementation and support effectiveness, as staff can experience small successes and are not overburdened with intervention activities [264, 266]. The integration of SuperFIT into daily practice was supported by organizational support, increased understanding about the purpose of the SuperFIT approach, and appreciation for the intervention activities from preschool staff. As a result, these factors became facilitating for the maintenance phase. It appeared that over time, SuperFIT invaded the system in which it was implemented more and more, which caused contextual factors to become more positive for implementation [43].

An important barrier for implementation and maintenance was the perceived top-down approach of SuperFIT. Although efforts were taken to involve preschool staff (e.g., continued needs assessment and active involvement of the preschool organization in development), this appeared to be insufficient for staff to feel involved. Involvement of the target group can take several forms with increasing intensity [267]. From the primary school setting it is known that mutual adaptation processes (i.e., combining top-down and bottom-up approaches) may be essential for successful intervention implementation [268, 269]. To our knowledge, such processes are not described yet for intervention development in the ECE setting. Although this approach also has barriers, such as time and resources that are needed, more or different efforts should be taken to increase bottom-up intervention development.

Group composition and characteristics of the children was an important barrier throughout the implementation and maintenance phase. Research has shown that childcare chaos negatively influences the coping responses of childcare staff [270]. This may limit their perceived possibilities to implement SuperFIT elements when groups were perceived as 'difficult'. Further, research has shown that child characteristics influence their EBRB [71, 271] and also interact with the ECE environment [167], indicating that different children might need

different approaches. Tailoring of interventions to the characteristics of children and groups may support implementation.

Changes in the ECE setting due to SuperFIT were predominantly seen in the social environment. Improvements in the nutrition and PA-related practices of the preschool staff were seen, although these could not be statistically tested due to the small sample size. Staff were also using more play materials and initiating more activities indoors. Effects of other interventions on the social ECE environment have been inconclusive, with some showing changes in the practices of staff while others did not [272-276]. Little changes were seen in the physical environment, except for the SuperFIT materials that were provided. Although intervention studies have been inconclusive, a review showed that changes in the physical environment can evoke large effects on behaviour [224, 277, 278]. The importance of the physical environment for EBRB, also specifically in the ECE setting, has been readily established [71, 72, 76, 152, 279-281]. Interventions should try to include changes to the physical environment to help promote healthy EBRB in pre-schoolers. In addition, interaction between the types of environments should be taken into account, as for example, changes in the physical environment also ask for changes in the social environment to be able to have an effect on pre-schoolers EBRB [48, 282].

An important issue mentioned in this process evaluation was the influence of other settings on the behaviour of pre-schoolers. Therefore, the role of the preschool setting in pre-schoolers' EBRB was experienced by participating preschool teachers as limited. The home setting (parents) was described as mainly responsible for pre-schoolers' EBRB, in particular related to nutrition. This may be true for preschools in the Netherlands, as they only provide a snack moment. However, other types of childcare (e.g., full-day childcare) contribute for a large part to the dietary intake of children and attention to healthy nutrition is very important [283]. Still, the home setting exerts a great influence on child EBRB for example, through the physical environment [284, 285], and parenting style and parenting practices of parents [50, 53]. Furthermore, research has shown that inconsistencies between the ECE and home setting may have negative effects on children's EBRB [49]. It remains important to integrate these settings in interventions on pre-schoolers EBRB to decrease the inconsistencies between the ECE and home settings.

Strengths and limitations of the study

It is important to see the results of this study in light of its strengths and limitations. Due to the mixed methods design of this study, data triangulation was possible. Both quantitative and qualitative data were available and ensured an elaborate understanding of processes that influenced implementation and maintenance. This process evaluation also goes beyond studying the 'quantitative' variables that are more traditionally used to describe implementation. The theoretical framework that was adopted supported this more

elaborate study of implementation and maintenance. Further, different stakeholders were included in the study, which enabled studying the implementation and maintenance of SuperFIT from different perspectives. Research methods were flexible, which enabled the researcher to, for example, add interview rounds when it appeared that this would increase the understanding of implementation and maintenance.

This study describes the factors that influenced the implementation and maintenance processes of SuperFIT, which was implemented in a specific region in the Netherlands. Results of this study may not be generalizable to other intervention programs or other implementation regions. However, the lessons learned from this study may be valuable for all intervention developers and implementers. Furthermore, this highlights the importance of a contextual approach to intervention development and implementation, which takes into account the specific contextual factors that may be of influence in a particular region or for a specific organization [43, 217]. The quantitative analyses were performed on preschool level, which resulted in a small sample size. Therefore, no statistical testing was possible and only descriptive analyses could be performed. However, calculated effect sizes for the changes in preschool teachers' practices, provide some insights into the relevance of the differences detected in the preschool teachers' practices in this study [286]. Selection bias may have occurred in the recruitment of the preschool teachers for the interviews. Due to participant burden, these were performed on a voluntary basis and this may have resulted in the participation of preschool teachers with a more positive view on SuperFIT. However, the quantitative process evaluation was performed among all preschool teachers participating in SuperFIT.

Conclusion

Several factors influenced the implementation and maintenance of the SuperFIT approach in preschools. Over time, some of these factors changed from barriers to facilitators, indicating the importance of allowing sufficient intervention duration and follow-up to be able to initiate and detect change. Changes mainly occurred in the social environment. An important perceived change was in the awareness of the preschool staff of their role and influence in pre-schoolers EBRB. This may be a prerequisite for behavioural changes to occur and indicates the importance of involvement of preschool staff in the early phases of intervention development. Bottom-up or mutual adaptation approaches may support this, although this requires active involvement of preschool staff which may be regarded as a barrier for such approaches. In order to change pre-schoolers EBRB, a comprehensive approach was considered indispensable.

Appendix

Table S6.1. Use of SuperFIT materials during implementation and maintenance within the intervention preschools.

Variable	1st observation (implementation)	2nd observation (implementation)	3rd observation (maintenance)
Physical activity			
Number of materials visible[a] (min/max, mean± SD)	0/3, 1.20± 1.23	0/5, 1.80± 1.69	0/8, 2.00± 2.40
Number of locations with PA materials used	7	8	9
Number of materials used by staff[a] (min/max, mean± SD)	0/3, 1.10± 1.10	0/4, 0.90± 1.29	0/4, 1.20± 1.62
Number of materials used by children[a] (min/max, mean± SD)	0/3, 1.20± 1.14	0/4, 1.40± 1.17	0/3, 1.20± 1.03
PA-related cards used by staff (yes/no)	0/10	1/9	4/6
Nutrition			
Number of locations with nutrition materials used	8	7	7
Number of materials visible[a] (min/max, mean± SD)	0/4, 1.30± 1.16	0/2, 0.60± 0.70	0/4, 1.60± 1.43
Number of materials used by staff[a] (min/max, mean± SD)	0/1, 0.40± 0.52	0/1, 0.30± 0.48	0/1, 0.30± 0.48
Number of materials used by children[a] (min/max, mean± SD)	0/2, 0.80± 0.92	0/3, 1.10± 0.99	0/3, 1.00± 0.94
Nutrition related cards used by staff (yes/no)	0/10	1/9	1/9

Note: 1st, 2nd and 3rd observation were performed in September/October 2017, April 2018, and September 2018 resp.; [a] visibility, use by staff and use by children are based on all preschools, zero reflects no visibility or use of the materials; max. = maximum, min = minimum, SD = standard deviation.

Table S6.2. Quantitative process evaluation of SuperFIT from the preschool teachers.

Process questionnaire regarding implementation	Mean	SD
The SuperFIT intervention program		
What do you think of SuperFIT in general? [a]	3.96	0.73
Did you find SuperFIT interesting? [b]	3.84	0.80
Did you find SuperFIT educational? [c]	3.76	0.83
Did you find SuperFIT clear? [d]	4.08	0.86
Are you satisfied about the communication about SuperFIT? [e]	3.72	0.94
What did you think about the amount of time SuperFIT cost you? [f]	3.44	0.87
Did SuperFIT meet your expectations?[g]	3.44	0.96
Do you think that SuperFIT helped you to better address the nutrition and physical activity of pre-schoolers? [h]	3.56	0.92
Do you think that SuperFIT has led to a healthier lifestyle of you personally? [h]	2.28	1.17

Table S6.2. Continued

Process questionnaire regarding implementation	Mean	SD
Do you think that the pre-schoolers are more physically active due to SuperFIT? [h]	3.60	1.12
Do you think that the pre-schoolers eat more healthily due to SuperFIT? [h]	3.28	1.10
Do you feel like you use a more positive way in addressing the pre-schoolers? [h]	3.04	1.10
Training off-the-job and coaching on-the-job		
Did you find the materials used during the training off-the-job interesting? [b]	3.72	0.79
Did you find the materials used during the training off-the-job clear? [d]	4.08	0.70
Did you find the trainer on nutrition qualified? [i]	4.20	0.83
Did you find the trainer on physical activity qualified? [i]	4.28	0.79
Did you find the trainer on positive parenting qualified? [i]	4.16	0.85
What did you think about the group-size during the training off-the-job? [j]	3.28	0.46
Did you find the coaching on-the-job useful? [c]	3.64	0.86
Did you find the coach on physical activity qualified? [i]	4.20	0.87
Did you find the coach on nutrition qualified? [i]	4.18	0.73
Did you find the coaching on-the-job fit with the training off-the-job? [h]	4.48	0.28
Fruit and vegetables delivery		
What do you think about the fruit and vegetables delivery in general? [a]	4.38	0.80
What did you think about the variation of the fruit and vegetables delivery? [k]	4.62	0.54
What did you think about the amount of the fruit and vegetables delivered? [l]	2.98	0.55
Do you find preparing the fruit and vegetables difficult? [m]	3.56	0.85
How much extra time does it cost you to prepare the fruit and vegetables? [n]	3.46	0.71
Did you find it difficult to let the pre-schoolers eat the new fruit and vegetables? [m]	3.16	0.88
How often did the pre-schoolers eat the new fruit and vegetables? [o]	3.54	0.71
General material box and nutrition and physical activity cards		
Do you find the materials of the general material box useful? [c]	4.28	0.89
Do you find the materials of the general material box easy to use? [m]	4.08	0.64
Do you find the materials appropriate for the preschool? [p]	4.16	0.69
How often do you use the materials of the general material box? [o]	3.72	0.54
What do you think of the nutrition and physical activity cards? [a]	3.48	0.82
Do you find the nutrition and physical activity cards useful? [c]	3.64	0.81
Do you find the nutrition and physical activity cards easy to use? [m]	3.52	0.71
Do you find the nutrition and physical activity cards appropriate for preschools? [p]	3.24	0.83
How often do you use the nutrition and physical activity cards? [o]	3.20	0.65
SuperFIT is too complicated for me to implement. [a]	1.68	0.69
I think the principles of SuperFIT are right. [a]	3.92	0.91
SuperFIT fits well with my daily practice. [a]	3.88	0.97
I think SuperFIT is appropriate for pre-schoolers. [a]	4.00	0.91

Table S6.2. Continued

Process questionnaire regarding maintenance	Mean	SD
I have enough knowledge to implement SuperFIT. [q]	4.24	0.83
I know enough about the content of SuperFIT. [q]	4.24	0.83
I think it is part of my job to implement SuperFIT. [q]	3.88	0.88
Implementing SuperFIT has disadvantages for me personally. [q]	2.32	0.95
Implementing SuperFIT has advantages for me personally. [q]	3.68	0.95
I think pre-schoolers are healthier due to SuperFIT. [q]	3.48	1.05
I can count on the help of my colleagues in implementing SuperFIT. [q]	4.20	0.87
I can count on the help of my manager in implementing SuperFIT. [q]	3.84	0.90
How many of your colleagues for which SuperFIT was intended, also implement SuperFIT according to you? [r]	3.44	1.00
To what extent do your colleagues expect you to implement SuperFIT? [s]	3.84	0.69
To what extent does your manager expect you to implement SuperFIT? [s]	4.28	0.54
To what extent does the management of your organization expect you to implement SuperFIT? [s]	4.24	0.52
To what extent do parents of the pre-schoolers expect you to implement SuperFIT? [s]	3.04	0.89
I feel like I can implement the principles of SuperFIT in my daily work. [s]	4.20	0.58
My organization has taken measures to ensure implementation of SuperFIT by new employees. [q]	2.88	0.60
My organization has sufficient staff to implement SuperFIT. [q]	3.52	0.59
There are sufficient financial resources to implement SuperFIT. [q]	3.00	0.87
My organization ensures that I have enough time available to implement SuperFIT. [q]	3.08	0.81
My organization ensures that I have sufficient materials and services available to implement SuperFIT. [q]	3.24	1.01
There is regular feedback on the implementation of SuperFIT with my manager. [q]	3.00	1.00
I have access to information on the implementation of SuperFIT within my organization. [q]	3.40	0.71
	Yes%	**No%**
Are there formal agreements (policies or work instructions) made by the management of your organization?	36%	64%
Were there any other changes within your organization during the implementation of SuperFIT? (reconstitution, mergers, cuts, or turnover)	20%	80%
Were there, besides SuperFIT, any other innovations during the implementation of SuperFIT?	16%	84%

All items were measured on a 5-point Likert scale. Answering scales: [a]really bad [(1)] to really good [(5)], [b]very uninteresting [(1)] to very interesting [(5)], [c]very useless [(1)] to very useful [(5)], [d]very unclear [(1)] to very clear [(5)], [e]very dissatisfied [(1)] to very satisfied [(5)], [f]worse than expected [(1)] to better than expected [(5)], [g]none of the expectations [(1)] to almost all of the expectations [(5)], [h]certainly not [(1)] to certainly [(5)], [i]very inappropriate [(1)] to very appropriate [(5)], [j]too small [(1)] to too large [(5)], [k]not at all varied [(1)] to very varied [(5)], [l]too little [(1)] to too much [(5)], [m]very difficult [(1)] to very easy [(5)], [n]no extra time [(1)] to a lot extra time [(5)], [o]never [(1)] to always [(5)], [p]very inappropriate [(1)] to very appropriate [(5)] [q]totally disagree [(1)] to totally agree [(5)], [r]none of my colleagues [(1)] to all of my colleagues [(5)], [s]most certainly not [(1)] to certainly [(5)]. SD = standard deviation.

Table S6.3. The physical activity and nutrition-related social environment at the intervention preschools of SuperFIT (N=10).

Variable	1st observation (implementation)	2nd observation (implementation)	3rd observation (maintenance)
Physical activity			
Outside play (Yes/No) [a]	7/3	7/3	7/3
Teacher initiated play outside (Yes/No) [a]	4/6	0/10	2/8
Outside play materials (yes/no) [a]	7/3	7/3	7/3
Number of used outdoor play materials (min/max, mean± SD)	0/5, 1.70± 1.77	0/6, 2.10± 1.97	0/6, 2.70± 2.06
Outside supportive staff behaviour (min/max, mean± SD)	0/4, 2.43± 1.99	0/3, 0.57± 1.13	1/6, 2.71± 1.70
Outside limiting staff behaviour (yes/no) [b]	0/7	0/7	0/7
Supportive social environment outside (min/max, mean± SD) [c]	1/5, 3.43± 1.99	1/4, 1.57± 1.13	2/10, 4.29± 2.75
Inside play (Yes/No) [a]	10/0	10/0	10/0
Teacher initiated play inside (Yes/No) [a]	8/2	7/3	9/1
Number of used indoor play materials (min/max, mean± SD)	0/5, 2.10± 1.52	1/6, 3.50± 1.58	0/7, 2.80± 2.39
Inside supportive staff behaviour (min/max, mean± SD)	2/6, 3.90± 1.37	1/9, 4.10± 2.38	0/9, 5.20± 2.39
Inside limiting staff behaviour (min/max, mean± SD)	0/5, 3.20± 1.32	2/5, 2.80± 1.03	1/5, 3.30± 1.16
Supportive social environment inside (min/max, mean± SD) [c]	2/8, 5.20± 2.35	1/13, 5.30± 3.43	2/12, 6.80± 2.78
Nutrition			
Supportive staff behaviour (min/max, mean± SD)	1/6, 4.30± 1.64	2/6, 4.50± 1.65	2/6, 4.10± 1.37
Non-supportive staff behaviour (min/max, mean± SD)	0/1, 0.20± 0.42	0/0	0/1, 0.40± 0.42
Supportive social environment [c] (min/max, mean± SD)	5/10, 8.10± 1.73	6/10, 8.50± 1.65	5/10, 7.70± 1.57
Strategies used to promote tasting (min/max, mean± SD)	1/5, 2.75± 1.58	1/4, 2.13± 1.36	1/3, 2.00± 0.63

Note: 1st, 2nd and 3rd observation were performed in September/October 2017, April 2018, and September 2018 resp.; [a] Scores reflect activities at preschool level; [b] Scores are based on one question; [c] Scores are based on the combination of supporting and limiting staff behaviour, where limiting behaviours were recoded in order to calculate an overall positive score; max. = maximum, min = minimum, SD = standard deviation.

Table S6.4. The physical activity-related physical environment at the intervention preschools of SuperFIT (N=12).

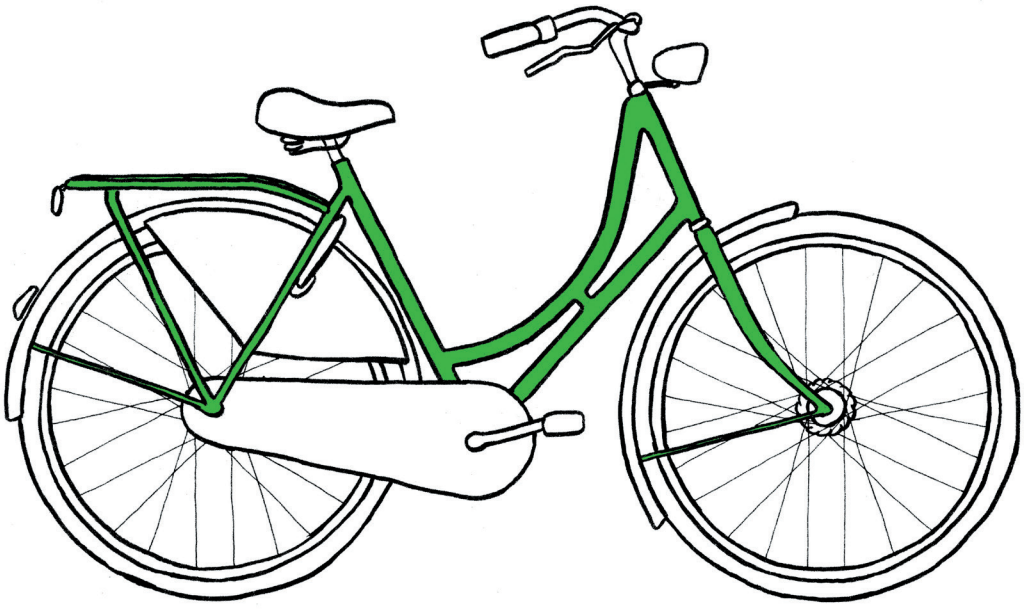
	1st measurement	2nd measurement	3rd measurement
Fixed play equipment available outdoors (mean types± SD)	4.00± 2.71	4.33± 2.61	4.50± 2.75
Portable play equipment available outdoors (mean types± SD)	5.90± 1.73	4.75± 2.30	6.25± 2.30
Fixed play equipment available indoors (mean types± SD)	3.90± 1.66	3.00± 1.95	2.67± 1.37
Portable play equipment available indoors (mean types± SD)	8.60± 1.58	8.00± 3.22	8.83± 3.46
Screens and electrical devices (TV, DVD, smartboard) available (mean± SD)	1.70± 1.16	1.42± 1.09	1.08± 0.90

Note: SD= standard deviation.

Table S6.5. The nutrition-related physical environment during the observations at the intervention preschools of SuperFIT (N=10).

	1st observation (implementation)	2nd observation (implementation)	3rd observation (maintenance)
Availability of food at number of preschools			
Fruit	10	10	10
Vegetables	6	4	3
Different types of fruit (min/max, mean± SD)	3/7, 4.70± 1.16	4/6, 5.20± 0.79	4/6, 4.40± 0.84
Different types of vegetables (min/max, mean± SD)	1/3, 1.50± 0.84	1/3, 1.80± 1.10	1/2, 1.67± 0.58
Availability of drinks at number of preschools			
Water	9	9	10
Lemonade	1	1	0

Note: 1st, 2nd and 3rd observation were performed in September/October 2017, April 2018, and September 2018 resp.; max. = maximum, min = minimum, SD = standard deviation.



Chapter 7

General Discussion

The overall aim of this dissertation was to develop, implement and evaluate an intervention approach aimed at promoting healthy energy balance-related behaviours (EBRB) in 2-4-year-old children. Formative research (a systematic literature review and a needs assessment) was performed as input for the intervention development, after which the intervention was developed in a close partnership of health promotion professionals, a local PA-providing organisation, and an Early Care and Education (ECE) organisation. This resulted in the SuperFIT approach, a comprehensive, integrated intervention approach in the Early Care and Education (ECE) and home settings. SuperFIT was implemented in an urban region (Sittard-Geleen) in the south of the Netherlands and evaluated with both an effect and a process evaluation. The aim of the effect evaluation within this dissertation was to evaluate the effectiveness of SuperFIT on physical activity (PA) outcomes and body mass index (BMI). The aim of the process evaluation within this dissertation was to evaluate the implementation and maintenance process, and impact of the preschool-based component of SuperFIT. The effects of SuperFIT on dietary outcomes and the process evaluation of the family-based component will be described elsewhere [87].

This chapter will discuss the studies that were performed during the development, implementation and evaluation of SuperFIT. In addition, methodological considerations, lessons learned, and recommendations for research and practice will be given.

Main findings

Part one: Formative Research

To support the development of the intervention approach, a systematic literature review was conducted to study the effectiveness of interventions in the ECE setting that included direct parental involvement (Chapter 2). Direct parental involvement has shown to be most promising for intervention effectiveness and was operationalized as 'the requested presence of parents at educational sessions, family behavioural counselling, or parent training sessions' [58]. A total of 22 studies describing 17 individual interventions were included in the systematic review. The majority of the studies showed favourable effects in the intervention group for at least one of the measured outcomes (61.1% for weight-related outcomes, 73.3% for PA outcomes, 88.9% for sedentary behaviour outcomes, and 100% for nutrition outcomes). However, few studies were able to show significant differences between the intervention and control group. Effect sizes (ES) were predominantly small or moderate, with some exceptions of large effect sizes [103]. Methodological quality of the included studies was low, which may be an explanation for their inability to detect effects of the interventions. The majority of the interventions aimed to change the physical and sociocultural environment. Interventions that, in addition to the physical and sociocultural, also aimed at changing the political environment (e.g., changing PA-related policies) appeared to be more effective in changing the related behaviour. Further, the intensity of parental involvement (e.g., active

participation in intervention development or delivery) seemed to result in more effects on children's EBRB.

To increase our understanding of the context of the ECE setting in general, and the local setting specifically, a needs assessment was performed (Chapter 3). The aim was to explore factors that influenced children's EBRB in the ECE setting and needs of childcare staff and parents that may exist regarding changing these factors. A qualitative study using semi-structured interviews was performed. Different stakeholders (childcare managers N=9, childcare workers N=23, and parents N=31) were included in the study to get a comprehensive picture of influencing factors in the childcare setting. The Environmental Research framework for weight Gain prevention (EnRG) was used as theoretical framework for identification of influencing factors [39]. Influencing factors were identified in all types of environments (sociocultural, physical, economic, and political). In the sociocultural environment, for example, the use of (un)favourable practices by childcare workers, and the influence of others such as parents were mentioned as important factors. The availability of healthy foods, play materials, and space were important factors in the physical environment. In the economic environment, the financial possibilities of the ECE organisations and parents were mentioned. The lack of formal (e.g., regarding birthday treats or PA) was an important factor in the political environment. Some interaction between environmental factors was described. For example, an interaction between the sociocultural and political environment was described as the implementation of policies depends strongly on the behaviour of childcare workers. Further, an interaction between the ECE setting and home setting was described. Possibilities in the home setting and/or the behaviour of parents determined for a great part the capabilities of the children within the ECE setting. For example, poor opportunities to be physically active at home influence the motor skills development of young children, which influences how active they are in the ECE setting. Some differences were seen between the stakeholders in the perceived influential factors, in particular related to the physical environment. Childcare workers perceived more limitations in the physical environment compared to childcare managers or parents. The interviews revealed limited perceived needs for change. In general, participants were content with 'the way things went'. However, the interviews did reveal unfavourable environmental factors that may require change, such as the serving of sugar sweetened drinks. A lack of awareness may cause the participants being unable to express their needs or even lacking a need for change. This study showed that interactions between different types of environments, and between different settings play a role in the promotion of healthy EBRB in young children. This calls for a comprehensive, integrated approach in the development of interventions.

Part two: Development, Implementation and Evaluation of SuperFIT

A comprehensive, integrated intervention approach was developed: SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial) (Chapter 4). SuperFIT was developed in a partnership of a local PA-providing organisation (implementers), a childcare organisation (target population), and health promotion experts. The process of development was characterized by continuous co-creation, feedback and adaptation during intervention implementation. The SuperFIT approach has three main principles that are combined in intervention strategies. The first principle is that intervention strategies target both PA and nutrition. The aims of SuperFIT within this principle are to increase fruit, vegetable, and water consumption, to decrease unhealthy snacking, to increase PA, and to decrease sedentary behaviour. The second principle is an integrated approach that includes different types of environments for intervention strategies, i.e., the sociocultural, physical, and political environments are targeted within the intervention. The third principle is the inclusion of multiple settings that are important for young pre-schoolers. Although the ECE setting is the primary setting for SuperFIT and serves as the point of entry, the intervention also includes a family-based component. In addition, the community setting may be included in the intervention. In the pilot region, the preschool-based component included a training off-the-job and coaching on-the-job for preschool staff, and PA and nutrition-related activity cards to change the sociocultural environment. The training off-the-job and coaching on-the-job were aligned to help preschool staff implement SuperFIT in their daily practice. To change the physical environment, unfamiliar fruits and vegetables were delivered at the preschools (e.g., raspberries, cherries, bell peppers, and radish), and new play materials and nutrition-related materials were provisioned (e.g., bean bags, hoops, water tap, and nutrition-related story books). To change the political environment, policies regarding nutrition and physical activity were updated or developed. The family-based component consisted of group-based sessions including both family sessions and caregiver-only sessions. The aim of the family sessions was to provide fun activities for the whole family. They were characterised by, for example, PA games that could easily be translated to the home setting and nutrition activities such as a food tasting. The caregiver-only sessions were based on Lifestyle Triple P [203]. During these sessions, caregivers were able to exchange experiences with regard to PA, nutrition and child rearing with each other and a trained Triple P professional. Further, the influence of different types of environments in the home setting was discussed. The community-based component consisted of the development of a social map indicating PA possibilities (sports associations and playgrounds) for young children in the community. SuperFIT was evaluated with an effect and process evaluation. Effects on BMI z-score, PA, and sedentary behaviour were studied using a quasi-experimental design and are described in this dissertation (Chapter 5). In addition, effects on nutrition were also studied but are presented elsewhere [87]. The process evaluation aimed to study the implementation and

maintenance of SuperFIT and identify influencing factors. In addition, the impact of SuperFIT on the PA and nutrition-related practices of the preschool staff, and the physical and sociocultural environment was evaluated (Chapter 6). The process and impact evaluation were performed with a mixed-methods design. The implementation of SuperFIT started in April 2017 and lasted until May 2018.

The effectiveness of SuperFIT on BMI, PA, and sedentary behaviour was evaluated using a quasi-experimental research design (Chapter 5). Height and weight of the pre-schoolers were measured in order to evaluate changes in BMI z-score, standardized for child age, gender, and ethnicity. PA and sedentary behaviour were measured using Actigraph GT3X+ accelerometers. Observations were performed at intervention preschools to assess changes in time in PA activities during preschool hours. Linear mixed-models were used to evaluate the effectiveness of SuperFIT on BMI z-score, PA and sedentary behaviour. ES were calculated to gain insight in the magnitude of the effects of SuperFIT. Pre-schoolers from intervention preschools could be exposed to both the preschool-based component and the family-based component (full intervention) or only to the preschool-based component (partial intervention). At baseline, 191 pre-schoolers were included in the study (47 full intervention, 52 partial intervention, and 92 control group). During the course of implementation, the time pre-schoolers spent in PA activities at preschool increased (~13 minutes), while the time spent in sedentary behaviour decreased (~13 minutes). Healthy changes in PA levels occurred within all study groups over time. Pre-schoolers in the full intervention showed significant differences with the control group on sedentary behaviour (ES -0.62), moderate-to-vigorous physical activity (MVPA) (ES 0.85), and counts-per-minute (CPM) (ES 0.45) on preschool days at the first follow-up. However, these effects were not seen at the final follow-up. The partial intervention group showed no significant differences in PA on preschool days compared to the control group and the differences were mostly small (ES <0.15). With regard to overall PA, no significant differences were found between the intervention groups and control group at both follow-up measurements. For some outcomes, favourable changes were seen for the control group. All effect sizes related to the overall PA outcomes were small (ES <0.32). SuperFIT did not result in statistically significant differences in BMI z-score between both intervention groups and the control group at both follow-up measurements and the effect sizes were small (<0.14). No differences were detected between the intervention groups and control group on weekly PA outcomes and BMI z-score to support effectiveness of SuperFIT. SuperFIT may induce changes in the preschool setting regarding sedentary behaviour and physical activity. Changes in pre-schoolers' physical activity and sedentary behaviour in the ECE setting may be supported by the combination of the ECE setting and home setting within SuperFIT.

To gain insight in the implementation and maintenance of SuperFIT a process evaluation was conducted within the ECE setting (Chapter 6). In addition, the process evaluation

was used to evaluate the impact of SuperFIT in this setting. A mixed-methods study was performed. Semi-structured interviews were performed during implementation (June/ July 2017 and February/March 2018) and maintenance (October/November 2018) with different stakeholders (preschool teachers, implementers, and managers at the preschool organisation). Observations were used to evaluate changes of the physical and sociocultural environment of the intervention preschools. Further, changes in PA and nutrition-related practices, as part of the sociocultural environment, were measured using questionnaires for childcare staff. Factors influencing implementation and maintenance were identified using an integrated framework of the Implementation Framework of Fleuren et al. [252] and the Consolidated Framework for Implementation Research (CFIR) of Damschröder et al. [251]. The framework consisted of the main categories 'characteristics of the intervention', 'characteristics of the user', 'inner setting', and 'outer setting', as predictors of successful implementation and maintenance.

Several intervention activities were implemented in the ECE setting as planned, however translation of the activities into practice had to grow over time. Several facilitating and hindering factors were identified for the implementation process. An important factor was a perceived incongruence of the SuperFIT approach with current practice at the start of implementation (characteristic of the intervention). As staff got more acquainted with SuperFIT, their attitudes towards SuperFIT changed (characteristic of the user) and the incongruence of SuperFIT changed from a barrier to a facilitating factor, as staff perceived SuperFIT to be congruent with current practice in the maintenance phase. Within the inner setting of the preschools, an important factor was the group composition. Several characteristics of the groups (e.g., language issues and number of children present) influenced the possibilities of staff to integrate SuperFIT activities. The current societal attention for healthy nutrition and PA, both in general and specifically for the ECE setting, was experienced as an important facilitating factor of the outer setting. A major change was perceived in the awareness of the staff towards their role in healthy nutrition and PA of pre-schoolers. This awareness was translated into positive changes in the nutrition- and PA-related practices used by the preschool teachers. The observations also showed positive changes in the social environment, with staff starting to use more play materials and showing supportive behaviours for PA and nutrition. However, related to nutrition these supportive behaviours reduced over time. No major changes were seen in the physical environment, except for the intervention induced changes such as the additional play materials and (temporary) fruit and vegetable delivery.

Effects on dietary intake and process evaluation of the family component

As described in the general introduction the evaluation of SuperFIT also consisted of the evaluation of the effects on dietary intake and the process evaluation of the family

component. Although they are not presented in this dissertation a summary of the findings will be described here. The full results are presented elsewhere [87, 287].

The aim of the effect evaluation with regard to dietary intake was to evaluate the effects of SuperFIT on intake of fruits, vegetables, water, and sweet beverages. An adapted 24-hour dietary recall method was conducted with parents to assess children's dietary intake. One 24-hour dietary recall was conducted each measurement and the protocol focussed on intake of fruits and vegetables, water and sweet beverages. Recorded intake of fruits, vegetables, water and sweet beverages were recoded to grams or millilitres using the Dutch portion size codebook [288]. Effects were analysed on daily intake of each food group, meeting daily recommendations of each food group, and average food intake for the subsample that consumed the food groups. A three-level hierarchical logistic regression with two random effects (preschool and child) to correct for the nested structure of the data, was conducted. The results show no significant differences between the partial intervention group and the control group on the consumption of fruits, vegetables, water, and sweet beverages on any of the measurements. A significant positive difference was seen in the consumption of sweet beverages and a significant negative difference in the consumption of vegetables for the full intervention group compared to the control group at the final follow-up. No other differences were seen for the full intervention group and the control group on dietary intake. In addition, no significant differences were seen in meeting daily recommendations between the intervention groups and the control group. Only a small part of the partial intervention group met daily recommendations for fruit (22.6%) and vegetables (38.5%) at the final follow-up. In the full intervention group, also less than half of the pre-schoolers met daily recommendations for fruit (46.2%) and vegetables (48.4%). Further, descriptive exploration of the amounts in the subgroup of pre-schoolers who consumed the products, showed already a high consumption of fruits and vegetables in all groups at all measurements and little change was seen over time. Pre-schoolers consumed about two children's cups of water at baseline, this increased over time in all groups. Also, about two children's cups of sweet beverage are consumed and this changed only minimally over time. These results do not support effectiveness of SuperFIT on the dietary intake of pre-schoolers, although a significant difference was seen for sweet beverage consumption in the full intervention group. On the other hand, a negative significant difference was seen for vegetable consumption in the full intervention group. The important role of parents in the dietary intake of pre-schoolers may ask for strengthening of the family component within SuperFIT in order to change their dietary intake.

In order to understand the lack of effects of SuperFIT on child outcomes in the home setting, a process and impact evaluation of the family component was performed. A mixed-methods research design was adopted using quantitative questionnaires and qualitative in-depth interviews among parents, and observations of the family component activities

to evaluate the implementation process and the impact of the family component in the home setting. The RE-AIM framework was used to present the results of the process and impact evaluation. Forty-seven families were reached with the family component, which is about a tenth of the families attending preschools participating in SuperFIT. Attendance rates at the group-sessions varied and family-sessions were attended best. With regard to adoption, 'no time' and 'no need' were reasons provided most frequently for not participating in the family component. More information on the content and the design of the group sessions may have increased participation of parents. Parents were surprised by the prominent role of positive parenting in the parent sessions, they did not expect this to be part of SuperFIT. Parents appreciated the family-sessions most, due to their character of 'on-the-spot' guidance or coaching, especially the physical activity session invited for active parent participation. This was seen less in the nutrition family-session, and minimally in the parent-only sessions regardless of efforts by the implementer to increase interactivity. Some changes were made during implementation on the amount and planning of the group sessions; however, this was not perceived as a major barrier to participate. Parents mainly described an impact of SuperFIT on their own awareness and behaviours regarding healthy nutrition and physical activity, for example, during dinner time. This was also reflected in their use of supportive nutrition and physical activity-related parenting practices. No notable changes were seen in the physical home environment. In addition, the parents did not recognize a change in the EBRB of their children, although they described their children wanting to perform activities that were done during the SuperFIT family-sessions, such as creating fruit-animals. This reflected the appreciation and enthusiasm of the children for the SuperFIT activities. Direct and active involvement of parents in intervention activities is known to support intervention effectiveness. However, this may compromise reach and adoption. Further research is needed to better understand the balance needed between content, intensity and accessibility of intervention activities for parents.

Methodological considerations

The results of the studies presented in this dissertation should be considered in light off their strengths and limitations. A detailed discussion of the results of the individual studies are presented within the previous chapters. However, some general methodological considerations will be discussed here.

Study design

The effectiveness of SuperFIT was evaluated using a quasi-experimental research design. This means that no randomisation was used to assign participants to either the intervention or the control group. Although a randomized controlled trial (RCT) is considered the gold standard to evaluate intervention effects [289], this design is not often compatible within practice-based health promotion research [290]. In the case of SuperFIT, intervention development

was initiated from a research-practice cooperation and therefore, intervention locations were pre-assigned and control locations could not be recruited within the organization. The nature of the intervention prevented randomisation at the participant level, because intervention strategies were implemented at preschool level and thus all pre-schoolers attending the preschool were exposed to the preschool-based component. In addition, randomisation prevents differences in characteristics between the research groups that may explain differences in outcomes between the groups [291]. In our effectiveness study, significant baseline differences were seen between the intervention and control group regarding parental country of birth and parental education level. In the control group more parents had a non-western country of birth and a lower education level. With regard to the BMI z-score outcome, the results were adjusted for these factors as these are known predictors for childhood overweight and obesity [67]. For PA outcomes, literature has shown that these characteristics do not influence pre-schoolers PA [292]. Known factors to influence pre-schoolers PA are child age, child gender and weather [177, 292]. Therefore, the PA outcomes were only adjusted for these factors.

It was also not possible to blind participants for intervention goals and study outcomes due to the nature of the study (e.g., active participation in the intervention was requested from preschool staff and parents). Further, researchers were not blinded to intervention allocation of the participants. The lack of blinding could have provoked some changes in behaviour that were seen in the control group. It may have been the case, that due to the research activities (children wearing accelerometers or filling out dietary intake of the children) preschool teachers in the control group also got an increased awareness of the EBRB of the children in their care and subsequently changed their own behaviour and/or their routines. As participants were not blinded to study outcomes due to the nature of the measurements, it may be that socially desirable answers were given, in particular for the questionnaires. Further, the measurements such as wearing an accelerometer, may induce reactivity to the measurement [293, 294].

Although adopting a quasi-experimental design lowered the internal validity of the effectiveness study, it often results in a higher external validity [295]. Highly controlled trials showing efficacy of interventions are often not able to show the same effectiveness when repeated with less controlled conditions [296]. Due to the 'real-life' circumstances of our effectiveness study, results may better reflect the effects of the intervention in the real world and increases generalizability of the results to other situations.

Participant recruitment and sample size

Participant recruitment was difficult, although recruitment strategies were adopted that were previously experienced as successful, such as informing parents during drop-off and pick-up times [167, 297]. The sample size included in the effectiveness study was quite small

and not sufficient, based on the a priori power calculation, to detect statistically significant differences on the primary outcome: BMI z-score. BMI z-score is the most distal (health) outcome for the evaluation of SuperFIT. Therefore, the smallest effects may be expected for this outcome, as is also shown in previous research [80, 98]. The a priori sample size was thus based on the most conservative expectation of change. We assessed the possible changes that could be detected with the realised sample size and effects similar to other studies on behaviour could have been detected with the achieved sample (Chapter 4). The final results showed that the changes that were actually achieved with SuperFIT were, however, generally small and therefore, the study proved to be underpowered to detect statistically significant differences for most outcomes. For all outcomes in which we measured change, we also calculated Cohen's *d* effect sizes [102]. Effect sizes provide an indication for the magnitude of change that was achieved. This magnitude of effects may be more informative within the behavioural sciences compared to statistical significance, as this can be a better indication of (clinical) relevance of the achieved change [286]. Although most of the effect sizes we found were small, some moderate and large effects were found. Our effect sizes are comparable to the effect sizes found in similar intervention studies (chapter 2) [224]. With regard to BMI, such small effect sizes during childhood might already prevent large increases in prevalence of obesity in adulthood, making these small effects already clinically relevant [98].

Several factors influenced participant recruitment. The participating preschools were all situated in disadvantaged communities. We experienced that the parents of the children attending these preschools may have been less familiar with research and may be less inclined to participate [298]. This may be exacerbated by a certain suspicion towards formal institutions such as the university [299]. In addition, to comply with the requirements for informed consent from the Medical Ethics Committee, the general information provision towards parents may have been too difficult and too elaborate, which may have discouraged parents to participate. In particular, this information regarded medical research and was mostly not applicable for this study. Medical ethical procedures may need to be tailored to the type of research that is performed to support practicability of that specific study. It is already known from healthcare that (health) illiteracy may influence the informed consent procedure [300, 301]. An important factor is the understandability of the information provided. Easier written information or using more interactive media can support understanding of the consent procedure [300]. Further, it is shown that easier text or the use of illustrations helps people with low health literacy and does not deter people with high health literacy [302]. Alternative ways of information provision may need to be considered for informed consent procedures involving people with low (health) literacy.

In the Netherlands, as soon as children turn four, they transfer to primary school. This may be an important reason for lost to follow-up or dropout of the study. Therefore, we decided to follow children also after transferring to primary school. This ensured a long-term follow-

up of the majority of the study population. As a consequence, not all children were exposed to the complete SuperFIT approach and contamination with other interventions may have occurred. For example, in both the intervention and the control region, a national, community-based intervention program 'Jongeren Op Gezond Gewicht' (JOGG) [141], derived from the French EPODE approach [140], was being implemented at the time SuperFIT was implemented. JOGG primarily aims its activities at primary schools. Activities are, for example, campaigns to increase water drinking or consumption of vegetables, and the Daily Mile (daily 15-minute walk/run around the school) [141, 303]. In addition, communities can implement their own activities in light of JOGG. Participating children that transferred to primary school may also have been exposed to this program. This may also partially explain the changes that were seen in behaviour of the participants in the control region, particularly because the control region appeared to be more active in implementing the JOGG approach compared to the intervention region. Moreover, preschools are often situated in the buildings of primary schools and this may support spill-over of interventions within the primary school to the preschool (e.g., left-over fruits from the European Union (EU) fruit initiative would be supplied to the preschool). Although, these are positive developments in light of healthy EBRB in pre-schoolers, it is difficult to disentangle the true effects of SuperFIT within this real-life setting.

Measurement instruments

In designing the evaluation study, attention was paid to use objective, reliable and validated measurement instruments as much as possible, while also keeping in mind participant burden. PA was measured with accelerometers, a valid and feasible way to measure PA in young children, which does not bother them [205]. Still, questionnaires were quite long, and some measurements took quite some time (e.g., the 24HR recall for dietary intake). The large time investment at the first measurement moment may have influenced the willingness to participate and may have caused participants to drop out of the study. There may be alternative ways of gathering data in order to lower participant burden and increase data quality. A method that has already been often used, also in the studies in this dissertation, is observations. Several validated observation instruments are available for the ECE setting and they can provide an elaborate overview of both children's behaviour and environmental factors that influence the behaviour [211, 304]. A disadvantage of observations is the time investment needed from researchers to gather the data [305]. Further, training of researchers in the use of the observation protocols is needed to ensure inter-rater reliability [305]. Video observations may be an alternative way for data gathering, which may be suitable in the ECE setting. Video observations provide complete, rich datasets that are permanent and can be reviewed several times [306, 307]. With training, video recordings ensure a high inter-rater reliability [306, 307]. However, reviewing and coding of videos is very labour intensive, it may bring additional costs, and it requires elaborate ethical reviewing [306]. The use of existing data may also be an alternative way of data gathering to reduce participant burden.

In the Netherlands, several health indicators (e.g., length and weight) of young children are monitored by youth health care. This service is not obligatory, but a majority (almost 95%) of the Dutch parents make use of it [308], providing a rich data source. The data is gathered following standardized protocols and with validated instruments ensuring the quality of the gathered data. Still, issues may occur in working with existing data: there is no control on completeness of the data [309], data may not be delivered in a way that is compatible with analysis software, and exchange of the data may be a difficult process especially since the enforcement of the General Data Protection Regulation (GDPR) of the European Union. However, the use of different measurement instruments or alternative ways of data collection may enable a lower participant burden. This may support participation in research and increase sample size and power of these type of studies. Researchers should consider whether to invest available funds in (intensive) recruitment efforts or in more demanding data collection methods.

Intervention development and implementation

From an planned health promotion perspective, intervention development is often performed using strict protocols such as Intervention Mapping [310]. Following the different steps for the Intervention Mapping process ensures that the intervention builds on available evidence and its effectiveness may be theoretically expected [310]. However, the (often) prefixed interventions that result from an Intervention Mapping process may not allow for adaptations that may be needed to support implementation. To overcome these implementation challenges, interventions need to be developed in cooperation with practice partners or the target population. A so-called mutual adaptation approach may ensure the fit of an intervention with its implementation context, keeping in mind the evidence base for intervention activities [311, 312]. Within the development of SuperFIT we tried to adopt a mutual adaptation approach. First of all, SuperFIT was developed through a cooperation of practice-based and research professionals. Both the implementers and the target population (preschool teachers) were represented in this cooperation. Several activities were undertaken to involve preschool teachers, such as a needs assessment, co-creation sessions, collective brainstorms and interviews. Further, informal conversations with preschool teachers were used as input for intervention development. As a result, SuperFIT was developed keeping in mind the theoretical framework and selecting evidence-based intervention strategies, while taking into account the practical possibilities and applicability for the target population. This was a very intensive process and often it was difficult to ensure an equal contribution of all parties involved. The balance between top-down and bottom-up development did often tip towards top-down. It is important to note, that despite the efforts that were taken to involve the preschool teachers, they often experienced implementation as top-down and did not feel involved in intervention development. Even more explicit co-creation techniques, such as working groups (ensuring active participation in selection of intervention activities [268, 313]) or group based model building (community-based technique to identify processes and

recommendations within systems [314, 315]) may be needed. Working with representatives of the target population (in our case managers of preschool teachers) may not be sufficient to ensure bottom-up development of intervention activities.

SuperFIT focused on the promotion of PA levels in general and not on quality of PA. As pre-schoolers are still developing their motor skills, quality of PA may be very important within the ECE setting [316]. Interventions have shown to be effective in changing the fundamental motor skills of pre-schoolers [123, 126]. In addition, some preschool teachers expressed they would have liked to be coached on providing PA opportunities in the physical education room, which is often more aimed at fundamental motor skill development. This could be a valuable addition to SuperFIT to include the quality of PA within the ECE setting.

Lessons Learned and Recommendations

Mutual adaptation in the ECE setting

As said, SuperFIT was developed adopting a mutual adaptation approach. During the development, lessons were learned on adopting such an approach in the ECE setting. We encountered competition of this project-based work with other tasks and duties in the possibilities and prioritizing the activities of practice partners. Sometimes this caused delays in the development and implementation of SuperFIT activities. Childcare staff are supposed to prepare and run their daily (educational) programme, observe pre-schoolers and fill out forms, and care for the pre-schoolers in very limited time. It is understandable that health promotion and active participation in intervention development may not be high in their priorities. This needs to be taken into account within intervention development and more upstream changes may be needed [317]. If health promotion in the ECE setting is a national or organizational priority, these factors should be taken into account and (more) prominent attention for the ECE setting is needed in national policies such as 'The National Prevention Agreement' (Het Nationaal Preventie Akkoord). True commitment of the involved parties is very important for a mutual adaptation approach, and should be reflected, for example, in making time and/or incentives available for individuals to work on the project. Further, we experienced that a linking-pin, someone who understands all parties involved, speaks their language and has the trust of all parties, is essential in the success of such mutual adaptation processes. This may be a health promotion professional or a health broker, as other studies have shown [268, 318]. Involvement within practice, flexibility, and context sensitivity are characteristics that may be needed in such a linking-pin [268]. Ideally, a consistent group of people is involved in intervention development and implementation reducing influences of handing over of duties. Parents were not actively involved in the development of SuperFIT, except for the participants of the needs assessment. More involvement of parents within intervention development may enrich the intervention activities that are eventually implemented and ensure a fit with the needs of the parents resulting in more sustainable

activities [108]. Community engagement and participatory action research can facilitate the involvement of parents, while this may require a different approach towards goal setting and evaluation [319].

Effectiveness of interventions in the ECE setting

The evaluation of SuperFIT indicated some positive changes in the intervention group, however effectiveness could not be demonstrated as changes were also seen in the control group. With regard to its effectiveness, SuperFIT is no exception among interventions in the ECE setting, unfortunately. Increasing attention is being paid to healthy nutrition and physical activity in the ECE setting and different types of interventions have been studied internationally. However, these interventions have shown limited effectiveness [201, 247, 320-323]. Although the ECE setting is considered a promising setting to implement health promoting intervention, it appears to be quite difficult to achieve changes in behaviour. One explanation could be that because health promotion in young children is still relatively new, the ECE setting is less ready for implementation of interventions. This may mean that more effort needs to be taken to make sure that ECE staff is committed to the topic, before the start of an implementation process. Integrating health promotion or healthy lifestyle in the education programmes of ECE staff may be the first step needed. Education on healthy nutrition and PA is important, as preschool staff may still lack knowledge on healthy nutrition and PA, and more how to put this knowledge into practice [324]. Studies have shown that children in ECE centres with staff trained regarding PA are more physically active and less sedentary [152]. Currently, courses on health promotion are elective in the Dutch ECE staff curriculum. A fixed place in the curriculum would ensure that all ECE staff working with young children have the same basis related to a healthy lifestyle. Further, early involvement of staff in designing and developing interventions may assist to enthuse staff on the topic. Up till now, interventions appear to be predominantly top-down developed and implemented. Important factors for ECE staff such as work demand, specific needs, and scheduling may thus not be taken into account. These are often mentioned as hindering factors for high quality intervention implementation [253, 256]. Such contextual factors may be more important in the support of successful intervention implementation than for example, personal determinants. During the implementation of SuperFIT, preschool staff often indicated that they found it very important to address healthy nutrition and PA, but felt constraint by strict budgets, limited time, and high workload. However, the personal determinants of ECE staff may also need to be addressed. There is a persistent misconception that pre-schoolers are by nature sufficiently active and that they do not need stimulation to be active and sitting on a chair is often associated with structure [173, 325]. In addition, ECE staff may not feel that it is their responsibility to promote healthy nutrition and PA in pre-schoolers, as they regard parents the main responsible [74, 325]. As a result, there may be a limited perceived need for change in the ECE setting. Large, national initiatives may be needed to increase awareness and need for change in the ECE setting. In addition, such national initiatives can

support the implementation of health promoting activities within the ECE setting. In the Netherlands, the 'Healthy Childcare' program (following the 'Healthy School' initiative) can support childcare organizations with health promotion activities. It is an integrated, systematic approach for ECE organizations to work on different health-related topics, among which are nutrition and PA [262]. This may aid childcare organizations to take the first step when they want to start with health promoting activities. As described before, the JOGG initiative is implemented in many municipalities in the Netherlands [141]. Their activities are primarily aimed at the primary school setting, although locally attention has been given to the ECE setting and young children. Expanding and translating their (national) activities and campaigns to the ECE setting may aid childcare organizations in their attempts to promote healthy nutrition and PA. A cooperation with JOGG may also improve the availability of materials and resources needed to implement activities.

Intervention components, activities and delivery

From a theoretical perspective, the SuperFIT approach was developed as a multi-component, comprehensive, integrated intervention approach [38, 45, 47, 86]. The clustering of nutrition and PA behaviour indicates the need to address both behaviours when promoting healthy EBRB in young children [136, 326]. Studies have shown the increased effectiveness of intervention taking a comprehensive approach [137, 248, 327]. Our systematic review also showed that comprehensive interventions had increased odds for effects on weight-related outcomes (Chapter 2). However, taking a comprehensive approach also results in complicated and demanding intervention programs, which may lead to implementation difficulties [184, 328]. Within SuperFIT, intervention activities aimed at nutrition and PA were implemented simultaneously. There is a risk to overburden participants with intervention activities, which may influence implementation and effectiveness of interventions [263, 266]. Further, participants indicated that they selectively implemented mostly activities that were close to their personal interest or that they presumed the most needed (often more PA related activities were implemented). In this way the comprehensive approach is compromised. Alternative ways of implementing comprehensive interventions may be needed. For example, a sequential implementation of intervention activities on different subjects may be needed. For example, first intervention activities are implemented aimed at improving nutrition, after which they are followed by intervention activities aimed at improving PA. This allows for an in-depth approach of the different subjects and allows for success experiences to increase motivation to work on other subjects [264].

Some of the activities of SuperFIT, both in the preschool-based and family-based component, had an educational character, such as the training for the preschool staff and the caregiver-only sessions of the family component. The effectiveness of such purely educational activities may be debatable [95, 224, 329]. Therefore, SuperFIT also consisted of coaching on-the-job and fun family-sessions. To increase participation of parents the emphasis may have

to be put on fun and family-activities instead of pressing the need for behavioural change [127]. Often parents know what is healthy for their children and may even also be aware of their unhealthy habits, they do not want to hear that again within interventions [128]. Parents do want to spend quality time with their children in fun activities that they both enjoy [108]. Intervention activities first need to be fun and may then provide the opportunity to also educate parents on healthy nutrition and PA. Opportunities could be seized in joining existing initiatives, such as 'jungle gym' organized around Saint Nicholas ('Pietengym'), or (health-related) theatre shows [330].

Integration of different types of environments

The influence of different types of environments on pre-schoolers behaviour has been well established (e.g., [74, 134, 152, 189]) and was also recognized in the needs assessment of SuperFIT (Chapter 3). Most interventions in the ECE setting integrate the physical and sociocultural environments, but the political and economic environments are underrepresented in interventions (Chapter 2). The political environment may serve as the backbone for interventions and research has shown the importance of supportive policies in the ECE setting [73, 276]. Policies may support in more sustainable behavioural change and are considered more upstream intervention strategies [245, 331]. Within SuperFIT, policies were mainly addressed during the maintenance phase. At that point the ECE organization reformulated their organizational vision on healthy childcare and this created opportunities for the continuation of SuperFIT within the organization. It is important for ECE organizations to consider that organizational commitment goes beyond formulating visions and/or policies. The organization should take into account that it also entails the provision of sufficient resources, such as time or money, to support intervention implementation and maintenance. These factors, related to the economic environment, are hardly described in intervention research in the ECE setting. However, financial issues may be very important for both intervention implementation and maintenance. Common practice may be that (research) grants provide for the initial development and implementation. However, they mostly do not provide for sustainability. We experienced that once the target organization becomes responsible for the costs of intervention maintenance, much of the implementation efforts may fade away. To be able to change the behaviour of pre-schoolers and to have an effect on health outcomes such as overweight and obesity, the sustainability of interventions may be crucial. Therefore, it is necessary to increase attention towards the political and economic environments.

When taking into account the different types of environments, it is also necessary to address interactions between the different types of environments [48]. The provision of play materials (physical environment) may still need preschool staff to provide and use these materials during play time (sociocultural environment). Implementation of new policies (political environment) still requires preschool staff and parents to adhere to these policies

(sociocultural environment). Little research has been done on the interaction of different types of environments [48, 282]. Further research is needed to increase our understanding on the role of interactions between types of environments, both on intervention implementation as well as pre-schoolers' EBRB.

Alignment of different settings

One of the pillars of SuperFIT is the alignment of different settings. Therefore, SuperFIT primarily targeted both the ECE and the home settings. This alignment was supportive for the effects of SuperFIT as the largest effects on the behaviour of pre-schoolers were seen in those participating in the family-based component. Previous research has shown the importance of parental involvement within interventions in the ECE setting [99]. Moreover, direct parental involvement appears to be more beneficial compared to indirect parental involvement strategies [58]. However, parental involvement might also be one of the biggest challenges. Even when all preconditions are taken into account, parental participation within interventions remains limited [131]. In addition, the home setting is difficult to change directly, as all changes need to occur through the parents. Barriers that may not be changeable through an intervention, such as the financial possibilities of parents or the characteristics of their house, may influence the integration of intervention activities in their daily life. As a result, limited intervention effects may be found in the home setting. It is important to increase our understanding of intervention strategies that may work in the home setting. This might require experimenting with different ways of directly involving parents. Alternative strategies may be, for example, providing an 'activity backpack' that children bring home [332] or using online intervention activities [333, 334].

Further, alignment may be needed between the ECE and primary school settings. The influence of the primary school was mentioned several times during implementation of SuperFIT. Due to the fact that preschools and day-cares are often situated within the building of the primary school, the primary school influences their possibilities with regard to healthy nutrition and PA. When alignment between the ECE and primary school was positive, this would serve as a supportive factor for implementation of SuperFIT. In addition, transition from ECE to primary school may be very influential on children's EBRB. Such transitions are up till now predominantly studied in the transition from primary to secondary education and shows that PA is negatively affected by this transition [335-337]. Little is known of the transition from ECE to primary school; one study showed a decrease in PA after this transition [338]. It may be hypothesized that alignment between ECE and primary school on healthy behaviours is supportive for the EBRB of children. Further research on the influence of this transition and the influence of inconsistencies between these settings may

increase our knowledge on how to influence children's EBRB in such a way that it will result in lifelong changes.

General conclusion

SuperFIT is a comprehensive, integrated intervention approach to promote healthy energy balance-related behaviours in 2-4-year-old children and prevent childhood overweight and obesity. SuperFIT aims to change different types of environments in both the preschool and home settings. Changes were seen in the preschool setting. More time was spent in PA activities and less time sedentary. An increased awareness among preschool staff of their role in the EBRB of young children, resulted in changes in their nutrition and PA-related practices. As a result, a more supportive social environment was formed. The duration of the intervention, as well as the long follow-up were important to be able to establish and detect these changes. However, no differences were found in the PA of pre-schoolers and their BMI z-score between the intervention and control group to support the effectiveness of SuperFIT.

Several factors were identified that influenced the implementation and maintenance of SuperFIT. In particular, the perceived top-down implementation may have hindered integration of SuperFIT in practice. Although difficult and often time-consuming, bottom-up approaches may need to be intensified. Alternative ways should be sought to ensure that bottom-up processes are experienced as such. Furthermore, the home setting is considered as an important influence on pre-schoolers EBRB. SuperFIT aims to actively involve parents through a family-based component, but parental recruitment was a challenge. Developing intervention strategies that appeal to parents and may lead to effects in the home setting is difficult and the golden bullet has yet to be found. Optimisation of the family-based component is crucial in ensuring true alignment between the preschool and home settings and the promotion of healthy energy balance-related behaviours in young children. SuperFIT has taken first, promising steps in the alignment between the ECE setting and home setting and has shown directions for further development.

References

References

1. Afshin A, Forouzanfar MH, Reitsma MB, Sur P, Estep K, Lee A, et al. Health Effects of Overweight and Obesity in 195 Countries over 25 Years. N Engl J Med. 2017;377(1):13-27.
2. Daniels SR. Complications of obesity in children and adolescents. Int J Obes (Lond). 2009;33 Suppl 1:S60-5.
3. World Health Organization. Ending Childhood Obesity. 2016.
4. de Onis M, Blössner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. Am J Clin Nutr. 2010;92(5):1257-64.
5. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA, et al. Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. PLoS One. 2011;6(11):e27608.
6. Kumar S, Kelly AS. Review of Childhood Obesity: From Epidemiology, Etiology, and Comorbidities to Clinical Assessment and Treatment. Mayo Clin Proc. 2017;92(2):251-65.
7. De Kroon MLA, Renders CM, Van Wouwe JP, Van Buuren S, Hirasing RA. The Terneuzen Birth Cohort: BMI Changes between 2 and 6 Years Correlate Strongest with Adult Overweight. PLoS One. 2010;5(2):e9155.
8. Singh AS, Mulder C, Twisk JW, van Mechelen W, Chinapaw MJ. Tracking of childhood overweight into adulthood: a systematic review of the literature. Obes Rev. 2008;9(5):474-88.
9. Parsons TJ, Power C, Manor O. Fetal and early life growth and body mass index from birth to early adulthood in 1958 British cohort: longitudinal study. BMJ (Clinical research ed). 2001;323(7325):1331-5.
10. World Health Organization. Diet, nutrition, and the prevention of chronic diseases. Report of a WHO Study Group. Geneva, Switzerland: World Health Organization; 2003. Report No.: No. 797 Contract No.: No. 797.
11. Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. Best Pract Res Clin Endocrinol Metab. 2005;19(3):343-58.
12. Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-related behaviours from childhood to adulthood: A systematic review. Maturitas. 2011;70(3):266-84.
13. Goldfield GS, Harvey A, Grattan K, Adamo KB. Physical activity promotion in the preschool years: a critical period to intervene. Int J Environ Res Public Health. 2012;9(4):1326-42.
14. Telama R, Yang X, Leskinen E, Kankaanpaa A, Hirvensalo M, Tammelin T, et al. Tracking of physical activity from early childhood through youth into adulthood. Med Sci Sports Exerc. 2014;46(5):955-62.
15. Carson V, Lee E-Y, Hewitt L, Jennings C, Hunter S, Kuzik N, et al. Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). BMC Public Health. 2017;17(5):854.
16. Casas R, Castro-Barquero S, Estruch R, Sacanella E. Nutrition and Cardiovascular Health. Int J Mol Sci. 2018;19(12).

17. Frankel S, Gunnell DJ, Peters TJ, Maynard M, Davey Smith G. Childhood energy intake and adult mortality from cancer: the Boyd Orr Cohort Study. BMJ (Clinical research ed). 1998;316(7130):499-504.
18. Fidler Mis N, Braegger C, Bronsky J, Campoy C, Domellöf M, Embleton ND, et al. Sugar in Infants, Children and Adolescents: A Position Paper of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. J Pediatr Gastroenterol Nutr. 2017;65(6):681-96.
19. Vos MB, Kaar JL, Welsh JA, Van Horn LV, Feig DI, Anderson CAM, et al. Added Sugars and Cardiovascular Disease Risk in Children: A Scientific Statement From the American Heart Association. Circulation. 2017;135(19):e1017-e34.
20. Berglind D, Tynelius P. Objectively measured physical activity patterns, sedentary time and parent-reported screen-time across the day in four-year-old Swedish children. BMC Public Health. 2017;18(1):69.
21. Chaput J-P, Colley RC, Aubert S, Carson V, Janssen I, Roberts KC, et al. Proportion of preschool-aged children meeting the Canadian 24-Hour Movement Guidelines and associations with adiposity: results from the Canadian Health Measures Survey. BMC Public Health. 2017;17(5):829.
22. Hinkley T, Salmon J, Okely AD, Crawford D, Hesketh K. Preschoolers' physical activity, screen time, and compliance with recommendations. Med Sci Sports Exerc. 2012;44(3):458-65.
23. De Craemer M, McGregor D, Androutsos O, Manios Y, Cardon G. Compliance with 24-h Movement Behaviour Guidelines among Belgian Pre-School Children: The ToyBox-Study. Int J Environ Res Public Health. 2018;15(10).
24. Tremblay MS, Chaput J-P, Adamo KB, Aubert S, Barnes JD, Choquette L, et al. Canadian 24-Hour Movement Guidelines for the Early Years (0–4 years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep. BMC Public Health. 2017;17(5):874.
25. Cardon GM, De Bourdeaudhuij IM. Are preschool children active enough? Objectively measured physical activity levels. Res Q Exerc Sport. 2008;79(3):326-32.
26. Cooper AR, Goodman A, Page AS, Sherar LB, Esliger DW, van Sluijs EM, et al. Objectively measured physical activity and sedentary time in youth: the International children's accelerometry database (ICAD). Int J Behav Nutr Phys Act. 2015;12:113.
27. Farooq MA, Parkinson KN, Adamson AJ, Pearce MS, Reilly JK, Hughes AR, et al. Timing of the decline in physical activity in childhood and adolescence: Gateshead Millennium Cohort Study. Br J Sports Med. 2018;52(15):1002-6.
28. Gubbels JS, Raaijmakers LG, Gerards SM, Kremers SP. Dietary intake by Dutch 1- to 3-year-old children at childcare and at home. Nutrients. 2014;6(1):304-18.
29. Banfield EC, Liu Y, Davis JS, Chang S, Frazier-Wood AC. Poor Adherence to US Dietary Guidelines for Children and Adolescents in the National Health and Nutrition Examination Survey Population. J Acad Nutr Diet. 2016;116(1):21-7.
30. Centraal Bureau voor de Statistiek. Kinderen eten te weinig fruit, groente en vis [Internet]. 2017 [cited 3 May 2018]. Available from: *https://www.cbs.nl/nl-nl/nieuws/2017/46/kinderen-eten-te-weinig-fruit-groente-en-vis*.

31. Sluik D, van Lee L, Engelen AI, Feskens EJ. Total, Free, and Added Sugar Consumption and Adherence to Guidelines: The Dutch National Food Consumption Survey 2007-2010. Nutrients. 2016;8(2):70.
32. Ling J, Zahry NR, Wasilevich E, Robbins LB. Dietary Intake Among Head Start Preschooler-caregiver Dyads. J Pediatr Nurs. 2018;42:65-72.
33. Azaïs-Braesco V, Sluik D, Maillot M, Kok F, Moreno LA. A review of total & added sugar intakes and dietary sources in Europe. Nutr J. 2017;16(1):6-.
34. World Health Organization. Guideline: Sugars intake for adults and children. Geneva, Switzerland; 2015.
35. van Rossem CTM, Buurma-Rethans EJM, Vennemann FBC, Beukers M, Brants HAM, de Boer EJ, et al. The diet of the Dutch: Results of the first two years of the Dutch National Food Consumption Survey 2012-2016. Bilthoven, the Netherlands: National Institute for Public Health and the Environment; 2016.
36. Ford CN, Slining MM, Popkin BM. Trends in dietary intake among US 2- to 6-year-old children, 1989-2008. J Acad Nutr Diet. 2013;113(1):35-42.
37. Ajzen I. From Intentions to Actions: A Theory of Planned Behavior. In: Kuhl J, Beckmann J, editors. Action Control: From Cognition to Behavior. Berlin, Heidelberg: Springer Berlin Heidelberg; 1985. p. 11-39.
38. Sallis JF, Owen N, Fisher E. Ecological models of health behavior. In: Glanz K, Rimer BK, Viswanath K, editors. Health behavior: theory, research, and practice. San Francisco: Jossey-Bass; 2008. p. 465-85.
39. Kremers SPJ, de Bruijn GJ, Visscher TL, van Mechelen W, de Vries NK, Brug J. Environmental influences on energy balance-related behaviors: a dual-process view. Int J Behav Nutr Phys Act. 2006;3:9.
40. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Health Educ Q. 1988;15(4):351-77.
41. Stokols D, Grzywacz JG, McMahan S, Phillips K. Increasing the health promotive capacity of human environments. American journal of health promotion : AJHP. 2003;18(1):4-13.
42. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. Prev Med. 1999;29(6 Pt 1):563-70.
43. Hawe P, Shiell A, Riley T. Theorising interventions as events in systems. Am J Community Psychol. 2009;43(3-4):267-76.
44. Wachs TD. Integrating multiple influences, midlevel, processes, and systems. In: Wachs TD, editor. Necessary but not sufficient: the respective roles of single and multiple inlfuences on individual development. Washington: American Psychological Association; 2000. p. 261-316.
45. Bronfenbrenner U. The Ecology of Human Development. Cambridge, Massachusetts and London, England: Harvard University Press; 1979.
46. Laughlin L. Who's minding the kids? Childcare arrangements: Spring 2011. Washington, DC: U.S. Census Bureau; 2013.

47. Bradley RH. From home to day care: chaos in the family/child-care mesosystem. In: Evans GW, Wachs TD, editors. Chaos and its influence on children's development An ecological perspective Washington: American Psychological Association; 2010.
48. Gubbels JS, Van Kann DH, de Vries NK, Thijs C, Kremers SP. The next step in health behavior research: the need for ecological moderation analyses - an application to diet and physical activity at childcare. Int J Behav Nutr Phys Act. 2014;11:52.
49. Gubbels JS, Stessen K, van de Kolk I, de Vries NK, Thijs C, Kremers SPJ. Energy balance-related parenting and child-care practices: The importance of meso-system consistency. PLoS One. 2018;13(9):e0203689.
50. Sleddens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP. General parenting, childhood overweight and obesity-inducing behaviors: a review. Int J Pediatr Obes. 2011;6(2-2):e12-27.
51. Darling N, Steinberg L. Parenting Style as Context: An Integrative Model. Psychological Bulletin. 1993;113:487-96.
52. Gubbels JS, Kremers SP, Stafleu A, de Vries SI, Goldbohm RA, Dagnelie PC, et al. Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: the KOALA Birth Cohort Study. Int J Behav Nutr Phys Act. 2011;8:18.
53. Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. J Law Med Ethics. 2007;35(1):22-34.
54. Wiseman N, Harris N, Downes M. Preschool children's preferences for sedentary activity relates to parent's restrictive rules around active outdoor play. BMC Public Health. 2019;19(1):946.
55. Brown HE, Atkin AJ, Panter J, Wong G, Chinapaw MJ, van Sluijs EM. Family-based interventions to increase physical activity in children: a systematic review, meta-analysis and realist synthesis. Obes Rev. 2016;17(4):345-60.
56. Barkin SL, Gesell SB, Po'e EK, Escarfuller J, Tempesti T. Culturally tailored, family-centered, behavioral obesity intervention for Latino-American preschool-aged children. Pediatrics. 2012;130(3):445-56.
57. Walton K, Filion AJ, Gross D, Morrongiello B, Darlington G, Randall Simpson J, et al. Parents and Tots Together: Pilot randomized controlled trial of a family-based obesity prevention intervention in Canada. Can J Public Health. 2016;106(8):e555-62.
58. Hingle MD, O'Connor TM, Dave JM, Baranowski T. Parental involvement in interventions to improve child dietary intake: a systematic review. Prev Med. 2010;51(2):103-11.
59. Morgan PJ, Collins CE, Plotnikoff RC, Callister R, Burrows T, Fletcher R, et al. The 'Healthy Dads, Healthy Kids' community randomized controlled trial: A community-based healthy lifestyle program for fathers and their children. Prev Med. 2014;61:90-9.
60. Organisation for Economic Co-operation and Development. PF3.2: Enrolment in childcare and pre-school [Internet]. 2016 [cited 28 June 2018]. Available from: *http://www.oecd.org/els/soc/PF3_2_Enrolment_childcare_preschool.pdf*.
61. Eurostat. Eurostat News Release. Childcare in the EU in 2006. A quarter of children aged less than three in formal childcare. Eurostat Press Office; 2008.

62. Alberdi G, McNamara AE, Lindsay KL, Scully HA, Horan MH, Gibney ER, et al. The association between childcare and risk of childhood overweight and obesity in children aged 5 years and under: a systematic review. Eur J Pediatr. 2016;175(10):1277-94.
63. Geoffroy MC, Power C, Touchette E, Dubois L, Boivin M, Seguin JR, et al. Childcare and overweight or obesity over 10 years of follow-up. J Pediatr. 2013;162(4):753-8.e1.
64. Gubbels JS, Kremers SP, Stafleu A, Dagnelie PC, de Vries NK, van Buuren S, et al. Child-care use and the association with body mass index and overweight in children from 7 months to 2 years of age. Int J Obes (Lond). 2010;34(10):1480-6.
65. Koleilat M, Harrison GG, Whaley S, McGregor S, Jenks E, Afifi A. Preschool enrollment is associated with lower odds of childhood obesity among WIC participants in LA County. Matern Child Health J. 2012;16(3):706-12.
66. Lumeng JC, Gannon K, Appugliese D, Cabral HJ, Zuckerman B. Preschool child care and risk of overweight in 6- to 12-year-old children. Int J Obes (Lond). 2005;29(1):60-6.
67. Flores G, Lin H. Factors predicting severe childhood obesity in kindergarteners. Int J Obes (Lond). 2013;37(1):31-9.
68. O'Brien KT, Vanderloo LM, Bruijns BA, Truelove S, Tucker P. Physical activity and sedentary time among preschoolers in centre-based childcare: a systematic review. Int J Behav Nutr Phys Act. 2018;15(1):117.
69. Hesketh KR, Griffin SJ, van Sluijs EM. UK Preschool-aged children's physical activity levels in childcare and at home: a cross-sectional exploration. Int J Behav Nutr Phys Act. 2015;12:123.
70. Hinkley T, Salmon J, Crawford D, Okely AD, Hesketh KD. Preschool and childcare center characteristics associated with children's physical activity during care hours: an observational study. Int J Behav Nutr Phys Act. 2016;13(1):117.
71. Tonge KL, Jones RA, Okely AD. Correlates of children's objectively measured physical activity and sedentary behavior in early childhood education and care services: A systematic review. Prev Med. 2016;89:129-39.
72. Gubbels JS, Van Kann DH, Jansen MW. Play equipment, physical activity opportunities, and children's activity levels at childcare. J Environ Public Health. 2012;2012:326520.
73. van Zandvoort M, Tucker P, Irwin JD, Burke SM. Physical activity at daycare: issues, challenges and perspectives. Early Years. 2010;30(2):175-88.
74. Wilke S, Opdenakker C, Kremers SP, Gubbels JS. Factors influencing childcare workers' promotion of physical activity in children aged 0–4 years: a qualitative study. Early Years. 2013;33(3):226-38.
75. Ward S, Belanger M, Donovan D, Carrier N. Systematic review of the relationship between childcare educators' practices and preschoolers' physical activity and eating behaviours. Obes Rev. 2015;16(12):1055-70.
76. Vereecken C, Huybrechts I, van Houte H, Martens V, Wittebroodt I, Maes L. Results from a dietary intervention study in preschools "Beastly Healthy at School". Int J Public Health. 2009;54(3):142-9.

77. Larson N, Ward DS, Neelon SB, Story M. What Role Can Child-Care Settings Play in Obesity Prevention? A Review of the Evidence and Call for Research Efforts. J Am Diet Assoc. 2011;111(9):1343-62.
78. Lloyd-Williams F, Bristow K, Capewell S, Mwatsama M. Young children's food in Liverpool day-care settings: a qualitative study of pre-school nutrition policy and practice. Public Health Nutr. 2011;14(10):1858-66.
79. Ling J, Robbins LB, Wen F. Interventions to prevent and manage overweight or obesity in preschool children: A systematic review. Int J Nurs Stud. 2016;53:270-89.
80. Ling J, Robbins LB, Wen F, Zhang N. Lifestyle Interventions in Preschool Children: A Meta-analysis of Effectiveness. Am J Prev Med. 2017;53(1):102-12.
81. Sisson SB, Krampe M, Anundson K, Castle S. Obesity prevention and obesogenic behavior interventions in child care: A systematic review. Prev Med. 2016;87:57-69.
82. World Health Organization. Health-promoting schools: a healthy setting for living, learning and working. 1997.
83. Gezonde school. Wat is Gezonde School? [Internet]. n.d. [cited 8 October 2020]. Available from: *https://www.gezondeschool.nl/aanpak/wat-is-gezonde-school*.
84. De Jong M, Van Koperen M. Jaarrapportage Gezonde School 2019. 2020.
85. Langford R, Bonell CP, Jones HE, Pouliou T, Murphy SM, Waters E, et al. The WHO Health Promoting School framework for improving the health and well-being of students and their academic achievement. Cochrane Database Syst Rev. 2014(4).
86. Spence JC, Lee RE. Toward a comprehensive model of physical activity. Psychol Sport Exerc. 2003;4(1):7-24.
87. Harms LSE, Gubbels JS, Van de Kolk I, Bessems KMHH, Vanbelle S, Hahnraths MTH, et al. The effects of SuperFIT, a comprehensive, integrated intervention approach, on pre-schoolers dietary intake. BMC Public Health. submitted.
88. Wabitsch M, Moss A, Kromeyer-Hauschild K. Unexpected plateauing of childhood obesity rates in developed countries. BMC Med. 2014;12:17.
89. Cunningham SA, Kramer MR, Narayan KM. Incidence of childhood obesity in the United States. N Engl J Med. 2014;370(5):403-11.
90. Kremers SP, Visscher TL, Seidell JC, van Mechelen W, Brug J. Cognitive determinants of energy balance-related behaviours: measurement issues. Sports Med. 2005;35(11):923-33.
91. Gubbels JS, Kremers SP, Goldbohm RA, Stafleu A, Thijs C. Energy balance-related behavioural patterns in 5-year-old children and the longitudinal association with weight status development in early childhood. Public Health Nutr. 2012;15(8):1402-10.
92. Fernandez-Jimenez R, Al-Kazaz M, Jaslow R, Carvajal I, Fuster V. Children Present a Window of Opportunity for Promoting Health: JACC Review Topic of the Week. J Am Coll Cardiol. 2018;72(25):3310-9.
93. Perrin EM, Howard JB, Ward DS. In the Absence of Clear Causation, Casting a Wider Net for Prevention. Pediatrics. 2016;138(5).

94. Escalante Y, Garcia-Hermoso A, Backx K, Saavedra JM. Playground designs to increase physical activity levels during school recess: a systematic review. Health Educ Behav. 2014;41(2):138-44.
95. Temple M, Robinson JC. A systematic review of interventions to promote physical activity in the preschool setting. J Spec Pediatr Nurs. 2014;19(4):274-84.
96. Hendrie GA, Coveney J, Cox DN. Defining the complexity of childhood obesity and related behaviours within the family environment using structural equation modelling. Public Health Nutr. 2012;15(1):48-57.
97. Kader M, Sundblom E, Elinder LS. Effectiveness of universal parental support interventions addressing children's dietary habits, physical activity and bodyweight: A systematic review. Prev Med. 2015;77:52-67.
98. Waters E, de Silva-Sanigorski A, Burford BJ, Brown T, Campbell KJ, Gao Y, et al. Interventions for preventing obesity in children. Cochrane Database Syst Rev. 2011(12).
99. Ward DS, Welker E, Choate A, Henderson KE, Lott M, Tovar A, et al. Strength of obesity prevention interventions in early care and education settings: A systematic review. Prev Med. 2017;95:S37-S52.
100. Morris H, Skouteris H, Edwards S, Rutherford L. Obesity prevention interventions in early childhood education and care settings with parental involvement: A systematic review. Early Child Dev Care. 2015;185(8):1283-313.
101. Verjans-Janssen SRB, van de Kolk I, Van Kann DHH, Kremers SPJ, Gerards SMPL. Effectiveness of school-based physical activity and nutrition interventions with direct parental involvement on children's BMI and energy balance-related behaviors – A systematic review. PLoS One. 2018;13(9):e0204560.
102. Cohen J. Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Earlbaum Associates; 1988.
103. Lipsey MW, Aiken LS. Design sensitivity: Statistical power for experimental research: Sage; 1990.
104. Thomas BH, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. Worldviews Evid Based Nurs. 2004;1(3):176-84.
105. Adamo KB, Wasenius NS, Grattan KP, Harvey ALJ, Naylor PJ, Barrowman NJ, et al. Effects of a Preschool Intervention on Physical Activity and Body Composition. J Pediatr. 2017;188:42-9.e2.
106. Cespedes J, Briceno G, Farkouh ME, Vedanthan R, Baxter J, Leal M, et al. Targeting preschool children to promote cardiovascular health: cluster randomized trial. Am J Med. 2013;126(1):27-35 e3.
107. Cruz TH, Davis SM, Myers OB, O'Donald ER, Sanders SG, Sheche JN. Effects of an Obesity Prevention Intervention on Physical Activity Among Preschool Children: The CHILE Study. Health Promot Pract. 2016;17(5):693-701.

108. De Bock F, Genser B, Raat H, Fischer JE, Renz-Polster H. A participatory physical activity intervention in preschools: A cluster randomized controlled trial. Am J Prev Med. 2013;45(1):64-74.
109. Gao Y, Cai C, Li J, Sun W. Nutritional Intervention and Breakfast Behavior of Kindergartens. Iran J Public Health. 2016;45(3):297-304.
110. Hu C, Ye D, Li Y, Huang Y, Li L, Gao Y, et al. Evaluation of a kindergarten-based nutrition education intervention for pre-school children in China. Public Health Nutr. 2010;13(2):253-60.
111. Kaufman-Shriqui V, Fraser D, Friger M, Geva D, Bilenko N, Vardi H, et al. Effect of a School-Based Intervention on Nutritional Knowledge and Habits of Low-Socioeconomic School Children in Israel: A Cluster-Randomized Controlled Trial. Nutrients. 2016;8(4).
112. Lumeng JC, Miller AL, Horodynski MA, Brophy-Herb HE, Contreras D, Lee H, et al. Improving Self-Regulation for Obesity Prevention in Head Start: A Randomized Controlled Trial. Pediatrics. 2017;139(5).
113. Natale RA, Lopez-Mitnik G, Uhlhorn SB, Asfour L, Messiah SE. Effect of a child care center-based obesity prevention program on body mass index and nutrition practices among preschool-aged children. Health Promotion Practice. 2014;15(5):695-705.
114. Natale RA, Messiah SE, Asfour L, Uhlhorn SB, Delamater A, Arheart KL. Role modeling as an early childhood obesity prevention strategy: Effect of parents and teachers on preschool children's healthy lifestyle habits. J Dev Behav Pediatr. 2014;35(6):378-87.
115. Nyberg G, Norman A, Sundblom E, Zeebari Z, Elinder LS. Effectiveness of a universal parental support programme to promote health behaviours and prevent overweight and obesity in 6-year-old children in disadvantaged areas, the Healthy School Start Study II, a cluster-randomised controlled trial. Int J Behav Nutr Phys Act. 2016;13:4.
116. Nyberg G, Sundblom E, Norman A, Bohman B, Hagberg J, Elinder LS. Effectiveness of a universal parental support programme to promote healthy dietary habits and physical activity and to prevent overweight and obesity in 6-year-old children: the Healthy School Start Study, a cluster-randomised controlled trial. PLoS One. 2015;10(2):e0116876.
117. Puder JJ, Marques-Vidal P, Schindler C, Zahner L, Niederer I, Burgi F, et al. Effect of multidimensional lifestyle intervention on fitness and adiposity in predominantly migrant preschool children (Ballabeina): cluster randomised controlled trial. BMJ. 2011;343:d6195.
118. Roth K, Kriemler S, Lehmacher W, Ruf KC, Graf C, Hebestreit H. Effects of a Physical Activity Intervention in Preschool Children. Med Sci Sports Exerc. 2015;47(12):2542-51.
119. Story M, Hannan PJ, Fulkerson JA, Rock BH, Smyth M, Arcan C, et al. Bright Start: Description and main outcomes from a group-randomized obesity prevention trial in American Indian children. Obesity (Silver Spring). 2012;20(11):2241-9.
120. Williams PA, Cates SC, Blitstein JL, Hersey J, Gabor V, Ball M, et al. Nutrition-education program improves preschoolers' at-home diet: a group randomized trial. J Acad Nutr Diet. 2014;114(7):1001-8.

121. Davis SM, Myers OB, Cruz TH, Morshed AB, Canaca GF, Keane PC, et al. CHILE: Outcomes of a group randomized controlled trial of an intervention to prevent obesity in preschool Hispanic and American Indian children. Prev Med. 2016;89:162-8.
122. Natale RA, Messiah SE, Asfour LS, Uhlhorn SB, Englebert NE, Arheart KL. Obesity Prevention Program in Childcare Centers: Two-Year Follow-Up. Am J Health Promot. 2017;31(6):502-10.
123. Wasenius NS, Grattan KP, Harvey ALJ, Naylor PJ, Goldfield GS, Adamo KB. The effect of a physical activity intervention on preschoolers' fundamental motor skills - A cluster RCT. J Sci Med Sport. 2018;21(7):714-9.
124. Yin Z, Parra-Medina D, Cordova A, He M, Trummer V, Sosa E, et al. Miranos! Look at us, we are healthy! An environmental approach to early childhood obesity prevention. Child Obes. 2012;8(5):429-39.
125. Zhou Z, Ren H, Yin Z, Wang L, Wang K. A policy-driven multifaceted approach for early childhood physical fitness promotion: impacts on body composition and physical fitness in young Chinese children. BMC Pediatr. 2014;14:118.
126. Klein D, Manz K, Ferrari N, Struder H, Graf C. Effects of health promotion projects in preschools on body mass index and motor abilities. J Sports Med Phys Fitness. 2015;55(1-2):103-12.
127. Rhodes RE, Lim C. Promoting Parent and Child Physical Activity Together: Elicitation of Potential Intervention Targets and Preferences. Health Educ Behav. 2017:1090198117704266.
128. Martin-Biggers J, Spaccarotella K, Hongu N, Alleman G, Worobey J, Byrd-Bredbenner C. Translating it into real life: a qualitative study of the cognitions, barriers and supports for key obesogenic behaviors of parents of preschoolers. BMC Public Health. 2015;15:189.
129. Spoth R, Redmond C. Research on Family Engagement in Preventive Interventions: Toward Improved Use of Scientific Findings in Primary Prevention Practice. J Prim Prev. 2000;21(2):267-84.
130. Pettersson C, Linden-Bostrom M, Eriksson C. Reasons for non-participation in a parental program concerning underage drinking: a mixed-method study. BMC Public Health. 2009;9:478.
131. Heath SM, Wigley CA, Hogben JH, Fletcher J, Collins P, Boyle GL, et al. Patterns in Participation: Factors Influencing Parent Attendance at Two, Centre-Based Early Childhood Interventions. J Child Fam Stud. 2018;27(1):253-67.
132. Hendriks AM, Habraken J, Jansen MW, Gubbels JS, De Vries NK, van Oers H, et al. 'Are we there yet?' - operationalizing the concept of Integrated Public Health Policies. Health Policy. 2014;114(2-3):174-82.
133. van de Kolk I, Goossens AJM, Gerards S, Kremers SPJ, Manders RMP, Gubbels JS. Healthy Nutrition and Physical Activity in Childcare: Views from Childcare Managers, Childcare Workers and Parents on Influential Factors. Int J Environ Res Public Health. 2018;15(12).
134. Mazarello Paes V, Ong KK, Lakshman R. Factors influencing obesogenic dietary intake in young children (0-6 years): systematic review of qualitative evidence. BMJ Open. 2015;5(9):e007396.

135. Tucker P, van Zandvoort MM, Burke SM, Irwin JD. The influence of parents and the home environment on preschoolers' physical activity behaviours: a qualitative investigation of childcare providers' perspectives. BMC Public Health. 2011;11:168.
136. Gubbels JS, Kremers SP, Stafleu A, Dagnelie PC, de Vries SI, de Vries NK, et al. Clustering of dietary intake and sedentary behavior in 2-year-old children. J Pediatr. 2009;155(2):194-8.
137. Bartelink NHM, van Assema P, Kremers SPJ, Savelberg HHCM, Oosterhoff M, Willeboordse M, et al. One- and Two-Year Effects of the Healthy Primary School of the Future on Children's Dietary and Physical Activity Behaviours: A Quasi-Experimental Study. Nutrients. 2019;11(3):689.
138. Lloyd M, Saunders TJ, Bremer E, Tremblay MS. Long-term importance of fundamental motor skills: a 20-year follow-up study. Adapt Phys Activ Q. 2014;31(1):67-78.
139. Loprinzi PD, Davis RE, Fu YC. Early motor skill competence as a mediator of child and adult physical activity. Prev Med Rep. 2015;2:833-8.
140. Borys JM, Le Bodo Y, Jebb SA, Seidell JC, Summerbell C, Richard D, et al. EPODE approach for childhood obesity prevention: methods, progress and international development. Obes Rev. 2012;13(4):299-315.
141. Jongeren Op Gezond Gewicht. JOGG Programme [Internet]. n.d. [cited 5 April 2019]. Available from: *https://jongerenopgezondgewicht.nl/jogg-aanpak*.
142. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535.
143. Gevers DW, Kremers SP, de Vries NK, van Assema P. Intake of energy-dense snack foods and drinks among Dutch children aged 7-12 years: how many, how much, when, where and which? Public Health Nutr. 2016;19(1):83-92.
144. Gubbels JS, van Assema P, Kremers SP. Physical Activity, Sedentary Behavior, and Dietary Patterns among Children. Curr Nutr Rep. 2013;2(2):105-12.
145. Ahrens W, Pigeot I, Pohlabeln H, De Henauw S, Lissner L, Molnar D, et al. Prevalence of overweight and obesity in European children below the age of 10. Int J Obes (Lond). 2014;38 Suppl 2:S99-107.
146. Organisation for Economic Co-operation and Development. Obesity Update 2017. 2017.
147. de Kroon MLA, Renders CM, van Wouwe JP, van Buuren S, Hirasing RA. The Terneuzen Birth Cohort: BMI change between 2 and 6 years is most predictive of adult cardiometabolic risk. PLoS One. 2010;5(11):e13966.
148. Swyden K, Sisson SB, Lora K, Castle S, Copeland KA. Association of childcare arrangement with overweight and obesity in preschool-aged children: a narrative review of literature. Int J Obes (Lond). 2017;41(1):1-12.
149. de Jong E, Visscher TL, HiraSing RA, Seidell JC, Renders CM. Home environmental determinants of children's fruit and vegetable consumption across different SES backgrounds. Pediatr Obes. 2015;10(2):134-40.

150. Centraal Bureau voor de Statistiek. Meer kinderen naar kinderopvang [Internet]. 2016 [cited 15 March 2017]. Available from: *https://www.cbs.nl/nl-nl/nieuws/2016/23/meer-kinderen-naar-kinderopvang*.
151. Goldbohm RA, Rubingh CM, Lanting CI, Joosten KF. Food Consumption and Nutrient Intake by Children Aged 10 to 48 Months Attending Day Care in The Netherlands. Nutrients. 2016;8(7).
152. Bower JK, Hales DP, Tate DF, Rubin DA, Benjamin SE, Ward DS. The childcare environment and children's physical activity. Am J Prev Med. 2008;34(1):23-9.
153. Hesketh KR, Lakshman R, van Sluijs EMF. Barriers and facilitators to young children's physical activity and sedentary behaviour: a systematic review and synthesis of qualitative literature. Obes Rev. 2017;18(9):987-1017.
154. Hirsch T, Lim C, Otten JJ. What's for Lunch?: A Socio-ecological Approach to Childcare Nutrition. Proceedings of the 2016 ACM Conference on Designing Interactive Systems; Brisbane, QLD, Australia. 2901793: ACM; 2016. p. 1160-71.
155. Government of the Netherlands. Welke soorten kinderopvang zijn er? [Internet]. n.d. [cited 16 August 2017]. Available from: *https://www.rijksoverheid.nl/onderwerpen/kinderopvang/vraag-en-antwoord/soorten-kinderopvang*.
156. Tax and Customs administration. Kinderopvangtoeslag (Childcare benefit) [Internet]. n.d. [cited 10 December 2018]. Available from: *https://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/prive/toeslagen/kinderopvangtoeslag/kinderopvangtoeslag-2019/kinderopvangtoeslag-2019*.
157. FCB Kinderopvang. CAO Kinderopvang 2018-2019. 2018.
158. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res. 2005;15(9):1277-88.
159. Organisation for Economic Co-operation and Development. Classifying Educational Programs; Manual for ISCED-97 implementation in OECD countries. Paris; 1999.
160. van de Gaar VM, van Grieken A, Jansen W, Raat H. Children's sugar-sweetened beverages consumption: associations with family and home-related factors, differences within ethnic groups explored. BMC Public Health. 2017;17(1):195.
161. Scharf RJ, DeBoer MD. Sugar-Sweetened Beverages and Children's Health. Annu Rev Public Health. 2016;37:273-93.
162. Lee E-Y, Hesketh KD, Hunter S, Kuzik N, Rhodes RE, Rinaldi CM, et al. Meeting new Canadian 24-Hour Movement Guidelines for the Early Years and associations with adiposity among toddlers living in Edmonton, Canada. BMC Public Health. 2017;17(5):840.
163. Roman-Viñas B, Chaput J-P, Katzmarzyk PT, Fogelholm M, Lambert EV, Maher C, et al. Proportion of children meeting recommendations for 24-hour movement guidelines and associations with adiposity in a 12-country study. Int J Behav Nutr Phys Act. 2016;13(1):123.
164. Santos R, Zhang Z, Pereira JR, Sousa-Sá E, Cliff DP, Okely AD. Compliance with the Australian 24-hour movement guidelines for the early years: associations with weight status. BMC Public Health. 2017;17(5):867.

165. Kreichauf S, Wildgruber A, Krombholz H, Gibson EL, Vogele C, Nixon CA, et al. Critical narrative review to identify educational strategies promoting physical activity in preschool. Obes Rev. 2012;13 Suppl 1:96-105.
166. Boldemann C, Blennow M, Dal H, Martensson F, Raustorp A, Yuen K, et al. Impact of preschool environment upon children's physical activity and sun exposure. Prev Med. 2006;42(4):301-8.
167. Gubbels JS, Van Kann DHH, Cardon G, Kremers SPJ. Activating Childcare Environments for All Children: the Importance of Children's Individual Needs. Int J Environ Res Public Health. 2018;15(7):1400.
168. Bjorgen K. Physical activity in light of affordances in outdoor environments: qualitative observation studies of 3-5 years olds in kindergarten. Springerplus. 2016;5(1):950.
169. Anzman-Frasca S, Savage JS, Marini ME, Fisher JO, Birch LL. Repeated exposure and associative conditioning promote preschool children's liking of vegetables. Appetite. 2012;58(2):543-53.
170. Coleman B, Dyment JE. Factors that limit and enable preschool-aged children's physical activity on child care centre playgrounds. J Early Child Res. 2013;11(3):203-21.
171. Connelly JA, Champagne M, Manningham S. Early Childhood Educators' Perception of Their Role in Children's Physical Activity: Do We Need to Clarify Expectations? J Res Child Educ. 2018;32(3):283-94.
172. Vandeweghe L, Moens E, Braet C, Van Lippevelde W, Vervoort L, Verbeken S. Perceived effective and feasible strategies to promote healthy eating in young children: focus groups with parents, family child care providers and daycare assistants. BMC Public Health. 2016;16(1):1045.
173. Gerritsen S, Morton SM, Wall CR. Physical activity and screen use policy and practices in childcare: results from a survey of early childhood education services in New Zealand. Aust N Z J Public Health. 2016;40(4):319-25.
174. Dowda M, Brown WH, McIver KL, Pfeiffer KA, O'Neill JR, Addy CL, et al. Policies and Characteristics of the Preschool Environment and Physical Activity of Young Children. Pediatrics. 2009;123(2):e261-e6.
175. Copeland KA, Sherman SN, Kendeigh CA, Saelens BE, Kalkwarf HJ. Flip flops, dress clothes, and no coat: clothing barriers to children's physical activity in child-care centers identified from a qualitative study. Int J Behav Nutr Phys Act. 2009;6:74.
176. Cardon G, Van Cauwenberghe E, Labarque V, Haerens L, De Bourdeaudhuij I. The contribution of preschool playground factors in explaining children's physical activity during recess. Int J Behav Nutr Phys Act. 2008;5:11.
177. Harrison F, Goodman A, van Sluijs EMF, Andersen LB, Cardon G, Davey R, et al. Weather and children's physical activity; how and why do relationships vary between countries? Int J Behav Nutr Phys Act. 2017;14(1):74.
178. Dovey TM, Staples PA, Gibson EL, Halford JCG. Food neophobia and 'picky/fussy' eating in children: A review. Appetite. 2008;50(2):181-93.
179. Monasta L, Batty GD, Cattaneo A, Lutje V, Ronfani L, Van Lenthe FJ, et al. Early-life determinants of overweight and obesity: a review of systematic reviews. Obes Rev. 2010;11(10):695-708.

180. Schmutz EA, Leeger-Aschmann CS, Radtke T, Muff S, Kakebeeke TH, Zysset AE, et al. Correlates of preschool children's objectively measured physical activity and sedentary behavior: a cross-sectional analysis of the SPLASHY study. Int J Behav Nutr Phys Act. 2017;14(1):1.
181. van Rossem L, Vogel I, Moll HA, Jaddoe VW, Hofman A, Mackenbach JP, et al. An observational study on socio-economic and ethnic differences in indicators of sedentary behavior and physical activity in preschool children. Prev Med. 2012;54(1):55-60.
182. Dev DA, McBride BA, Speirs KE, Blitch KA, Williams NA. "Great Job Cleaning Your Plate Today!" Determinants of Child-Care Providers' Use of Controlling Feeding Practices: An Exploratory Examination. J Acad Nutr Diet. 2016;116(11):1803-9.
183. Kremers SPJ. Theory and practice in the study of influences on energy balance-related behaviors. Patient Educ Couns. 2010;79(3):291-8.
184. Moore GF, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, et al. Process evaluation of complex interventions: Medical Research Council guidance. BMJ. 2015;350:1258.
185. Durlak JA, DuPre EP. Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. Am J Community Psychol. 2008;41(3-4):327-50.
186. van Lenthe FJ, Mackenbach JP. Neighbourhood deprivation and overweight: the GLOBE study. Int J Obes Relat Metab Disord. 2002;26(2):234-40.
187. World Health Organization. Essential Nutrition Actions: Mainstreaming nutrition through the life-course. Geneva, Switzerland; 2019.
188. Pitt E, Cameron CM, Thornton L, Gallegos D, Filus A, Ng S-K, et al. Dietary patterns of Australian children at three and five years of age and their changes over time: A latent class and latent transition analysis. Appetite. 2018;129:207-16.
189. Gubbels JS, Kremers SP, Stafleu A, Dagnelie PC, de Vries NK, Thijs C. Child-care environment and dietary intake of 2- and 3-year-old children. J Hum Nutr Diet. 2010;23(1):97-101.
190. Labarque V, Gubbels JS, Cardon G. Preschooler's physical activity levels and associations with lesson context, teacher's behavior, and environment during preschool physical education. Early Child Res Q. 2012;27(2):221-30.
191. Black AP, D'Onise K, McDermott R, Vally H, O'Dea K. How effective are family-based and institutional nutrition interventions in improving children's diet and health? A systematic review. BMC Public Health. 2017;17(1):818.
192. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. Pediatrics. 2013;132(1):e201-10.
193. Peterson KE, Fox MK. Addressing the Epidemic of Childhood Obesity through School-Based Interventions: What Has Been Done and Where Do We Go from Here? J Law Med Ethics. 2007;35(1):113-30.
194. Gubbels JS, Kremers SP, Stafleu A, Dagnelie PC, Goldbohm RA, de Vries NK, et al. Diet-related restrictive parenting practices. Impact on dietary intake of 2-year-old children and interactions with child characteristics. Appetite. 2009;52(2):423-9.

195. Glasgow RE, Klesges LM, Dzewaltowski DA, Estabrooks PA, Vogt TM. Evaluating the impact of health promotion programs: using the RE-AIM framework to form summary measures for decision making involving complex issues. Health Educ Res. 2006;21(5):688-94.
196. Chan A-W, Tetzlaff JM, Altman DG, Laupacis A, Gøtzsche PC, Krleža-Jerić K, et al. SPIRIT 2013 Statement: Defining Standard Protocol Items for Clinical Trials. Ann Intern Med. 2013;158(3):200-7.
197. van Kampen A, Kloprogge J, Rutten S, Schonewille B. Voor-en Vroegschoolse Zorg en Educatie. Utrecht: Sardes. 2005.
198. Roeters A, Bucx F. Kijk op kinderopvang. The Hague: Sociaal en Cultureel Planbureau; 2018.
199. Van Stan S, Lessard L, Dupont Phillips K. The impact of a statewide training to increase child care providers' knowledge of nutrition and physical activity rules in Delaware. Child Obes. 2013;9(1):43-50.
200. Reinke WM, Stormont M, Herman KC, Newcomer L. Using Coaching to Support Teacher Implementation of Classroom-based Interventions. J Behav Educ. 2014;23(1):150-67.
201. Tucker P, Vanderloo LM, Johnson AM, Burke SM, Irwin JD, Gaston A, et al. Impact of the Supporting Physical Activity in the Childcare Environment (SPACE) intervention on preschoolers' physical activity levels and sedentary time: a single-blind cluster randomized controlled trial. Int J Behav Nutr Phys Act. 2017;14(1):120.
202. Caton SJ, Ahern SM, Remy E, Nicklaus S, Blundell P, Hetherington MM. Repetition counts: repeated exposure increases intake of a novel vegetable in UK pre-school children compared to flavour-flavour and flavour-nutrient learning. Br J Nutr. 2013;109(11):2089-97.
203. Bartlett JA. The Lifestyle Triple P multilevel system of parenting and family support for the prevention and treatment of childhood obesity. Queensland, Australia: The University of Queensland; 2016.
204. The Netherlands Institute for Social Research. SCP Statusscores 2014 [Internet]. 2014 [cited 2 Juli 2019]. Available from: *http://www.scp.nl/Formulieren/Statusscores_opvragen*.
205. Van Cauwenberghe E, Gubbels J, De Bourdeaudhuij I, Cardon G. Feasibility and validity of accelerometer measurements to assess physical activity in toddlers. Int J Behav Nutr Phys Act. 2011;8:67.
206. Gubbels JS, Sleddens EF, Raaijmakers LC, Gies JM, Kremers SP. The Child-care Food and Activity Practices Questionnaire (CFAPQ): development and first validation steps. Public Health Nutr. 2015:1-12.
207. O'Connor TM, Cerin E, Hughes SO, Robles J, Thompson DI, Mendoza JA, et al. Psychometrics of the preschooler physical activity parenting practices instrument among a Latino sample. Int J Behav Nutr Phys Act. 2014;11:3.
208. Musher-Eizenman D, Holub S. Comprehensive Feeding Practices Questionnaire: validation of a new measure of parental feeding practices. J Pediatr Psychol. 2007;32(8):960-72.
209. Niermann C, Krapf F, Renner B, Reiner M, Woll A. Family health climate scale (FHC-scale): development and validation. Int J Behav Nutr Phys Act. 2014;11(1):30.

210. Ward DS, Mazzucca S, McWilliams C, Hales D. Use of the Environment and Policy Evaluation and Observation as a Self-Report Instrument (EPAO-SR) to measure nutrition and physical activity environments in child care settings: validity and reliability evidence. Int J Behav Nutr Phys Act. 2015;12:124.
211. Ball S, Benjamin S, Hales D, Marks J, McWilliams C, Ward D. The Environment and Policy Assessment and Observation (EPAO) child care nutrition and physical activity instrument. Center for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill. 2005.
212. Baranowski T, Davis M, Resnicow K, Baranowski J, Doyle C, Lin LS, et al. Gimme 5 fruit, juice, and vegetables for fun and health: outcome evaluation. Health Educ Behav. 2000;27(1):96-111.
213. Hanson S, Jones A. Missed opportunities in the evaluation of public health interventions: a case study of physical activity programmes. BMC Public Health. 2017;17(1):674.
214. Wiltsey Stirman S, Kimberly J, Cook N, Calloway A, Castro F, Charns M. The sustainability of new programs and innovations: a review of the empirical literature and recommendations for future research. Implement Sci. 2012;7(1):17.
215. Hawe P, Shiell A, Riley T, Gold L. Methods for exploring implementation variation and local context within a cluster randomised community intervention trial. J Epidemiol Community Health. 2004;58(9):788-93.
216. Kremers SPJ, Visscher TLS, Schuit AJ. Effect in zijn context. Tijdschrift voor gezondheidswetenschappen. 2018;96(3):128-31.
217. Moore GF, Evans RE, Hawkins J, Littlecott H, Melendez-Torres GJ, Bonell C, et al. From complex social interventions to interventions in complex social systems: Future directions and unresolved questions for intervention development and evaluation. Evaluation. 2019;25(1):23-45.
218. Green LW. Evaluation and measurement: some dilemmas for health education. Am J Public Health. 1977;67(2):155-61.
219. Timmons BW, Leblanc AG, Carson V, Connor Gorber S, Dillman C, Janssen I, et al. Systematic review of physical activity and health in the early years (aged 0-4 years). Appl Physiol Nutr Metab. 2012;37(4):773-92.
220. Ruiz RM, Sommer EC, Tracy D, Banda JA, Economos CD, JaKa MM, et al. Novel patterns of physical activity in a large sample of preschool-aged children. BMC Public Health. 2018;18(1):242.
221. Brouwer SI, Küpers LK, Kors L, Sijtsma A, Sauer PJJ, Renders CM, et al. Parental physical activity is associated with objectively measured physical activity in young children in a sex-specific manner: the GECKO Drenthe cohort. BMC Public Health. 2018;18(1):1033.
222. Gustafson SL, Rhodes RE. Parental correlates of physical activity in children and early adolescents. Sports Med. 2006;36(1):79-97.
223. Sleddens EF, Kremers SP, Hughes SO, Cross MB, Thijs C, De Vries NK, et al. Physical activity parenting: a systematic review of questionnaires and their associations with child activity levels. Obes Rev. 2012;13(11):1015-33.

224. Gordon ES, Tucker P, Burke SM, Carron AV. Effectiveness of physical activity interventions for preschoolers: a meta-analysis. Res Q Exerc Sport. 2013;84(3):287-94.
225. van de Kolk I, Gerards SMPL, Harms LSE, Kremers SPJ, van Dinther-Erkens AMHS, Snellings M, et al. Study Protocol for the Evaluation of "SuperFIT", a Multicomponent Nutrition and Physical Activity Intervention Approach for Preschools and Families. Int J Environ Res Public Health. 2020;17(2).
226. Baumgartner JJ, McBride B. Exploring parental philosophies regarding childcare: overlap orientations and the influence of childcare programmes on families. Early Child Dev Care. 2009;179(7):931-47.
227. Gerards SM, Dagnelie PC, Gubbels JS, van Buuren S, Hamers FJ, Jansen MW, et al. The effectiveness of lifestyle triple P in the Netherlands: a randomized controlled trial. PLoS One. 2015;10(4):e0122240.
228. Gerards SM, Dagnelie PC, Jansen MW, van der Goot LO, de Vries NK, Sanders MR, et al. Lifestyle Triple P: a parenting intervention for childhood obesity. BMC Public Health. 2012;12:267.
229. Morgan PJ, Lubans DR, Plotnikoff RC, Callister R, Burrows T, Fletcher R, et al. The 'Healthy Dads, Healthy Kids' community effectiveness trial: study protocol of a community-based healthy lifestyle program for fathers and their children. BMC Public Health. 2011;11:876.
230. Troiano RP. Large-scale applications of accelerometers: new frontiers and new questions. Med Sci Sports Exerc. 2007;39(9):1501.
231. Pate RR, Almeida MJ, McIver KL, Pfeiffer KA, Dowda M. Validation and calibration of an accelerometer in preschool children. Obesity (Silver Spring). 2006;14(11):2000-6.
232. UNESCO Institute for Statistics. International standard classification of education: ISCED 2011. . Montreal: UNESCO Institute for Statistics; 2012.
233. Koninklijk Nederlands Metereologisch Instituut. Uurgegevens van het weer in Nederland [Internet]. n.d. [cited 5 September 2019]. Available from: *https://projects.knmi.nl/klimatologie/uurgegevens/selectie.cgi*.
234. Cohen J. A power primer. Psychological bulletin. 1992;112(1):155.
235. Gezondheidsraad. Beweegrichtlijnen 2017. Den Haag: Gezondheidsraad; 2017. Contract No.: 2017/08.
236. Määttä S, Ray C, Roos G, Roos E. Applying a Socioecological Model to Understand Preschool Children's Sedentary Behaviors from the Viewpoints of Parents and Preschool Personnel. Early Child Educ J. 2015;44(5):491-502.
237. van de Kolk I, Verjans-Janssen SRB, Gubbels JS, Kremers SPJ, Gerards SMPL. Systematic review of interventions in the childcare setting with direct parental involvement: effectiveness on child weight status and energy balance-related behaviours. Int J Behav Nutr Phys Act. 2019;16(1):110.
238. Oosterhoff M, Joore M, Ferreira I. The effects of school-based lifestyle interventions on body mass index and blood pressure: a multivariate multilevel meta-analysis of randomized controlled trials. Obes Rev. 2016;17(11):1131-53.

239. Glasgow RE, Klesges LM, Dzewaltowski DA, Bull SS, Estabrooks P. The future of health behavior change research: What is needed to improve translation of research into health promotion practice? Ann Behav Med. 2004;27(1):3-12.
240. Zhou YE, Emerson JS, Levine RS, Kihlberg CJ, Hull PC. Childhood obesity prevention interventions in childcare settings: systematic review of randomized and nonrandomized controlled trials. Am J Health Promot. 2014;28(4):e92-103.
241. Gubbels JS, Gerards SM, Kremers SP. Use of food practices by childcare staff and the association with dietary intake of children at childcare. Nutrients. 2015;7(4):2161-75.
242. Brown WH, Pfeiffer KA, McIver KL, Dowda M, Addy CL, Pate RR. Social and environmental factors associated with preschoolers' nonsedentary physical activity. Child Dev. 2009;80(1):45-58.
243. Hannon JC, Brown BB. Increasing preschoolers' physical activity intensities: an activity-friendly preschool playground intervention. Prev Med. 2008;46(6):532-6.
244. Sugiyama T, Okely AD, Masters JM, Moore GT. Attributes of Child Care Centers and Outdoor Play Areas Associated With Preschoolers' Physical Activity and Sedentary Behavior. Environ Behav. 2012;44(3):334-49.
245. Lessard L, Breck A. Childhood Obesity Prevention in Childcare Settings: the Potential of Policy and Environmental Change Interventions. Curr Obes Rep. 2015;4(2):191-7.
246. Geoffroy MC, Power C, Touchette E, Dubois L, Boivin M, Seguin JR, et al. Childcare and overweight or obesity over 10 years of follow-up. J Pediatr. 2013;162(4):753-8 e1.
247. De Craemer M, Verloigne M, De Bourdeaudhuij I, Androutsos O, Iotova V, Moreno L, et al. Effect and process evaluation of a kindergarten-based, family-involved cluster randomised controlled trial in six European countries on four- to six-year-old children's steps per day: the ToyBox-study. Int J Behav Nutr Phys Act. 2017;14(1):116.
248. Okely AD, Collins CE, Morgan PJ, Jones RA, Warren JM, Cliff DP, et al. Multi-site randomized controlled trial of a child-centered physical activity program, a parent-centered dietary-modification program, or both in overweight children: the HIKCUPS study. J Pediatr. 2010;157(3):388-94, 94 e1.
249. Zask A, Adams JK, Brooks LO, Hughes DF. Tooty Fruity Vegie: an obesity prevention intervention evaluation in Australian preschools. Health Promot J Austr. 2012;23(1):10-5.
250. van de Kolk I, Gerards SMPL, Harms LSE, Kremers SPJ, Gubbels JS. The Effects of a Comprehensive, Integrated Obesity Prevention Intervention Approach (SuperFIT) on Children's Physical Activity, Sedentary Behavior, and BMI Z-Score. Int J Environ Res Public Health. 2019;16(24).
251. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implementation science : IS. 2009;4:50-.
252. Fleuren M, Wiefferink K, Paulussen T. Determinants of innovation within health care organizations: literature review and Delphi study. Int J Qual Health Care. 2004;16(2):107-23.

253. Driediger M, Vanderloo LM, Burke SM, Irwin JD, Gaston A, Timmons BW, et al. The Implementation and Feasibility of the Supporting Physical Activity in the Childcare Environment (SPACE) Intervention: A Process Evaluation. Health Educ Behav. 2018;45(6):935-44.
254. Kennedy AB, Schenkelberg M, Moyer C, Pate R, Saunders RP. Process evaluation of a preschool physical activity intervention using web-based delivery. Eval Program Plann. 2017;60:24-36.
255. Langford R, Jago R, White J, Moore L, Papadaki A, Hollingworth W, et al. A physical activity, nutrition and oral health intervention in nursery settings: process evaluation of the NAP SACC UK feasibility cluster RCT. BMC Public Health. 2019;19(1):865.
256. Ward S, Chow AF, Humbert ML, Belanger M, Muhajarine N, Vatanparast H, et al. Promoting physical activity, healthy eating and gross motor skills development among preschoolers attending childcare centers: Process evaluation of the Healthy Start-Depart Sante intervention using the RE-AIM framework. Eval Program Plann. 2018;68:90-8.
257. Portney LG, Watkins MP. Foundations of clinical research: applications to practice: Pearson/ Prentice Hall Upper Saddle River, NJ; 2009.
258. Attkisson CC, Zwick R. The client satisfaction questionnaire: Psychometric properties and correlations with service utilization and psychotherapy outcome. Eval Program Plann. 1982;5(3):233-7.
259. Fleuren MAH, Paulussen TGWM, Van Dommelen P, Van Buuren S. Towards a measurement instrument for determinants of innovations. Int J Qual Health Care. 2014;26(5):501-10.
260. Timmermans S, Tavory I. Theory Construction in Qualitative Research:From Grounded Theory to Abductive Analysis. Soc Theory. 2012;30(3):167-86.
261. Lipsey MW. Design sensitivity: Newbury Park, CA: Sage; 1990.
262. Gezonde Kinderopvang. Wat Is Gezonde Kinderopvang? *(What is Healthy Child Care?)* [Internet]. n.d. [cited 24 April 2020]. Available from: *https://www.gezondekinderopvang.nl/aan-de-slag/wat-gezonde-kinderopvang*.
263. Saunders RP, Pfeiffer K, Brown WH, Howie EK, Dowda M, O'Neill JR, et al. Evaluating and Refining the Conceptual Model Used in the Study of Health and Activity in Preschool Environments (SHAPES) Intervention. Health Educ Behav. 2017:1090198116686334.
264. McKee SL, Cooksey-Stowers K, St. Louis R, Schwartz MB. Understanding the process of implementing nutrition and physical activity policies in a large national child care organization: a mixed-methods study. Transl Behav Med. 2019.
265. Johannessen B, Helland SH, Bere E, Øverby NC, Fegran L. ?A bumpy road?: Kindergarten staff's experiences with an intervention to promote healthy diets in toddlers. Appetite. 2018;127:37-43.
266. Sleet K, Sisson SB, Dev DA, Love C, Williams MB, Hoffman LA, et al. The Impact of Responsive Feeding Practice Training on Teacher Feeding Behaviors in Tribal Early Care and Education: The Food Resource Equity and Sustainability for Health (FRESH) Study. Curr Dev Nutr. 2019;4(Supplement_1):23-32.
267. Arnstein SR. A Ladder Of Citizen Participation. J Am Inst Plann. 1969;35(4):216-24.

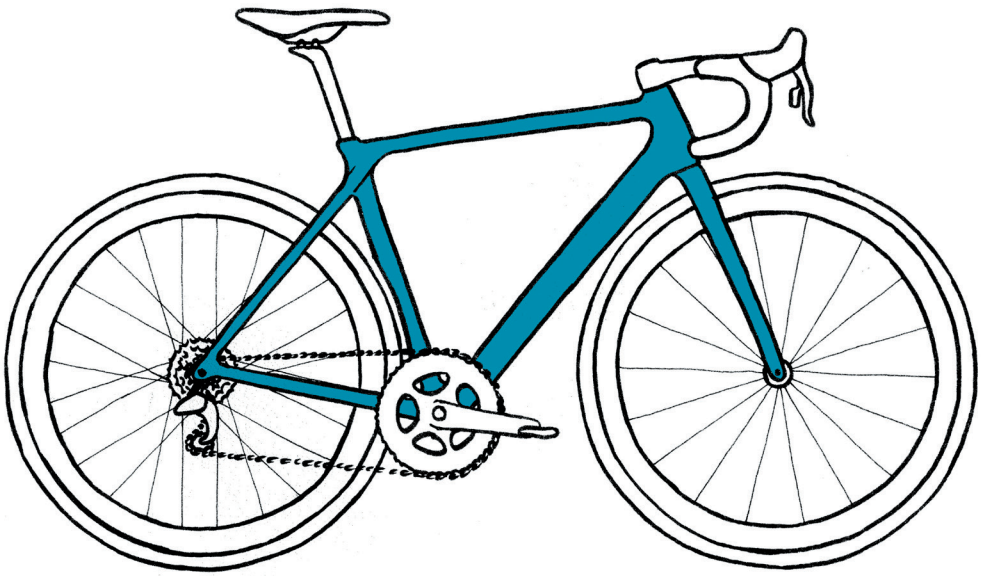
268. Verjans-Janssen SRB, Gerards SMPL, Verhees AH, Kremers SPJ, Vos SB, Jansen MWJ, et al. Implementation of KEIGAAF in Primary Schools: A Mutual Adaptation Physical Activity and Nutrition Intervention. Int J Environ Res Public Health. 2020;17(3).
269. Bartelink NHM, van Assema P, Jansen MWJ, Savelberg H, Moore GF, Hawkins J, et al. Process evaluation of the healthy primary School of the Future: the key learning points. BMC Public Health. 2019;19(1):698.
270. Jeon L, Hur E, Buettner CK. Child-care chaos and teachers' responsiveness: The indirect associations through teachers' emotion regulation and coping. J Sch Psychol. 2016;59:83-96.
271. Hinkley T, Crawford D, Salmon J, Okely AD, Hesketh K. Preschool children and physical activity: a review of correlates. Am J Prev Med. 2008;34(5):435-41.
272. Alkon A, Crowley AA, Neelon SE, Hill S, Pan Y, Nguyen V, et al. Nutrition and physical activity randomized control trial in child care centers improves knowledge, policies, and children's body mass index. BMC Public Health. 2014;14:215.
273. Battista RA, Oakley H, Weddell MS, Mudd LM, Greene JB, West ST. Improving the physical activity and nutrition environment through self-assessment (NAP SACC) in rural area child care centers in North Carolina. Prev Med. 2014;67 Suppl 1:S10-6.
274. de Zwarte D, Kearney J, Corish CA, Glennon C, Maher L, Johnston Molloy C. Randomised study demonstrates sustained benefits of a pre-school intervention designed to improve nutrition and physical activity practices. J Public Health (Oxf). 2019;41(4):798-806.
275. Finch M, Wolfenden L, Falkiner M, Edenden D, Pond N, Hardy LL, et al. Impact of a population based intervention to increase the adoption of multiple physical activity practices in centre based childcare services: a quasi experimental, effectiveness study. Int J Behav Nutr Phys Act. 2012;9:101.
276. O'Neill JR, Dowda M, Benjamin Neelon SE, Neelon B, Pate RR. Effects of a New State Policy on Physical Activity Practices in Child Care Centers in South Carolina. Am J Public Health. 2017;107(1):144-6.
277. Ng M, Rosenberg M, Thornton A, Lester L, Trost SG, Bai P, et al. The Effect of Upgrades to Childcare Outdoor Spaces on Preschoolers' Physical Activity: Findings from a Natural Experiment. Int J Environ Res Public Health. 2020;17(2).
278. Cardon G, Labarque V, Smits D, De Bourdeaudhuij I. Promoting physical activity at the pre-school playground: the effects of providing markings and play equipment. Prev Med. 2009;48(4):335-40.
279. Henderson KE, Grode GM, O'Connell ML, Schwartz MB. Environmental factors associated with physical activity in childcare centers. Int J Behav Nutr Phys Act. 2015;12:43.
280. Benjamin Neelon SE, Vaughn A, Ball SC, McWilliams C, Ward DS. Nutrition practices and mealtime environments of North Carolina child care centers. Child Obes. 2012;8(3):216-23.
281. Martyniuk OJ, Vanderloo LM, Irwin JD, Burke SM, Tucker P. Comparing the nutrition environment and practices of home- and centre-based child-care facilities. Public Health Nutr. 2016;19(4):575-84.

282. Gubbels JS, Kremers SP, van Kann DH, Stafleu A, Candel MJ, Dagnelie PC, et al. Interaction between physical environment, social environment, and child characteristics in determining physical activity at child care. Health Psychol. 2011;30(1):84-90.
283. Benjamin Neelon SE, Briley ME. Position of the American Dietetic Association: benchmarks for nutrition in child care. J Am Diet Assoc. 2011;111(4):607-15.
284. Sheldrick PM, Maitland C, Mackintosh AK, Rosenberg M, Griffiths JL, Fry R, et al. Associations between the Home Physical Environment and Children's Home-Based Physical Activity and Sitting. Int J Environ Res Public Health. 2019;16(21).
285. Vereecken C, Haerens L, De Bourdeaudhuij I, Maes L. The relationship between children's home food environment and dietary patterns in childhood and adolescence. Public Health Nutr. 2010;13(10a):1729-35.
286. Volker MA. Reporting effect size estimates in school psychology research. Psychol Sch. 2006;43(6):653-72.
287. Harms LSE, Gerards SMPL, Kremers SPJ, Bessems KMHH, van Luik C, Arslan T, et al. Involving parents to promote healthy energy balance-related behaviours in pre-schoolers, an impact and process evaluation. . submitted.
288. Rijksinstituut voor Volksgezondheid en Milieu. Portie-online versie 2017/1.1. Bilthoven: RIVM; 2017.
289. Hariton E, Locascio JJ. Randomised controlled trials - the gold standard for effectiveness research: Study design: randomised controlled trials. BJOG. 2018;125(13):1716-.
290. Koelen MA, Vaandrager L, Colomér C. Health promotion research: dilemmas and challenges. Journal of Epidemiology and Community Health. 2001;55(4):257.
291. Roberts C, Torgerson DJ. Understanding controlled trials: baseline imbalance in randomised controlled trials. BMJ (Clinical research ed). 1999;319(7203):185-.
292. Pfeiffer KA, Dowda M, McIver KL, Pate RR. Factors related to objectively measured physical activity in preschool children. Pediatr Exerc Sci. 2009;21(2):196-208.
293. Baumann S, Groß S, Voigt L, Ullrich A, Weymar F, Schwaneberg T, et al. Pitfalls in accelerometer-based measurement of physical activity: The presence of reactivity in an adult population. Scand J Med Sci Sports. 2018;28(3):1056-63.
294. Dössegger A, Ruch N, Jimmy G, Braun-Fahrländer C, Mäder U, Hänggi J, et al. Reactivity to accelerometer measurement of children and adolescents. Med Sci Sports Exerc. 2014;46(6):1140-6.
295. Handley MA, Lyles CR, McCulloch C, Cattamanchi A. Selecting and Improving Quasi-Experimental Designs in Effectiveness and Implementation Research. Annu Rev Public Health. 2018;39:5-25.
296. Ernst E, Pittler MH. Efficacy or effectiveness? J Intern Med. 2006;260(5):488-90.
297. Gubbels JS, Gerards SM, Kremers SP. The association of parenting practices with toddlers' dietary intake and BMI, and the moderating role of general parenting and child temperament. Public Health Nutr. 2020;23(14):2521-9.

298. Frierson GM, Williams DM, Dunsiger S, Lewis BA, Whiteley JA, Albrecht AE, et al. Recruitment of a racially and ethnically diverse sample into a physical activity efficacy trial. Clinical Trials. 2008;5(5):504-16.
299. Nicholson LM, Schwirian PM, Groner JA. Recruitment and retention strategies in clinical studies with low-income and minority populations: Progress from 2004–2014. Contemp Clin Trials. 2015;45:34-40.
300. Sherlock A, Brownie S. Patients' recollection and understanding of informed consent: a literature review. ANZ J Surg. 2014;84(4):207-10.
301. Mancuso CA, Rincon M. Asthma patients' assessments of health care and medical decision making: the role of health literacy. J Asthma. 2006;43(1):41-4.
302. Meppelink CS, Smit EG, Buurman BM, van Weert JC. Should We Be Afraid of Simple Messages? The Effects of Text Difficulty and Illustrations in People With Low or High Health Literacy. Health Commun. 2015;30(12):1181-9.
303. Chesham RA, Booth JN, Sweeney EL, Ryde GC, Gorely T, Brooks NE, et al. The Daily Mile makes primary school children more active, less sedentary and improves their fitness and body composition: a quasi-experimental pilot study. BMC Med. 2018;16(1):64.
304. Brown WH, Pfeiffer KA, McLver KL, Dowda M, Almeida MJ, Pate RR. Assessing preschool children's physical activity: the Observational System for Recording Physical Activity in children-preschool version. Res Q Exerc Sport. 2006;77(2):167-76.
305. Ward D, Hales D, Haverly K, Marks J, Benjamin S, Ball S, et al. An instrument to assess the obesogenic environment of child care centers. Am J Health Behav. 2008;32(4):380-6.
306. Asan O, Montague E. Using video-based observation research methods in primary care health encounters to evaluate complex interactions. Inform Prim Care. 2014;21(4):161-70.
307. Coleman T. Using video-recorded consultations for research in primary care: advantages and limitations. Fam Pract. 2000;17(5):422-7.
308. Centraal Bureau voor de Statistiek. Ouders geven consultatiebureau gemiddeld een ruime 7 [Internet]. 2014 [Available from: *https://www.cbs.nl/nl-nl/nieuws/2014/44/ouders-geven-consultatiebureau-gemiddeld-een-ruime-7*.
309. Hoofs H, Jansen MW, Mohren DC, Reijs R, Jansen N, Kant I. Is het DD_JGZ bruikbaar voor epidemiologisch onderzoek? JA!-Plus. 2015;33.
310. Kay Bartholomew Eldredge L, Markham CM, Ruiter RA, Kok G, Fernandez ME, Parcel GS. Planning health promotion programs: an intervention mapping approach: John Wiley & Sons; 2016.
311. McLaughlin MW. The Rand Change Agent Study Revisited: Macro Perspectives and Micro Realities. Educational Researcher. 1990;19(9):11-6.
312. Patton MQ. Developmental evaluation: Applying complexity concepts to enhance innovation and use: Guilford press; 2010.
313. Van Kann DH, Jansen MW, de Vries SI, de Vries NK, Kremers SP. Active Living: development and quasi-experimental evaluation of a school-centered physical activity intervention for primary school children. BMC Public Health. 2015;15:1315.

314. Calancie L, Fullerton K, Appel JM, Korn AR, Hennessy E, Hovmand P, et al. Implementing Group Model Building With the Shape Up Under 5 Community Committee Working to Prevent Early Childhood Obesity in Somerville, Massachusetts. J Public Health Manag Pract. 2020;Publish Ahead of Print.
315. Hovmand PS. Group model building and community-based system dynamics process. Community based system dynamics: Springer; 2014. p. 17-30.
316. Hardy LL, King L, Farrell L, Macniven R, Howlett S. Fundamental movement skills among Australian preschool children. Journal of Science and Medicine in Sport. 2010;13(5):503-8.
317. Jones RA, Sousa-Sá E, Peden M, Okely AD. Childcare Physical Activity Interventions: A Discussion of Similarities and Differences and Trends, Issues, and Recommendations. Int J Environ Res Public Health. 2019;16(23).
318. Prevo L, Jansen M, Kremers SPJ. Jack of all trades? Exploring the role of a broker in the societal activation process of long-term welfare recipients. submitted.
319. Prevo L, Kremers S, Jansen M. Small Successes Make Big Wins: A Retrospective Case Study towards Community Engagement of Low-SES Families. Int J Environ Res Public Health. 2020;17(2).
320. Leis A, Ward S, Vatanparast H, Humbert ML, Chow AF, Muhajarine N, et al. Effectiveness of the Healthy Start-Départ Santé approach on physical activity, healthy eating and fundamental movement skills of preschoolers attending childcare centres: a randomized controlled trial. BMC Public Health. 2020;20(1):523.
321. Okely AD, Stanley RM, Jones RA, Cliff DP, Trost SG, Berthelsen D, et al. 'Jump start' childcare-based intervention to promote physical activity in pre-schoolers: six-month findings from a cluster randomised trial. Int J Behav Nutr Phys Act. 2020;17(1):6.
322. Pinket AS, Van Lippevelde W, De Bourdeaudhuij I, Deforche B, Cardon G, Androutsos O, et al. Effect and Process Evaluation of a Cluster Randomized Control Trial on Water Intake and Beverage Consumption in Preschoolers from Six European Countries: The ToyBox-Study. PLoS One. 2016;11(4):e0152928.
323. Wolfenden L, Jones J, Parmenter B, Razak LA, Wiggers J, Morgan PJ, et al. Efficacy of a free-play intervention to increase physical activity during childcare: a randomized controlled trial. Health Educ Res. 2018;34(1):84-97.
324. Rapson J, Conlon C, Ali A. Nutrition Knowledge and Perspectives of Physical Activity for Pre-Schoolers amongst Early Childhood Education and Care Teachers. Nutrients. 2020;12(7).
325. Sisson SB, Smith CL, Cheney M. Big impact on small children: child-care providers' perceptions of their role in early childhood healthy lifestyle behaviours. Child Care in Practice. 2017;23(2):162-80.
326. Leech RM, McNaughton SA, Timperio A. The clustering of diet, physical activity and sedentary behavior in children and adolescents: a review. Int J Behav Nutr Phys Act. 2014;11:4.
327. Verjans-Janssen SRB, Gerards SMPL, Kremers SPJ, Vos SB, Jansen MWJ, Van Kann DHH. Effects of the KEIGAAF intervention on the BMI z-score and energy balance-related behaviors of primary school-aged children. Int J Behav Nutr Phys Act. 2020;17(1):105.

328. Moore GF, Evans RE, Hawkins J, Littlecott HJ, Turley R. All interventions are complex, but some are more complex than others: using iCAT_SR to assess complexity. Cochrane Database Syst Rev. 2017;7:Ed000122.
329. Sung-Chan P, Sung YW, Zhao X, Brownson RC. Family-based models for childhood-obesity intervention: a systematic review of randomized controlled trials. Obes Rev. 2013;14(4):265-78.
330. Bush R, Capra S, Box S, McCallum D, Khalil S, Ostini R. An Integrated Theatre Production for School Nutrition Promotion Program. Children 2018;5(3).
331. Lakerveld J, Mackenbach J. The Upstream Determinants of Adult Obesity. Obes Facts. 2017;10(3):216-22.
332. Hong J, Bales DW, Wallinga CR. Using Family Backpacks as a Tool to Involve Families in Teaching Young Children About Healthy Eating. Early Child Educ J. 2018;46(2):209-21.
333. De Lepeleere S, De Bourdeaudhuij I, Cardon G, Verloigne M. The effect of an online video intervention 'Movie Models' on specific parenting practices and parental self-efficacy related to children's physical activity, screen-time and healthy diet: a quasi experimental study. BMC Public Health. 2017;17(1):366.
334. Hammersley ML, Jones RA, Okely AD. Parent-Focused Childhood and Adolescent Overweight and Obesity eHealth Interventions: A Systematic Review and Meta-Analysis. J Med Internet Res. 2016;18(7):e203.
335. De Meester F, Van Dyck D, De Bourdeaudhuij I, Deforche B, Cardon G. Changes in physical activity during the transition from primary to secondary school in Belgian children: what is the role of the school environment? BMC Public Health. 2014;14(1):261.
336. Hnatiuk JA, Lamb KE, Ridgers ND, Salmon J, Hesketh KD. Changes in volume and bouts of physical activity and sedentary time across early childhood: a longitudinal study. Int J Behav Nutr Phys Act. 2019;16(1):42.
337. Marks J, Barnett LM, Strugnell C, Allender S. Changing from primary to secondary school highlights opportunities for school environment interventions aiming to increase physical activity and reduce sedentary behaviour: a longitudinal cohort study. Int J Behav Nutr Phys Act. 2015;12(1):59.
338. Sigmund E, Sigmundova D, El Ansari W. Changes in physical activity in pre-schoolers and first-grade children: longitudinal study in the Czech Republic. Child Care Health Dev. 2009;35(3):376-82.



Summary
Samenvatting

Summary

Childhood overweight and obesity are an important public health problem. Childhood overweight and obesity are known to track into adulthood, making it a difficult health problem to cure once it is established. Overweight and obesity are predominantly the result of a disruption in energy balance. It is therefore important to promote healthy energy balance-related behaviours (EBRB) such as healthy dietary intake and physical activity (PA). This is already important for pre-schoolers (2-4-year-old children) as behavioural habits are formed and they may already have unhealthy dietary habits, are insufficiently physically active, and are highly sedentary.

The environment has an important influence on behaviour, for example, through the availability of healthy food or support of parents to engage in physical activity. For pre-schoolers there are two important settings that influence their behaviour: the Early Care and Education (ECE) setting and the home setting. These settings may interact, meaning that characteristics of the ECE setting may influence behaviour of pre-schoolers differently depending on the characteristics of the home setting, as well as the other way around. It is important to align these settings in order to exert a greater influence on the behaviour of pre-schoolers. A comprehensive, integrated intervention approach to promote healthy EBRB in pre-schoolers was initiated. The main aim of this dissertation was to develop, implement and evaluate this intervention approach. Formative research was performed as input for the intervention development. The development of SuperFIT is described and it was evaluated with an effect and process evaluation (**Chapter 1**).

The formative research consisted of a systematic literature review and a needs assessment. **Chapter 2** describes the results of the systematic literature review. The aim of the literature review was to evaluate the effectiveness of childcare-based interventions with direct parental involvement on pre-schoolers' weight status and EBRB (PA, sedentary behaviour, and nutrition-related behaviour). Information on the different types of environments that were targeted was extracted to narratively examine potential working principles of effective interventions. Four electronic databases were systematically searched to include studies on these types of interventions. To increase comparability between the studies, Cohen's *d* effect sizes were calculated. Twenty-two studies, describing seventeen unique interventions, were included. The majority of the studies found some favourable results on weight status, PA, sedentary behaviour, and/or nutrition-related behaviour for the intervention group. However, unfavourable results were also seen. Only a small number of studies was able to show significant differences between the intervention and control group. The effect sizes of the differences were predominantly small or moderate. Most interventions targeted both the sociocultural and physical environment in the childcare as well as the home setting. Interventions that also included the political environment (e.g., ECE nutrition policies)

appeared to be more effective. In addition, interventions that adopted a higher degree of parental involvement (e.g., active participation in development) appeared to be more effective in changing pre-schoolers weight status and EBRB. In conclusion, the literature review showed that childcare-based interventions with direct parental involvement show promising effects on pre-schoolers weight status and EBRB, although evidence is limited.

The results of the needs assessment are presented in **Chapter 3**. The aim of the needs assessment was to explore facilitators and barriers of healthy EBRB in childcare and identify needs for change. A qualitative study was performed using semi-structured interviews with childcare managers, childcare workers, and parents. The 'Environmental Research framework for weight Gain prevention' (EnRG framework) was used to guide the analysis. Forty-eight interviews were held with a total of 65 participants (9 childcare managers, 23 childcare workers and 33 parents). In all types of environment (physical, sociocultural, economic, and political) factors were identified that influenced pre-schoolers' EBRB. Some differences between the participants were seen in how they perceived influences of the different environments. An interaction between types of environments was indicated, for example, the potential impact of the physical environment depends on how the childcare worker uses the opportunities of the environment (sociocultural environment). Further, moderating factors relating to characteristics of the pre-schoolers were described. The interviews revealed opportunities for promoting healthy EBRB in pre-schoolers in the ECE setting, although a clear perceived need for change was not always expressed. An important issue arising from the interviews was the influence of the home setting. Within the ECE setting limited opportunities were felt to change pre-schoolers EBRB due to the limited time they spend at preschool. It appeared to be important to align the ECE and home setting with regard to healthy EBRB in pre-schoolers.

Chapter 4 describes the development and design of the evaluation of SuperFIT (Systems of Underprivileged Pre-schoolers in their home and preschool EnviRonment: Family Intervention Trial). SuperFIT is a comprehensive, integrated intervention approach for pre-schoolers. It was developed in a close partnership between a childcare organization, a local PA-providing organization, and health promotion experts. A continuous process of co-creation, feedback and adaptation was adopted during development and implementation. SuperFIT has three principles:

1. both nutrition and PA should be addressed in the intervention activities,
2. both the ECE and home settings should be included in intervention activities, and
3. different types of environment (physical, sociocultural, and political) should be integrated in intervention activities.

The SuperFIT intervention approach consisted of preschool-based, family-based, and community-based components. Intervention activities aimed at changing the physical, sociocultural and political environments in each setting and establishing increased alignment between the settings. To evaluate the effects of SuperFIT a quasi-experimental research design was adopted with twelve intervention and nine control preschools. Primary outcomes were Body Mass Index (BMI) z-scores, which was assessed with objectively measured height and weight of the pre-schoolers; PA and sedentary behaviour that were measured with accelerometers; and dietary intake that was measured with a 24-Hour recall. Secondary outcomes were the nutrition- and physical activity-related practices of preschool teachers and parents, and the physical home and preschool environment. The process evaluation was performed using a mixed methods design. Both quantitative questionnaires and qualitative measurements (in-depth interviews and observations) were used.

The effects of SuperFIT on PA, sedentary behaviour, and BMI z-score are presented in **Chapter 5**. Pre-schoolers could participate in both the preschool-based component and family-based component, which is regarded the full intervention. Pre-schoolers could also only participate in the preschool-based component, which is regarded the partial intervention. Both groups are compared with a control group. Measurements were performed at baseline (January – July 2017), first follow-up (November – December 2017), and final follow-up (May – June 2018). Observations were performed during implementation to assess changes in daily activities at the preschools. A total of 191 pre-schoolers participated in the study at baseline. On average the children were 3.1 years old, and 46.1% were boys. Healthy changes in PA levels occurred within both the intervention and control group over time. All groups showed an increase in light PA and moderate-to-vigorous physical activity (MVPA). A decrease was seen in sedentary behaviour. However, no significant differences were found in overall PA levels between the intervention groups and the control group. PA levels were also analysed on preschool days. The full intervention group showed significant positive differences on sedentary behaviour and MVPA at the first follow-up. These effects were not seen at the final follow-up. For PA levels on preschool days no significant differences were found between the partial intervention group and the control group on both measurements. At the preschools it was observed that more time was spent active, both inside and outside, and less time was spent sedentary. No effects of SuperFIT were seen on BMI z-score, except for the partial intervention in which BMI z-score improved significantly from baseline to final follow-up. No differences were seen between the intervention groups and control group for BMI z-score. Overall, this study did not show differences between the intervention groups and control group to support effectiveness of SuperFIT on PA and BMI z-score. Nevertheless, SuperFIT may induce changes in PA in the preschool setting. Especially, the combination of intervention components in the preschool setting and home setting appeared to support change in PA of pre-schoolers on preschool days.

To understand the effectiveness of SuperFIT better, a process evaluation was performed to gain insight in the implementation and its context, in particular for the preschool-based component (**Chapter 6**). In addition, the impact of SuperFIT in the preschool setting was studied. A mixed-methods study was performed, combining both qualitative and quantitative measurements. The process evaluation was performed among preschool teachers of the twelve participating preschools, managers of the preschool organization, and implementers. Quantitative measures were the Child-care Food and Activity Practices Questionnaire (CFAPQ) and a process questionnaire. Qualitative measures were semi-structured in-depth interviews and observations. Various SuperFIT activities were implemented in the preschool setting as planned (e.g., training and coaching of the preschool teachers, provisions of PA and nutrition related materials, and fruit and vegetables delivery). From the beginning of SuperFIT, the organizations involved intended to maintain SuperFIT within their organization. In particular, for the preschool organization this was hindered by available time and financial resources. Several factors were identified that influenced the implementation and maintenance of SuperFIT. For example, (in)congruence with current practice, limited perceived capabilities to integrate SuperFIT, group composition, and the perceived top-down implementation were important factors mentioned. Further, organizational vision and support and the current societal attention towards healthy behaviour supported the implementation and maintenance of SuperFIT. Duration of the intervention was considered invaluable to support implementation and allow time for integration within the preschool setting. SuperFIT impacted mainly the social environment in the preschool setting. An increased awareness among preschool teachers of their role in healthy EBRB of pre-schoolers was reported. Predominantly favourable changes were seen in the nutrition and physical activity-related practices of the preschool teachers and other aspects of the social environment (e.g., use of play materials and/or nutrition materials). Limited changes were seen in the physical environment, except for the materials provided from the SuperFIT intervention. SuperFIT invaded the preschool system and initiated change to support healthy EBRB in pre-schoolers. A different or more bottom-up or mutual adaptation approach may support the integration of SuperFIT within the preschool setting even more. In order to change the EBRB of pre-schoolers, a comprehensive approach was thought essential.

In **Chapter 7** the main results, methodological considerations, and lessons learned of this dissertation are discussed. When interpreting the effects of SuperFIT, the research design, lack of blinding, and the sample size should be taken into consideration. Although the development of SuperFIT was done adopting a mutual adaptation approach, this was not always experienced as such in practice. Alternative ways for (increasing) the involvement of the target population may be needed.

Many initiatives have been taken to promote healthy EBRB in the ECE setting in recent years. Although these interventions appear to be promising in supporting healthy EBRB

in pre-schoolers, few evaluation studies have been able to show significant differences between intervention and control groups. Extending successful nationwide programs from the primary school setting to the ECE setting would strengthen local initiatives to promote healthy EBRB in pre-schoolers.

A different approach towards intervention activities may be needed with regard to parental involvement. More focus on family activities and spending time together, instead of a high educational character and focus on improving health may be more appealing for parents to be involved in. The integration of different types of environment and the alignment between different settings are important aspects of SuperFIT. The economic and political environment received less attention within SuperFIT, compared to the sociocultural and physical environment. For the sustainability, taking into account these two types of environment may be very important as factors in these types of environment may be crucial (e.g., available time and resources, and organizational policies). SuperFIT focused on the alignment between the home and ECE setting. It is difficult to directly change the home environment and effects in the home setting may be hard to achieve through interventions. More knowledge on intervention activities that may work is needed. Further, to sustainably change health behaviour of pre-schoolers, alignment between the ECE setting and the primary school may be important.

SuperFIT is an intervention approach to promote healthy EBRB in pre-schoolers in both the preschool and home settings. In its current form SuperFIT appears to predominantly impact the preschool setting. It was challenging to involve the parents and thus the impact in the home setting may be limited. Further development of the family-based component and different intervention strategies for parents are needed to ensure true alignment between the preschool and home setting to optimally support healthy changes in the EBRB of pre-schoolers.

Samenvatting

Overgewicht en obesitas bij kinderen is een belangrijk gezondheidsprobleem. Het is bekend dat overgewicht en obesitas in de kindertijd vaak blijft voortbestaan in de volwassenheid. Het is dan ook een complex gezondheidsprobleem om te genezen, wanneer het zich voordoet. Overgewicht en obesitas zijn voornamelijk het gevolg van een verstoring in de energiebalans. Daarom is het belangrijk om gezond energiebalans gerelateerd gedrag te bevorderen, zoals bijvoorbeeld gezonde voeding en beweging. Dit is al belangrijk voor peuters (kinderen van 2-4 jaar oud) omdat gedragsgewoontes zich in die leeftijd al vormen en peuters mogelijk al ongezonde voedingsgewoontes hebben, onvoldoende bewegen en te veel zitten.

De omgeving heeft een belangrijke invloed op gedrag, door bijvoorbeeld de beschikbaarheid van gezonde voedingsproducten of de steun van ouders om actief te zijn. De kinderopvang- en de thuisomgeving hebben een belangrijke invloed op het gedrag van peuters. Er kan een interactie zijn tussen deze twee omgevingen. Dit betekent dat kenmerken van de kinderopvangomgeving, afhankelijk van de kenmerken van de thuisomgeving het gedrag van een kind anders kunnen beïnvloeden, en andersom. Het is belangrijk om deze omgevingen op één lijn te brengen om zo een grotere invloed op het gedrag van peuters te kunnen hebben. Een veelomvattende, integrale interventie aanpak om gezond energiebalans gerelateerd gedrag bij peuters te bevorderen werd geïnitieerd. Het hoofddoel van dit proefschrift was het ontwikkelen, implementeren en evalueren van deze interventie aanpak. Er werd onderzoek gedaan als basis voor de ontwikkeling van de interventie. De ontwikkeling van SuperFIT is beschreven en het programma werd geëvalueerd met zowel een effect- als procesevaluatie **(Hoofdstuk 1)**.

Als basis voor de ontwikkeling van de interventie aanpak werden een systematisch literatuuronderzoek en een behoefte onderzoek uitgevoerd. **Hoofdstuk 2** beschrijft de resultaten van het systematisch literatuuronderzoek. Het doel van het literatuuronderzoek was om de effecten van interventies in de kinderopvang met directe ouderbetrokkenheid op de gewichtsstatus van peuters en op hun energiebalans gerelateerd gedrag te evalueren (beweging, zitgedrag en voeding gerelateerd gedrag). Informatie over de verschillende typen omgevingen die onderdeel waren van de interventies werd gebruikt om mogelijke werkzame mechanismen van effectieve interventies te beschrijven. In vier digitale databases werd op een systematische manier gezocht naar studies over dit soort interventies. Om de vergelijkbaarheid tussen de studies te verhogen werd de grootte van effecten bepaald (Cohen's *d*). Tweeëntwintig studies, die zeventien unieke interventies beschreven, werden geïncludeerd. De meerderheid van de studies vond gunstige effecten op gewichtsstatus, beweging, zitgedrag en/of voeding gerelateerd gedrag voor de interventiegroep. Ongunstige effecten werden overigens ook gezien. Een klein aantal studies was in staat om significante

verschillen tussen de interventie- en controlegroep aan te tonen. De grootte van de effecten was voornamelijk klein of matig. De meeste interventies richtten zich zowel op de fysieke als de sociale omgeving binnen de kinderopvangomgeving en thuisomgeving. Interventies die zich daarnaast ook richtten op de politieke omgeving (bijvoorbeeld voedingsbeleid in de kinderopvang) leken meer effect te hebben. Interventies die ouders op een actieve manier betrokken, door bijvoorbeeld actieve betrokkenheid bij de ontwikkeling van de interventie, leken ook meer effecten te hebben op de gewichtsstatus en het gedrag van peuters. Concluderend: het literatuuronderzoek laat zien dat interventies in de kinderopvang met directe ouderbetrokkenheid veelbelovende resultaten hebben op de gewichtsstatus en het gedrag van peuters.

De resultaten van het behoefte onderzoek worden beschreven in **Hoofdstuk 3**. Het doel van het behoefte onderzoek was om factoren in de kinderopvang te onderzoeken die gezond energiebalans gerelateerd gedrag van peuters beïnvloeden en behoefte aan verandering te identificeren. Een kwalitatief onderzoek werd uitgevoerd waarin interviews werden gehouden met managers in de kinderopvang, pedagogisch medewerkers en ouders. Het 'Environmental Research framework for weight Gain prevention' (ENrG framework) werd gebruikt als kader voor de analyse. Achtenveertig interviews werden uitgevoerd met in totaal 65 deelnemers (9 managers, 23 pedagogisch medewerkers en 33 ouders). In alle typen omgeving (fysiek, sociaal, economisch en politiek) werden factoren benoemd die het energiebalans gerelateerd gedrag van peuters beïnvloeden. Er werden verschillen gezien tussen de deelnemers in hoeverre zij invloed ervaarden van de verschillende omgevingen. Indicaties werden gegeven voor een interactie tussen de verschillende typen omgeving. De mogelijke invloed van de fysieke omgeving hangt bijvoorbeeld af van hoe een pedagogisch medewerker gebruik maakt van de kansen in de fysieke omgeving (dit is sociale omgeving). Verder werden ook modererende factoren benoemd, zoals eigenschappen van peuters. De interviews lieten kansen zien om gezond energiebalans gerelateerd gedrag te bevorderen in de kinderopvangomgeving. Een behoefte aan verandering werd niet altijd duidelijk uitgesproken. Door de beperkte tijd die peuters in de peuteropvang doorbrengen werden er beperkte mogelijkheden gezien om het gedrag van peuters echt te veranderen binnen de peuteropvang. Het op één lijn brengen van de peuteropvang en thuisomgeving bleek erg belangrijk.

Hoofdstuk 4 beschrijft de ontwikkeling en het protocol voor de evaluatie van SuperFIT (Systemen van oUders en Peuters in EneRgiebalans: een Familie InTerventie). SuperFIT is een veelomvattende, integrale interventie aanpak voor peuters. Het werd ontwikkeld in een samenwerking tussen een kinderopvangorganisatie, een gemeentelijke sportstichting en experts in gezondheidsbevordering. De ontwikkeling en implementatie vonden plaats door een continu proces van co-creatie, feedback en aanpassingen. SuperFIT heeft drie pijlers:

1. er wordt aandacht besteed aan zowel voeding als beweging in de interventie activiteiten;
2. zowel de kinderopvang- als thuisomgeving zijn onderdeel van de interventie activiteiten,
3. verschillende typen omgeving (sociaal, fysiek en politiek) worden geïntegreerd in de interventie activiteiten.

De SuperFIT interventie aanpak bestond uit een peuteropvangcomponent, een familiecomponent en een wijkcomponent. De interventie activiteiten hadden als doel om veranderingen in de fysieke, sociale en politieke omgeving te bewerkstelligen binnen elke component. Daarnaast hadden de activiteiten als doel om de kinderopvang- en thuisomgeving meer op één lijn te brengen in relatie tot gezonde voeding en beweging. Een quasi-experimenteel onderzoeksdesign werd gebruikt om de effecten van SuperFIT te evalueren. Er deden twaalf interventie- en negen controlepeuterspeelzalen mee. De hoofduitkomstmaten waren Body Mass Index (BMI) z-score, waarvoor objectief gemeten lengte en gewicht van de peuters gebruikt werden; beweging en zitgedrag, wat werd gemeten met accelerometers; en voedingsinname, wat door middel van een 24-uurs recall werd gemeten. Secundaire uitkomstmaten waren de aan voeding en beweging gerelateerde opvoedpraktijken van de pedagogisch medewerkers en ouders, en de fysieke omgeving van thuis en de peuterspeelzaal. De procesevaluatie werd uitgevoerd met een mixed-methods onderzoeksdesign. Zowel kwantitatieve (vragenlijsten) als kwalitatieve (diepte-interviews en observaties) meetmethoden werden gebruikt.

De effecten van SuperFIT op beweging, zitgedrag en BMI z-score worden in **Hoofdstuk 5** gepresenteerd. Peuters konden deelnemen aan zowel de peuteropvangcomponent als de familiecomponent, dit wordt gezien als de volledige interventiegroep. Peuters konden ook alleen deelnemen aan de peuteropvangcomponent, dit wordt gezien als de gedeeltelijke interventiegroep. Beide groepen worden vergeleken met een controlegroep. De metingen werden uitgevoerd op baseline (januari tot juli 2017), de eerste nameting (november tot december 2017) en de laatste nameting (mei tot juni 2018). Er werden observaties gedaan tijdens de implementatie van SuperFIT om veranderingen in de activiteiten op de peuterspeelzalen vast te stellen. Bij de start van het onderzoek deden in totaal 191 peuters mee aan het onderzoek. De kinderen waren gemiddeld 3,1 jaar oud en 46,1% was jongen. Over de tijd vonden er gezonde veranderingen plaats in de hoeveelheid beweging in zowel de interventie- als controlegroep. Alle groepen lieten een toename in lichte fysieke activiteit en in matig-tot-zware fysieke activiteit zien. Er werd een daling gezien in het zitgedrag. Er werden geen significante verschillen in beweging gezien tussen de interventiegroepen en de controlegroep. De intensiteit van beweging werd ook geanalyseerd op peuterspeelzaaldagen. De volledige interventiegroep liet significante, positieve veranderingen zien in zitgedrag en matig-tot-zware fysieke activiteit bij de eerste nameting. Deze effecten werden niet gezien

bij de laatste nameting. Tussen de gedeeltelijke interventiegroep en de controlegroep werden geen verschillen gezien op beide meetmomenten. Op de peuterspeelzalen werd gezien dat er meer tijd actief werd doorgebracht, zowel binnen als buiten, en minder tijd zittend. Er werden geen effecten van SuperFIT gezien op BMI z-score, behalve in de gedeeltelijke interventiegroep waar BMI z-score significant verbeterde tussen baseline en de laatste nameting. Er werden geen verschillen gezien tussen beide interventiegroepen en de controlegroep voor BMI z-score. Over het geheel genomen laat deze studie geen verschillen zien tussen de interventiegroepen en controlegroep om de effectiviteit van SuperFIT te ondersteunen voor beweging en BMI z-score. SuperFIT kan wel veranderingen in fysieke activiteit in de peuteropvang teweegbrengen. Vooral de combinatie van de peuterspeelzaalcomponent en de familiecomponent lijken een verandering in beweging te ondersteunen op peuterspeelzaaldagen.

Om de effectiviteit van SuperFIT beter te begrijpen werd er een procesevaluatie uitgevoerd om meer inzicht te krijgen in het implementatieproces en de context, specifiek voor de peuterspeelzaalcomponent **(Hoofdstuk 6)**. De impact van SuperFIT in de peuterspeelzaalomgeving werd ook onderzocht. Een mixed-methods onderzoeksdesign werd gebruikt waarin kwantitatieve en kwalitatieve methoden werden gecombineerd. Pedagogisch medewerkers van de twaalf deelnemende peuterspeelzalen, managers van de opvangorganisatie en uitvoerders van SuperFIT namen deel aan dit onderzoek. Kwantitatieve metingen waren de Child-care Food and Activity Practices Questionnaire (CFAPQ) en een procesvragenlijst. Kwalitatieve metingen waren semigestructureerde diepte-interviews en observaties. Verschillende activiteiten werden zoals gepland in het kader van SuperFIT geïmplementeerd in de peuterspeelzaalomgeving (bijvoorbeeld de training en coaching van de pedagogisch medewerkers, voorzien in extra beweeg- en voedingsmaterialen en de fruit en groenten levering). Vanaf de start van SuperFIT was het de intentie van alle betrokken partijen om SuperFIT te borgen. Vooral voor de peuterspeelzaalorganisatie werd dit bemoeilijkt door de beschikbare tijd en financiële middelen. Verschillende factoren beïnvloedden de implementatie en borging van SuperFIT. (in)Congruentie met huidige werkwijze, beperkte ervaren mogelijkheden om SuperFIT te integreren, groepssamenstelling en de als top-down ervaren implementatie waren belangrijke factoren die werden genoemd. Visie van de organisatie en steun uit de organisatie en de huidige trends in de samenleving werden als steunend ervaren voor de implementatie en borging van SuperFIT. De duur van het programma was essentieel voor de implementatie van SuperFIT en om SuperFIT te integreren in de dagelijkse praktijk in de peuterspeelzaalomgeving. SuperFIT had voornamelijk impact op de sociale omgeving binnen de peuterspeelzaalomgeving. Er werd een grotere bewustwording gezien onder de pedagogisch medewerkers over hun rol in energiebalans gerelateerd gedrag van peuters. Er werden voornamelijk gunstige veranderingen gezien in de voeding- en beweging gerelateerde praktijken van de pedagogisch medewerkers en andere aspecten van de sociale omgeving (bijvoorbeeld het gebruik van beweeg- en voedingsmaterialen). Buiten de materialen die onderdeel waren van SuperFIT werden er beperkte veranderingen gezien in de fysieke omgeving. SuperFIT heeft tot eerste veranderingen in de peuterspeelzaalomgeving geleid die gezond energiebalans gerelateerd gedrag bij peuters ondersteunen. Een andere of meer bottom-up of wederkerige adaptatie

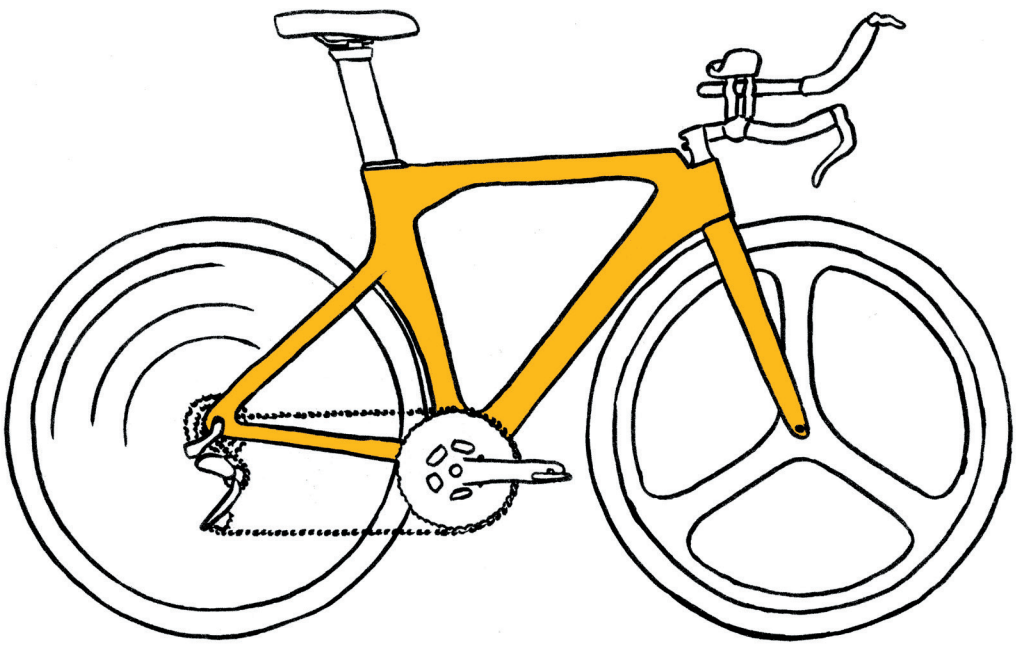
benadering zou de integratie van SuperFIT in de peuterspeelzaalomgeving nog meer kunnen ondersteunen. Een veelomvattende benadering werd essentieel beschouwd om het energiebalans gerelateerd gedrag van peuters te kunnen veranderen.

In **Hoofdstuk 7** worden de belangrijkste resultaten, methodologische overwegingen en geleerde lessen van SuperFIT bediscussieerd. Bij de interpretatie van de resultaten van het onderzoek moeten het design, het niet blinderen en de grootte van de steekproef in overweging genomen worden. Hoewel SuperFIT werd ontwikkeld door middel van wederkerige adaptatie, werd dit in de praktijk niet altijd zo ervaren. Alternatieve manieren voor (meer) betrokkenheid van de doelgroep zijn mogelijk nodig.

In de afgelopen jaren zijn er veel initiatieven genomen om gezond energiebalans gerelateerd gedrag bij peuters te bevorderen. Hoewel deze interventies de potentie hebben het gedrag van peuters te veranderen, zijn weinig studies in staat geweest om statistisch significante verschillen aan te tonen tussen de interventie- en controlegroep. Het uitbreiden van nationale initiatieven binnen de basisschoolomgeving naar de kinderopvangomgeving zou lokale initiatieven om het gedrag van peuters te veranderen kunnen ondersteunen.

In het kader van ouderbetrokkenheid is een andere benadering van interventie activiteiten nodig. Een grotere focus op familieactiviteiten en samen tijd doorbrengen spreekt ouders mogelijk meer aan dan hoofdzakelijk educatieve bijeenkomsten gefocust op het verbeteren van gezondheid. De integratie van verschillende typen omgeving en het op één lijn brengen van verschillende omgevingen zijn belangrijke aspecten van SuperFIT. De economische en politieke omgeving hebben minder aandacht gekregen binnen SuperFIT vergeleken met de sociale en fysieke omgeving. Voor het ondersteunen van de duurzaamheid van SuperFIT zijn deze typen omgeving mogelijk erg belangrijk omdat factoren in deze omgevingen cruciaal zijn (bijvoorbeeld beschikbare tijd en middelen en beleid van de organisatie). SuperFIT focuste op het op één lijn brengen van de thuis- en peuterspeelzaalomgeving. Het is complex om de thuisomgeving direct te veranderen en effecten via interventies in de thuisomgeving zijn mogelijk lastig om te bewerkstelligen. Er is meer kennis nodig over interventie activiteiten die zouden kunnen werken. Om het gedrag van peuters duurzaam te veranderen is het ook belangrijk om de opvangomgeving en de basisschoolomgeving op één lijn te brengen.

SuperFIT is een interventie programma gericht op de peuterspeelzaal en thuisomgeving. In de huidige vorm lijkt SuperFIT vooral een impact te hebben in de peuterspeelzaalomgeving. Het was moeilijk om ouders van de peuters te bereiken en aan SuperFIT te laten deelnemen. Hierdoor is de impact in de thuisomgeving mogelijk beperkt. Doorontwikkeling van de familiecomponent en andere interventie activiteiten voor ouders zijn nodig om de thuis- en peuterspeelzaalomgeving daadwerkelijk op één lijn te brengen om zo optimaal mogelijk het gezonde gedrag van peuters te stimuleren.



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The aim of this dissertation was the development, implementation, and evaluation of the intervention approach SuperFIT. SuperFIT is a comprehensive, integrated intervention approach to promote healthy energy balance-related behaviour in 2-4-year-old children (pre-schoolers). It addresses both physical activity and nutrition behaviour of pre-schoolers in the early care and education (ECE) setting and home setting. In addition, SuperFIT takes into account different types of environments, particularly, the physical environment (what is available), the sociocultural environment (the people in the environment), and the political environment (what rules, regulations, and policies are in place). SuperFIT was developed using a mutual adaptation approach: both top-down and bottom-up processes were used. A local sports foundation, a childcare organization, and health promotion experts worked together to develop SuperFIT. Continuously, co-creation was sought with the target population, for example, through co-creation sessions or interviews.

For the current project, SuperFIT was implemented in twelve preschools in low socio-economic communities in Sittard-Geleen in the south of the Netherlands. Several intervention activities were implemented such as training and coaching of preschool staff, delivery of fruit and vegetables at preschool, and family play sessions. Changes occurred in the preschool setting during the implementation of SuperFIT, particularly in the sociocultural environment. An increased awareness was seen among preschool teachers regarding their role in healthy energy balance-related behaviours of young children, as well as positive changes in the nutrition- and physical activity-related practices of the preschool teachers. More time was spent actively at the preschools. Pre-schoolers who also took part in the family-based component were more physically active and less sedentary on preschool days compared to the control group. However, for overall weekly physical activity, all pre-schoolers were more active over time and no differences were seen between pre-schoolers participating in SuperFIT and the control group. Further, no changes were seen in BMI-z score. The implementation of SuperFIT in the preschool setting was influenced by many factors that were related to the intervention (e.g., applicability in current practice), the preschool teachers (e.g., attitude towards the program) and the preschool context (e.g., group composition). Time strongly influenced implementation and integration of SuperFIT within practice. Sufficient duration of implementation is thus very important for the success of intervention programs. The SuperFIT approach aims to align the preschool and home setting in order to support healthy energy balance-related behaviours of pre-schoolers. This alignment remains a challenge, in particular due to the difficulty of involving parents in intervention activities.

This dissertation has both scientific and societal value and the lessons learned within SuperFIT may help future researchers and intervention developers.

Scientific impact

The SuperFIT approach explicitly aimed to align the ECE and home settings with regard to healthy nutrition and physical activity. Therefore, intervention activities aimed to reach similar goals in both settings. Measurements performed in order to evaluate changes were also aligned between the settings. For example, child behaviour, changes in the physical environment and social environment (nutrition- and physical activity related practices) were measured in similar ways. Most outcomes in the home setting were measured through the parents (questionnaires or dietary recall). A mutual adaptation approach was adopted in the development of SuperFIT. Top-down theory-based knowledge was combined with bottom-up needs. The program was adapted to the local context to support intervention applicability and sustainability. As a result, no prefab one-size-fits-all intervention was developed, but the intervention was adapted to the local needs and possibilities as much as possible. Such an approach is still relatively new in intervention development, particularly in the ECE setting. Within SuperFIT we learned that not all methods (e.g., interviews and co-creation sessions) we used to ensure the bottom-up processes were experienced as such by preschool teachers. Future initiatives should aim to explore other methods to ensure bottom-up engagement or ways to make sure bottom-up involvement is experienced as such. An important factor may be allowing time to get to know and understand each other (in Dutch “suddertijd”). In the case of SuperFIT, this may have been too limited, which may have resulted in less commitment of particularly the preschool staff to SuperFIT.

With regard to the family-based component, although the activities were also aimed at spending time as a family with fun activities regarding nutrition and physical activity, the emphasis was still largely on behavioural change, healthy behaviour and health. This may not have been appealing for all families to participate in and a different approach towards parental involvement may be needed. Direct parental involvement, such as attendance at group sessions or even more active participation in development or implementation, is needed to support intervention effectiveness. Nonetheless, the results of SuperFIT show that the combination of the preschool-based and family-based component was essential for intervention effects. This supports the hypothesis of SuperFIT that alignment of the ECE and home settings will result in better intervention effectiveness.

Most of the results of the studies in this dissertation are published in international, scientific journals. Further, the different studies of SuperFIT were presented at (inter)national scientific conferences. SuperFIT has been part of educational modules both in the Bachelor of Health Sciences and the Master of Health Education and Promotion of Maastricht University. SuperFIT was also used as practice-case in the educational program of ECE staff of Vista College Maastricht and the higher vocational education program ‘Communication and Multimedia Design’ of Zuyd Hogeschool.

Societal impact

First of all, SuperFIT had an impact in the preschools that implemented the intervention approach. The children attending these preschools during implementation benefitted from a more and more supportive environment for healthy nutrition and physical activity. The societal impact of SuperFIT is not limited to these twelve preschools.

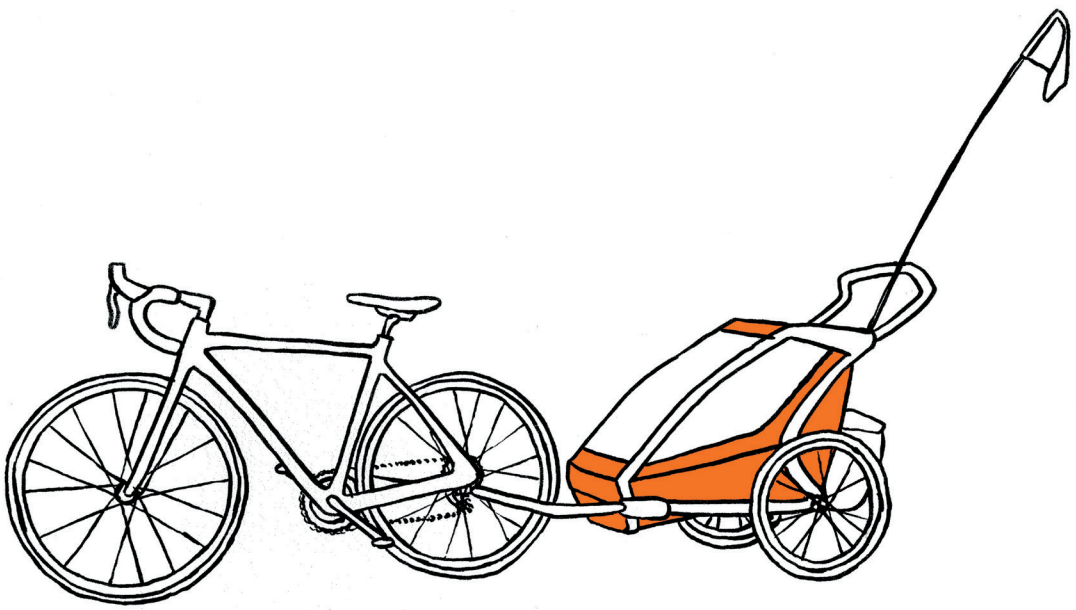
From the start of the development of SuperFIT, its sustainability was high on the agenda. Spelenderwijs (the adopting childcare organization) formulated an organizational vision regarding healthy childcare. Several managers were trained as 'Healthy Childcare coach', as part of the program 'Healthy Childcare' (Gezonde Kinderopvang) following the implementation of SuperFIT. Further, efforts were taken to disseminate SuperFIT to the remainder of the ECE locations part of Spelenderwijs. Spelenderwijs has 42 preschool locations throughout south Limburg and serve approximately 1200 pre-schoolers.

Ecsplore, the local sports foundation, adopted ownership of the SuperFIT approach. They have committed to continue to develop the SuperFIT approach in collaboration with Maastricht University, in particular the family-based component. They are involved in the dissemination of SuperFIT within Spelenderwijs as well as implementing SuperFIT in other municipalities. Three municipalities are currently implementing the full SuperFIT approach (both preschool-based and family-based component) and two municipalities (of which one is a merger of three former municipalities) are implementing the preschool-based component of SuperFIT. Ecsplore now employs a project leader and a health broker who work on the development and dissemination of SuperFIT. This is enabled with funding provided by local government. An increased awareness on the importance of healthy lifestyle in young children arose over the course of SuperFIT at the local government(s) which supported their willingness to fund SuperFIT. The SuperFIT approach and more general the promotion of a healthy lifestyle in young children is now internalised within Ecsplore and part of their business as usual. A website explaining the SuperFIT approach is available (*https://superfit.ecsplore.nl*) and two short animated movies were developed to support communication. One movie aims to explain the SuperFIT approach for the target groups, i.e., the ECE staff and parents, while the other movie is directed at ECE organizations and municipalities. Currently, efforts are made to register SuperFIT in the national database of recognized interventions ('Loket Gezond Leven') to support accessibility of SuperFIT.

In the local context of SuperFIT, the network of professional organizations involved with healthy nutrition and physical activity was strengthened. New linkages were made, for example, with the initiative 'Jong Leren Eten' (Learning to Eat) and a local greengrocer. Existing linkages were also intensified, such as the collaboration between Spelenderwijs and Ecsplore.

In May 2020, an article on SuperFIT was published in KIDDO, which is the trade journal for ECE staff in the Netherlands. In June 2019, a symposium regarding SuperFIT was organized. The symposium aimed to inform local practice professionals and local governments on the SuperFIT approach, and the results achieved in Sittard-Geleen. Relevant stakeholders such as municipalities, Spelenderwijs, Ecsplore, JOGG, Community Health Service (Dutch: GGD) were invited and attended. SuperFIT was presented at a symposium of the Academic Collaborative Centre for Public Health South Limburg. Professionals in public health from different disciplines attended this symposium.

SuperFIT was one of the first initiatives to support healthy energy balance-related behaviours in the ECE setting in Limburg and part of the first movement towards a healthy preschool in the Netherlands.



Dankwoord

Dankwoord

Hoewel het doorlopen van een promotietraject misschien overkomt als een solo prestatie, ik had dit niet kunnen volbrengen zonder de ploeg die door de jaren om mij heen stond. Iedereen heeft daarin zijn/haar rol vervuld en zonder jullie was het me niet gelukt om met mijn armen omhoog over de finish te komen. Ik wil jullie hier allemaal graag voor bedanken!

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Sanne, jij stelde vaak de vraag 'Moeten we het niet eerst nog hebben over hoe het met je gaat?' als ik alweer van start ging met het afwerken van de agenda voor dat overleg. Dat is tekenend voor hoe ik jou als begeleider heb ervaren. Je was altijd op zoek naar de goede manier om mij als wetenschapper en promovendus verder te helpen, maar ook zeker mij als persoon door dat proces te begeleiden. Je herkende veel van waar ik mee worstelde binnen mijn praktijkgerichte onderzoek vanuit jouw eigen promotietraject. Jouw ervaringen daarin heb ik weer kunnen gebruiken tijdens het mijne. Je was altijd open en eerlijk, ook als misschien even niet ging zoals we gedacht hadden. Bij jou (en Jessica) had ik altijd een plek om ook die dingen in mijn privéleven te delen die zoveel invloed konden hebben.

Jessica, je maakte zelf nog wel eens gekscherend het onderscheid good cop – bad cop tussen jou en Sanne. Jij in de rol van bad cop herken ik niet altijd zo, je was altijd positief betrokken bij mij als persoon. Jouw oneindige kennis, gedrevenheid en ervaring met onderzoek over voeding en beweging bij jonge kinderen, binnen de kinderopvang of thuisomgeving is bewonderenswaardig en zo belangrijk geweest voor mijn eigen project en onderzoek. Daarnaast kon je ook altijd wel als ervaringsdeskundige een anekdote delen over hoe dat nou gaat met voeding, beweging en opvoeding van jonge kinderen. Hoewel je hem fysiek vaak dicht had, stond je deur altijd open om mijn vragen te beantwoorden en ik hoefde

nooit lang te wachten op jouw feedback op mijn stukken (het is me nog een raadsel hoe je dat toch allemaal voor elkaar krijgt).

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Zonder onze samenwerkingspartners, **Ecsplore en Spelenderwijs,** was SuperFIT nooit geworden wat het nu is. Heel erg bedankt voor de fijne samenwerking gedurende de jaren en wat mooi dat we een programma hebben mogen ontwikkelen wat nog steeds wordt ingezet in deze organisaties.

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Monique, Marian, Marij en Sonja, hoe kan je een programma voor de peuteropvang maken zonder de peuteropvang te betrekken? Jullie input in de ontwikkeling en implementatie van SuperFIT is onmisbaar geweest. Jullie konden ons wijzen op de dagelijkse praktijk van pedagogisch medewerkers. Hoe ziet die er nu uit? Wat past daar nog binnen? Wat wordt er allemaal van ze verwacht? Het was super om samen te werken met een organisatie die het belang van gezonde voeding en beweging bij jonge kinderen al vroeg erkende en het ook aandurfde om hiermee in de praktijk aan de slag te gaan.

Ik wil de stuurgroep, **Maria, Patricia & Laura, Mariëlle, Tom & Glenn, Jeu & Marjon, Ashley & Maureen en Jolanda,** graag bedanken voor hun inbreng in de ontwikkeling en implementatie van SuperFIT. De brede kijk op het programma leverde altijd nuttige input op om de volgende stap te kunnen zetten.

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De **GVO-break'ers** <insert giphy Martien Meilandt>, you know what I mean. Bedankt dat jullie het thuis werken tijdens de corona periode net iets dragelijker maakten.

Ook buiten het werk zijn er een hoop mensen geweest die er voor mij waren tijdens mijn promotietraject. Ook hen wil ik uit het diepste van mijn hart bedanken.

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Curriculum Vitae
Publication List

Curriculum Vitae

Ilona van de Kolk was born on August 31st, 1988 in Elburg, the Netherlands. She attended VWO at Greijdanus College in Zwolle. After she graduated in 2006, she started studying Midwifery at the Academie Verloskunde Maastricht. However, during the course of her study she decided to switch education in order to pursue a more academic career. She started studying Health Sciences at Maastricht University in 2010, with a specialization in Prevention & Health. In the first year, she was awarded for being part of the top 3% of her study. She graduated within 2.5 years and received her bachelor's degree. She continued her education with the Health Sciences Research Master in 2013. She received her master's degree in 2015 with the distinction Cum Laude.

After her education, she started working as a research assistant at the department of Health Promotion, Maastricht University. She soon got the opportunity to start working on her own research as PhD candidate. Her research focused on the development, implementation and evaluation of SuperFIT. This is a comprehensive, intervention program aimed to promote healthy nutrition and physical activity in young children. The studies she conducted are presented in this dissertation. She presented her work at several national and international scientific conferences, but also non-scientific symposia. Further, she performed several teaching activities in the bachelor Health Sciences and master Health Education and Promotion. She acquired her University Teaching Qualification (UTQ).

Currently, Ilona works at Stichting Ecsplore, a local sports foundation located in Sittard-Geleen. She works as project manager on various projects of the foundation.

Publication List

Publications presented in this dissertation

van de Kolk, I., Gerards, S.M.P.L., Harms, L.S.E., Kremers, S.P.J., van Dinther-Erkens, A.M.H.S.; Snellings, M., Gubbels, J.S. (2020) Study Protocol for the Evaluation of "SuperFIT", a Multicomponent Nutrition and Physical Activity Intervention Approach for Preschools and Families. Int J Environ Res Public Health, 17, 603.

van de Kolk, I., Gerards, S.M.P.L., Harms, L.S.E., Kremers, S.P.J.,Gubbels, J.S. (2019) The Effects of a Comprehensive, Integrated Obesity Prevention Intervention Approach (SuperFIT) on Children's Physical Activity, Sedentary Behavior, and BMI Z-Score. Int J Environ Res Public Health, 16, 5016.

van de Kolk, I., Verjans-Janssen, S.R.B., Gubbels, J.S., Kremers, S. P. J., Gerards, S. M. P. L. (2019) Systematic review of interventions in the childcare setting with direct parental involvement: effectiveness on child weight status and energy balance-related behaviours. Int J Behav Nutr Phys Act, 16, 110.

van de Kolk, I., Goossens, A. J. M., Gerards, S. M. P. L., Kremers, S. P. J., Manders, R. M. P., & Gubbels, J. S. (2018). Healthy Nutrition and Physical Activity in Childcare: Views from Childcare Managers, Childcare Workers and Parents on Influential Factors. Int J Environ Res Public Health, 15, 12.

Other publications

Verjans-Janssen, S. R. B., **van de Kolk, I**., Van Kann, D. H. H., Kremers, S. P. J., & Gerards, S. M. P. L. (2018). Effectiveness of school-based physical activity and nutrition interventions with direct parental involvement on children's BMI and energy balance-related behaviors: - A systematic review. PLOS ONE, 13, 9.

Gubbels, J. S., Stessen, K., **van de Kolk, I.,** de Vries, N. K., Thijs, C., & Kremers, S. P. J. (2018). Energy balance-related parenting and child-care practices: The importance of meso-system consistency. PLOS ONE, 13, 9.

Verdonschot, R. J. C. G., Baijens, L. W. J., Vanbelle, S., **van de Kolk, I**., Kemer, B., & Leue, C. (2017). Affective symptoms in patients with oropharyngeal dysphagia: A systematic review. Journal of Psychosomatic Research, 97, 102-110.

Kremer I. E. H., Hiligsman M., Jongen P. J., **Kolk van de I.,** Dowie J., Weijden van der T., Evers S. M. A. A. (2015). Patient preferences for attributes of disease modifying drugs: results from a nominal group technique and best-worst scaling among patients with multiple sclerosis. Value of Health, 18, 7.