



## Process evaluation of fruit and vegetables distribution interventions in school-based settings: A systematic review

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### ABSTRACT

Despite the importance of process evaluation in program evaluations, research has focused primarily on the effectiveness of fruit and vegetables (FVs) distribution interventions on children's consumption, with little attention given to how these interventions achieve their outcomes. Five bibliographic databases (Embase, PubMed, ProQuest, Scopus, and Web of Science Core Collection) were searched in June 2019 for studies of interventions where the main focus was the implementation of distributed FVs to school-aged children as a snack. The Critical Appraisal Skills Programme (CASP) tool was used to appraise the risk of bias within included studies. Data were extracted based on study characteristics and findings. Results identified 24 studies reporting on 11 interventions and 1 policy. The findings of this systematic review indicate that the majority of the studies included limited references to implementation research. Recurring limitations include an absence of an evaluation theoretical framework and the data collection methods used. Also, several factors were identified as informing the success of snack-based FVs distribution programs, including participation of the school community, school characteristics, background knowledge, and parental engagement. Lack of timely FVs delivery, limited funding, inadequate awareness about the program, insufficient teachers' time, and food waste were identified as challenges to successful programming. Findings indicate that distributing FVs to school-aged children as a snack can increase their consumption, but only with proper implementation. Further evaluative research is required to better inform future implementation of snack-based FV distribution interventions in school settings.

### 1. Introduction

Fruit and vegetables (FVs) are important components of a healthy diet and sufficient daily consumption can help prevent the majority of non-communicable chronic diseases ([World Health Organization \[WHO\], 2003](#)), however children consume less FVs than recommended ([Dennison et al., 1998](#); [Garriguet, 2007](#); [Minaker and Hammond, 2016](#); [Colapinto et al., 2018](#); [Polisky and Garriguet, 2020](#)). To combat this problem, a number of intervention strategies have been developed to increase school-aged children's intake of healthy foods, particularly FVs ([Triador et al., 2015](#); [DeCosta et al., 2017](#); [Libman, 2007](#); [Margolin et al., 2018](#)). Increasing the availability and accessibility of FVs by distributing FVs to school-aged within the school environment has been consistently

identified as positive predictors of children's consumption of FVs ([Blanchette and Brug, 2005](#); [de Sa and Lock, 2008](#); [Rasmussen et al., 2006](#); [Knai et al., 2006](#); [Van Cauwenberghe et al., 2010](#)). Availability is defined as the presence of FVs at home or in school, while accessibility is defined as FVs that are prepared, presented, and/or maintained in a form that enables or encourages children to consume them (e.g., cutting up FVs or designating time to eat FVs) ([Blanchette and Brug, 2005](#)). While a recent systematic review and meta-analysis examined the effectiveness of distributing FVs as a snack during break-time to school-aged children ([Blinded for Review](#)), these studies rarely inform us of how interventions were executed and the importance of implementation for program effectiveness.

Process evaluation studies serve an important role in health

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promotion research by providing information about how interventions are implemented, the predictors of conditions under which interventions are likely to be most effective (i.e., mechanism of impact), and how the contextual environment affects the outcome (Oakley et al., 2006). Evidence from process evaluation is important to determine whether a lack of an effect is due to inadequate (i.e., poorly *implemented*) or ineffective (i.e., poorly *designed*) interventions, thereby qualifying the understanding of any effect of an intervention (Durlak and DuPre, 2008). Various theoretical frameworks (Baranowski and Stables, 2000; Linnan and Steckler, 2002; Saunders et al., 2005; Glasgow et al., 1999; Fleuren et al., 2004; Rogers, 2003) have been used to address process evaluation of public health interventions. Yet, despite heterogeneity, they are all intended to determine aspects that are not working in the program and that need to be further improved.

To our knowledge, this constitutes the first systematic review of the literature on snack-based FV distribution interventions in school settings to examine: 1) features of process evaluations of snack-based FV distribution intervention studies that have been conducted in this field of study; and 2) the benefits and impacts of these programs, successes of and challenges to the implementation, and potential recommendations into future implementation of these programs. The study primarily focuses on the implementation practices and processes of providing children with readily accessible and available FVs during school hours as snacks (outside of breakfast or lunch time). This is because these programs are considered feasible to implement, compared to breakfast or lunch meals, within the school environment due to the rudimentary resources needed (e.g., basic servery/kitchenette, preparation areas, storage infrastructure and volunteer/staff capacity). Knowledge gained from this review will not only guide future planning of process evaluations in this field, but also identify conditions and resources needed under which snack-based FV distribution interventions are likely to be most effective and sustainable.

## 2. Materials and methods

The authors followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines during all stages of design, implementation, and reporting (Moher et al., 2009).

### 2.1. Search strategy

Embase, ProQuest, PubMed, Scopus, and Web of Science Core Collection were searched in June 2019. No date limit, language or geographic location restrictions were applied. In consultation with an experienced librarian and informed by previously published literature, searches were carried out combining five different search arms: (*school\* OR "school-based"*) AND (*intervention\* OR program\* OR scheme\* OR campaign\* OR initiative\* OR project\**) AND (*"program evaluation" OR "process evaluation" OR implementation OR evaluation*) AND (*fruit\* OR vegetable\**) AND (*provision OR subsidized OR distribution OR free OR availability OR exposure OR accessibility*). This method was adapted when Medical Subject Headings (MeSH) terms were not available. One reviewer screened the titles of the studies and imported all relevant titles into a citation manager (Mendeley v1.17.10). Duplicates were then removed and from the remaining studies, an abstract screening was completed independently by two reviewers. For any potentially relevant studies, full texts were assessed for eligibility independently by two reviewers. Once eligible studies were identified, a manual search of the reference lists of the included studies was conducted to identify any missed relevant studies. Discrepancies were discussed, elucidated, and resolved with a third reviewer.

### 2.2. Study selection

Studies needed to meet the following inclusion criteria: **Population:** stakeholders (e.g., school staff, volunteers, children); **Intervention:**

distributed FVs as snacks in school-based setting solely or combined with another intervention approach (e.g., nutrition education, parental involvement); **Comparator:** not applicable; and **Outcome:** provided information on the functioning of the intervention (i.e., implementation, mechanisms of impact, and/or contextual factors). Studies were excluded if they were not reported in English, reviews, conference proceedings/abstracts, design protocols, process evaluation of approaches used to increase children's FVs consumption, but without providing children with FVs at schools (e.g., nutrition education, parental involvement) or studies that only reported on outcome evaluation with no information on process evaluation.

### 2.3. Data extraction and abstraction

Information from each study was extracted based on the following: 1) basic information about the study (authors, publication year, program name, and country); 2) process evaluation participants; 3) measurement methods; 4) and findings. The Critical Appraisal Skills Programme (CASP) was used to provide descriptive information on the quality of the included studies rather than as a basis for inclusion. Each study was rated independently by two reviewers. The tool consists of 10 questions, all of which can be answered with either "Yes", "No", or "Unclear" and are designed around three broad sections: 1) Are the results of the study valid? 2) What are the results? and 3) Will the results help locally? (Critical Appraisal Skills Programme [CASP], 2018).

### 2.4. Data synthesis

A qualitative synthesis was presented detailing: 1) features of process evaluations of snack-based FV distribution intervention studies that have been conducted in this field of study; and 2) process evaluation findings of stated implementation of the planned intervention. Data were analyzed using an inductive content analysis approach (Braun and Clarke, 2006; Auerbach and Silverstein, 2003). As a team, we developed a preliminary coding template, tested its implementation, and discussed any issues that arose during preliminary data analysis until a common theme template was developed. Studies were independently coded by a second reviewer (non-author) to establish inter-rater reliability. The coders achieved an initial agreement level of 87.5% before discussing individual differences in interpretation. This measure of agreement was determined by comparing codes each reviewer assigned and calculating the percentage of agreement (Nili et al., 2017). Any initial coding disagreements were discussed, elucidated, and resolved with a third author until a common theme template was developed.

Several strategies were employed to enhance trustworthiness of the data. The coding and interpretation of results were continuously discussed with co-authors and discrepancies were amended following discussion to clarify coding and emergent themes using a team analysis approach (also known as investigator triangulation) (Merriam, 2009). An IRR of 80% agreement between coders on 95% of the codes is considered sufficient agreement when multiple researchers involved in the coding process (McAlister et al., 2017). The primary author revisited the studies after the development of the final common theme template to verify that findings were rooted in the data. Data coding was checked using the specification in the NVivo software program (Version 12, QSR International Pty Ltd, Melbourne, Australia). A reflective diary of data collection and analysis provided data immersion, validity, and minimized researcher bias (Green et al., 2007).

## 3. Results

### 3.1. Literature search

Of the 1669 titles retrieved, 166 studies remained after title screening and removal of duplicates. Abstract screening left 93 studies, as 73 did not meet the pre-specified eligibility criteria. Full-text

screening left 18 studies, as 75 did not meet the eligibility criteria. An additional six studies were added from a manual search of reference lists of the included studies. In total, this search strategy identified 24 separate studies, reporting on 11 interventions and 1 policy, published between 2006 and 2019 (Fig. 1).

### 3.2. General characteristics of the studies

A descriptive summary of the characteristics of the included studies ( $n = 24$ ) is presented in Supplementary Table A. Most studies were based in Canada ( $n = 6$ ), USA ( $n = 5$ ), and Denmark ( $n = 4$ ), and included a

variety of participants (e.g., children, teachers). All interventions distributed free FVs as a snack during break-time within school hours, with the exception of one study (Bere et al., 2006a) in which FVs were distributed at parental costs (subsidized). In addition to distributing FVs, some intervention studies incorporated other supplementary components such as nutrition education (Bere et al., 2006a; Bouck et al., 2011; Wind et al., 2008; Aarestrup et al., 2014; Gates et al., 2011) peer modelling and rewards, (Clarke et al., 2009; Muellmann et al., 2017; Hayes et al., 2019) and parental involvement (Bere et al., 2006a; Wind et al., 2008; Jorgensen et al., 2016).

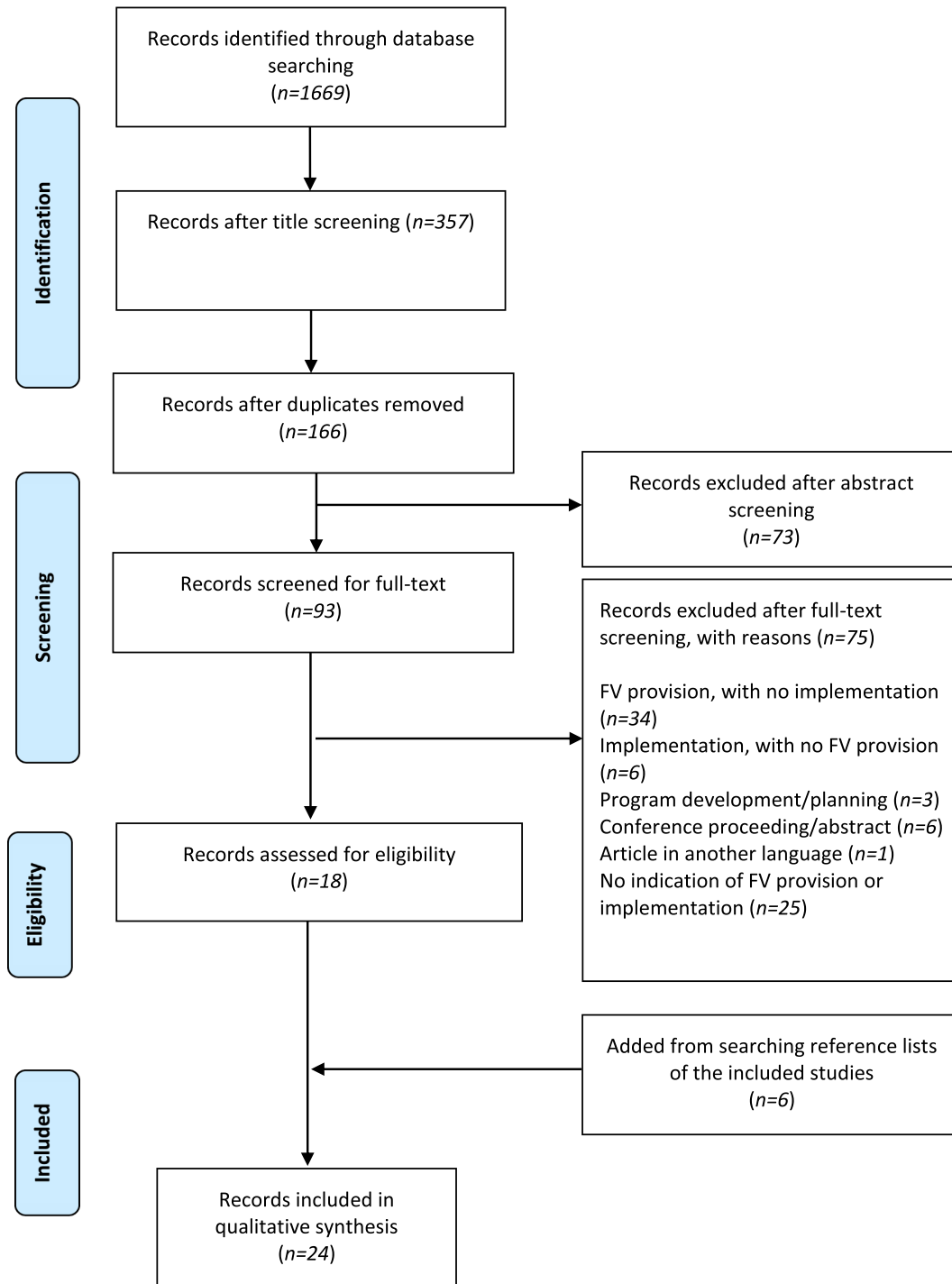


Fig. 1. Flow diagram of search strategy and review process based on PRISMA statement. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

### 3.3. Quality of evidence

The results of the quality assessment of the included studies ( $n = 24$ ) are presented in Supplementary Table B. A broad approach was used to avoid excluding studies based on quality assessment and to leave room for conducting exploratory research on the evidence base in this field. As there is no consensus on the relative weight that should be ascribed to any individual study, the presentation of a simple summed score of the tool's items would risk being more misleading than informative.

For the intervention studies, we did note a valuable contribution, but considerable heterogeneity in adequately describing the implementation practices and processes of these interventions. All studies provided an adequately clear statement of the aims (Item 1) and findings (Item 9). None of the studies raised any significant ethical concerns; however, two studies (Reinaerts et al., 2007a; White, 2006) did not report the appropriate ethical permission (Item 7). This may be partly due to the age of the studies and changing reporting requirements regarding ethical approval over time. Although all studies were assumed to offer some potential value through “novel findings or perspectives”, a number of studies reported minimal details concerning qualitative methods, reflecting the fact that this was supplemental to quantitative survey data. This was noted with respect to inadequacy and/or lack of participant identifier accompanying data, and lack of quotes accompanying data, which hampered assessment of the extent to which the authors had taken into consideration all available data (Bere et al., 2006a; Wind et al., 2008; Jorgensen et al., 2016; Reinaerts et al., 2007a; Aarestrup et al., 2015; Jamelske and Bica, 2014; Bai et al., 2011; Lin and Fly, 2016; Coyle et al., 2009; Skinner et al., 2012; Gates et al., 2012, 2016; Yeo and Edwards, 2006)

### 3.4. Features of process evaluation of Snack-based FV distribution intervention studies

#### 3.4.1. Terminology

17 studies used the term “process evaluation”, “program evaluation” or “implementation”, which could be found anywhere in the paper (e.g., title, abstract, introduction, methods) (Gates et al., 2012, 2016, 2011; Bere et al., 2006a; Bouck et al., 2011; Wind et al., 2008; Aarestrup et al., 2014, 2015; Muellmann et al., 2017; Hayes et al., 2019; Jorgensen et al., 2016, 2014; Reinaerts et al., 2007a; Jamelske and Bica, 2014; Bai et al., 2011; Lin and Fly, 2016; Coyle et al., 2009; Skinner et al., 2012; Gates et al., 2011; Hector et al., 2017).

#### 3.4.2. Aim, theoretical framework, research strategy and timing

17 studies identified aims and research questions specific to process evaluation (Bouck et al., 2011; Wind et al., 2008; Aarestrup et al., 2014, 2015; Gates et al., 2011, 2012, 2016; Muellmann et al., 2017; Hayes et al., 2019; Jorgensen et al., 2016, 2014; Reinaerts et al., 2007a; Jamelske and Bica, 2014; Bai et al., 2011; Yeo and Edwards, 2006; Potter et al., 2011; Hector et al., 2017), while the remaining provided a very broad description of these objectives. Only 9 studies reported the use of a theoretical framework to inform the design of the process evaluation (Wind et al., 2008; Aarestrup et al., 2014, 2015; Gates et al., 2016; Hayes et al., 2019; Jorgensen et al., 2016; Reinaerts et al., 2007a). The most frequently cited theoretical frameworks were Baranowski and Stables (2000), Linnan and Steckler (2002), Saunders et al. (2005), Glasgow et al., (1999), Diffusion of Innovation Theory (Rogers, 2003), and the Utilization-focused participatory approach (Rossi et al., 2004). Several research strategies including qualitative methods, such as interviews and focus group discussion (Muellmann et al., 2017; Hayes et al., 2019; Jorgensen et al., 2014; He et al., 2012), quantitative methods, such as pre-coded questionnaires and surveys (Bere et al., 2006; Wind et al., 2008; Clarke et al., 2009; Jorgensen et al., 2016; Reinaerts et al., 2007a; Aarestrup et al., 2015; Yeo and Edwards, 2006), or both (Bouck et al., 2011; Gates et al., 2011, 2012, 2016; Jamelske and Bica, 2014; Bai et al., 2011; Potter et al., 2011) were included in the implementation process. Most studies collected their findings at the end

of the intervention (Gates et al., 2011, 2012, 2016; Lin and Fly, 2016; Hayes et al., 2019; Jorgensen et al., 2016, 2014; Reinaerts et al., 2007a; Skinner et al., 2012; Yeo and Edwards, 2006), with some studies collecting their findings during the intervention (Wind et al., 2008; Aarestrup et al., 2014; Potter et al., 2011; Jamelske and Bica, 2014; Bai et al., 2011).

#### 3.4.3. Addressing context

18 studies explored the contextual factors (e.g., policy, socioeconomic status, school size) surrounding the implementation of the program (Bouck et al., 2011; Wind et al., 2008; Aarestrup et al., 2014, 2015; Gates et al., 2011, 2012, 2016; Clarke et al., 2009; Muellmann et al., 2017; Hayes et al., 2019; Jorgensen et al., 2016, 2014; Jamelske and Bica, 2014; Bai et al., 2011; Skinner et al., 2012; Yeo and Edwards, 2006; Potter et al., 2011; Hector et al., 2017).

#### 3.4.4. Describing those in charge of delivering the intervention

15 studies investigated the challenges, successes and experiences of intervention providers (Muellmann et al., 2017; Hayes et al., 2019; Reinaerts et al., 2007a; Bouck et al., 2011; Wind et al., 2008; Aarestrup et al., 2014, 2015; Gates et al., 2011, 2012, 2016; Jamelske and Bica, 2014; Bai et al., 2011; Yeo and Edwards, 2006; Jorgensen et al., 2014; Potter et al., 2011).

#### 3.4.5. Investigating recipients of the intervention

9 studies reported the experiences, motivations and opinions of those exposed to the intervention (Aarestrup et al., 2014, 2015; Gates et al., 2011, 2012, 2016; Lin and Fly, 2016; Potter et al., 2011).

#### 3.4.6. Linking intervention outcomes to process evaluation findings

16 studies used the findings from the process evaluation to build explanations/reasoning about intervention outcomes (Gates et al., 2011, 2012, 2016; Clarke et al., 2009; Jorgensen et al., 2016; Reinaerts et al., 2007a; Jamelske and Bica, 2014; Hector et al., 2017; Bouck et al., 2011; Wind et al., 2008; Lin and Fly, 2016; Coyle et al., 2009; Skinner et al., 2012; Yeo and Edwards, 2006).

### 3.5. Implementation of Snack-based FV Distribution Interventions

Five overarching themes emerged, including: benefits of snack-based FV distribution interventions; successes of, and challenges to the implementation; impact of, and implications for future programming.

#### 3.5.1. Benefits of snack-based FV distribution interventions

All studies highlighted the value of FV distribution interventions as these programs provided children with free, equitable reach to healthy dietary choices (Aarestrup et al., 2014, 2015; Gates et al., 2011; Reinaerts et al., 2007a; Potter et al., 2011; Hector et al., 2017). In particular, studies highlighted the benefits of program activities (e.g., kinesthetic lessons) (Wind et al., 2008; Gates et al., 2011), FV aesthetics (e.g., appearance) (Aarestrup et al., 2014, 2015), and quality, quantity and variety of served FVs (Bouck et al., 2011; Potter et al., 2011), which were all positively associated with children's degree of liking/enjoyment, and ultimately, their consumption of FVs. This was especially important in studies with limited exposure to FVs due to economic challenges, lack of nutrition knowledge (Bouck et al., 2011; White, 2006; Bai et al., 2011; Potter et al., 2011; Hector et al., 2017) or remoteness (Bouck et al., 2011; Gates et al., 2011, 2012, 2016; Skinner et al., 2012).

#### 3.5.2. Successes of FV snack-based FV distribution interventions

Many aspects contributed to the success of FV distribution interventions including: participation of the school community; school characteristics; background knowledge; and parental engagement.

Participation of the school community, including principals and school staff, particularly teachers' role modeling and positive attitudes was identified as being crucial to children's readiness to adopt and

sustain consuming FVs (Bere et al., 2006a; Bouck et al., 2011; Gates et al., 2011, 2016; Hayes et al., 2019; Reinaerts et al., 2007a; White, 2006; Bai et al., 2011; Potter et al., 2011; Yeo and Edwards, 2006). Identified strategies included teachers facilitating discussions of the served FVs, tasting FVs with children, and encouragement (Clarke et al., 2009; Reinaerts et al., 2007a; Bai et al., 2011).

School characteristics including size, pre-existing food policies or programs, and socio-demographic characteristics affected the implementation of the program. Schools with small size (i.e., fewer than 300 participants) (Jamelske and Bica, 2014), pre-existing food policies (Muellmann et al., 2017; Yeo and Edwards, 2006), programs (Hayes et al., 2019; Yeo and Edwards, 2006), and low percentage of children with special needs (Muellmann et al., 2017; Hayes et al., 2019) facilitated the implementation of the program.

Background knowledge was reported as a valuable resource in facilitating the implementation of the program. Previous experience in food service operation facilitated implementation in terms of ease of understanding of program procedures (Jamelske and Bica, 2014). Also, providing detailed and time savings guidelines on the implementation of the program (Wind et al., 2008; Jamelske and Bica, 2014; Jorgensen et al., 2014), and/or conducting a training workshop communicating the purpose and objectives of the program (Wind et al., 2008; Aarestrup et al., 2014, 2015; Jorgensen et al., 2014) enabled the adoption, and consequently, the implementation of the program.

Parental engagement in the program facilitated the implementation of the program through ensuring the availability and accessibility of FVs at home. This, in turn, was associated with enhanced children's consumption of FVs and the program's overall success (Gates et al., 2011; Clarke et al., 2009; Hayes et al., 2019; Aarestrup et al., 2015; Bai et al., 2011; Hector et al., 2017). Identified strategies included teaching children about nutrition and health, food preparation demonstrations, serving as a role model, setting rules, providing rewards (Bai et al., 2011), and participating in program-guided child-parent activities (Wind et al., 2008; Jorgensen et al., 2016).

### 3.5.3. Challenges to snack-based FVs distribution interventions

Although all of the included studies were generally positive about FV distribution interventions, some key challenges were identified, including: lack of timely FV delivery from suppliers; limited funding; inadequate awareness about the program; insufficient teachers' time; and food waste.

Lack of timely FV delivery from suppliers was a key barrier to implementation, despite suppliers' prospect to support a good cause (i.e., timely supply, storage and delivery of discounted FVs to schools) (Aarestrup et al., 2014; Muellmann et al., 2017; Hayes et al., 2019; Hector et al., 2017). Factors such as lack of communication (Bouck et al., 2011; Aarestrup et al., 2014), low priority on the delivery company schedule (Bouck et al., 2011), remoteness (Bouck et al., 2011; Aarestrup et al., 2014; Gates et al., 2012) seasonality, and/or business size (Aarestrup et al., 2014) contributed to FV lateness. Further, unforeseen weather circumstances often meant that FVs would be unavailable or of unacceptable quality (Bouck et al., 2011; Gates et al., 2012). In addition, delivery size was not perceived as convenient because of suppliers' business size (Aarestrup et al., 2014). Identified strategies included serving dried, instead of fresh fruit (Potter et al., 2011), serving less desirable healthy choices (Bouck et al., 2011; Gates et al., 2012), adequate communication (Aarestrup et al., 2014, 2015) or changing the distribution company (Bouck et al., 2011).

Limited funding had a negative impact on food type, program staff and planning, and acquisition of resources needed for implementation. For example, schools in remote locations are typically constrained by high costs of FVs and the inability to stretch limited funds by purchasing fresh FVs in bulk or at bulk prices, which ultimately impacts the quantity and quality of FVs offered (Gates et al., 2011, 2012, 2016; Skinner et al., 2012). In such situations, dried fruit or fruit juice was most frequently served because of long shelf-life and ease of transportation (Bouck et al.,

2011; Skinner et al., 2012). Limited funding was also linked to factors such as inadequate facilities for storage (i.e., refrigerator), limited space for preparation (i.e., sinks) (Gates et al., 2012, 2016), and/or lack of staff capacity (Bouck et al., 2011; Gates et al., 2012, 2016; Potter et al., 2011). The extra time needed for FV preparation not only led to an increased workload, but also affected other school duties. For example, the extra time in washing and cutting FVs (Bouck et al., 2011), and/or lack of school staff/volunteer capacity to coordinate the program (e.g., ordering, purchasing, preparing and delivering the snack) (Gates et al., 2012; Potter et al., 2011) led to serving whole fruit (e.g., bananas) rather than fruit requiring more preparation (e.g., pineapples), further limiting children's exposure to a variety of FVs (Jamelske and Bica, 2014; Bai et al., 2011; Hector et al., 2017). Identified strategies included transferring FVs to nearby schools with extra cooler space, assistance from additional staff and children, and/or ordering prepackaged FVs (Potter et al., 2011).

Inadequate awareness about the program was recognized as a challenge to program implementation (Jamelske and Bica, 2014; Bai et al., 2011) despite "school ethos and environment" (e.g., policies or activities that promote healthy nutrition values and attitudes within school). This is because promotional activities (e.g., posters, announcements, events) were designed to increase awareness and create excitement about the program but were not required.

Insufficient teachers' time was a barrier to the implementation of the program. In some cases, the amount of time teachers spent on the daily distribution of FVs was large (Aarestrup et al., 2014, 2015; Reinaerts et al., 2007a). This included cutting up FVs, allocating time to eat at the "FV break", and restoring order after children consumed FVs. This, in turn, led to disruption in teaching time, especially in classes of young children (Clarke et al., 2009). In addition to the daily distribution of FV workload, program curricular activities (e.g., lesson plans) (Wind et al., 2008; Aarestrup et al., 2014, 2015; Jorgensen et al., 2014) and duration (e.g., 1-year) (Jorgensen et al., 2014) further limit the implementation of the program.

Food waste was another key barrier to the implementation of the program. The amount of waste was dependent on the popularity of FVs served. The less popular the FVs served, the more that was leftover. Therefore, fruit was purchased more frequently than vegetables (Jamelske and Bica, 2014; Bai et al., 2011; Hector et al., 2017) to avoid waste and maintain children's interest in the program (Jamelske and Bica, 2014; Coyle et al., 2009; Yeo and Edwards, 2006; Potter et al., 2011). Other contributing factors to food waste were poor food quality because of remoteness, handling, and delivery issues (Bouck et al., 2011; Gates et al., 2011, 2012; Skinner et al., 2012) or receiving too much FVs (Bouck et al., 2011; He et al., 2012). Children sometimes felt that they did not receive enough FVs (Aarestrup et al., 2014, 2015) yet others felt there was too much leftovers and discussed ways to reduce waste (e.g., sending extras home) (He et al., 2012). Additionally, food aesthetics (e.g., appearance) contributed to food waste. For instance, children were not allowed to eat the "cut up" FVs because teachers control the time of the FV break. This, in turn, caused enzymatic browning of the FVs (e.g., apple slices turning brown), and therefore children perceived the provided FVs as unappetizing to consume (Aarestrup et al., 2014). Identified strategies included coating FVs with lemon juice (Aarestrup et al., 2014), serving vegetables with dips (Bouck et al., 2011; Lin and Fly, 2016; Coyle et al., 2009), stop purchasing vegetables that were rejected by children (Coyle et al., 2009), sending extra FVs home with children/teachers (Bouck et al., 2011; Reinaerts et al., 2007a), serving leftover FVs another day (Bouck et al., 2011), donating FVs to food banks (Bouck et al., 2011), serving more than one FV snack a day (Potter et al., 2011), or cooking vegetables (Lin and Fly, 2016; Coyle et al., 2009).

### 3.5.4. Impact of the snack-based FV distribution interventions

All studies reported the beneficial effects of FV distribution interventions on children, and parents' FV consumption and/or related behaviors. These include improved child focus on schoolwork (Gates

et al., 2011; Hector et al., 2017), bringing fresh FVs from home (Hector et al., 2017), increased knowledge, awareness, preference for, and consumption of a variety of FVs (Gates et al., 2011; Clarke et al., 2009; White, 2006; Potter et al., 2011; Hector et al., 2017), and stimulating social interactions (Aarestrup et al., 2014, 2015; He et al., 2012). Also, some studies reported the beneficial impacts of these programs on children's physical and cognitive benefits, feeling full, and the care that school staff demonstrated (Gates et al., 2011, 2012, 2016; Lin and Fly, 2016; Potter et al., 2011). Furthermore, improved children's FV related-eating behaviors, such as asking parents to buy FVs (Gates et al., 2011, 2012, 2016; Coyle et al., 2009; He et al., 2012) or coordinators to incorporate FV snack items into school meals (Jamelske and Bica, 2014) were also cited. Moreover, some studies reported that these programs extended their benefits to parents via potentially improving FV consumption (Clarke et al., 2009), influencing dietary purchasing practices (i.e., buying a variety of FVs) (Jamelske and Bica, 2014; Coyle et al., 2009), and reinforcing healthy dietary messages at home (Clarke et al., 2009) and schools (White, 2006).

### 3.5.5. Implications for future snack-based FV distribution interventions

Nearly all studies used process evaluation findings to generate suggestions and to develop recommendations regarding aspects of the intervention that could be adapted or modified to increase the chances of success of future programming (Supplementary Table C).

## 4. Discussion

The findings of this review contribute to the growing body of evidence of how best to inform the implementation design of intervention programs to promote children's consumption of FVs. The results highlight the factors that are particularly important to the success of an intervention in this setting. These include participation of the whole school community, school staff training, involving parents within the school and home environment, and adapting the program to meet school needs and resources. Barriers to the implementation of school-based interventions include limited funding and insufficient teachers' time due to other school priorities (i.e., crowded curriculum). Additionally, some programs could be perceived as too demanding or may gain insufficient support due to poor awareness, coordination, and communication between key stakeholders (teachers, school staff, suppliers, etc.).

All studies highlighted the benefits of FV distribution interventions in providing children with free, universal access to a variety of high-quality, FVs. For example, free distribution interventions were associated with children's consumption of FVs because these programs provided all children, particularly economically disadvantaged children, with universal access to FVs (Bere et al., 2007). Research shows that food items most influenced by income are FVs (Ricciuto et al., 2006). Therefore, introduction of healthy foods in the context of a universal school food program has the potential to increase children's intake of FVs, independent of family income (Riediger et al., 2007). Universal access was also seen to lower the risk of stigmatization and increased reach, which has been previously demonstrated with similar programs (Hector et al., 2017; Russell et al., 2008). However, when a subsidized version of the same program was implemented, the program was not associated with children's consumption because FVs were provided at a cost to parents, which increased the accessibility but not the availability, indicating the role of availability and accessibility of FVs in promoting children's consumption (Bere et al., 2006a).

Increasing the availability and accessibility to a variety FVs are known positive environmental mediators to consider when evaluating the impacts of these programs. Changing children's FV consumption (Yeo and Edwards, 2006; Bere et al., 2006a), parent consumption (Clarke et al., 2009) and related behaviors (e.g., increasing children's preferences, awareness, and attitudes (Hector et al., 2017), social norms and role modelling (Aarestrup et al., 2014), increasing independent

academic work (Potter et al., 2011), and changing parent dietary practices (Coyle et al., 2009) are all beneficial effects that have been reported previously in similar school food programming interventions (Reinaerts et al., 2007b, 2008; Bere et al., 2007, 2006b; Wells and Nelson, 2005; Easwaramoorthy, 2012; Te Velde et al., 2008; Roccaldo et al., 2017; Story et al., 2000; Bere and Klepp, 2005; Addressi et al., 2005). Health-promoting activities in school settings have the potential not only to enhance the health and well-being of children (Baxter et al., 1997; Veugelers and Fitzgerald, 2005) but also to reach a large number of parents, siblings and extended families, regardless of their ethnicity, socioeconomic background, and/or nutritional status, thus reducing social inequalities (Knai et al., 2006).

Children's dietary practices are a function of varied environments (e.g., familial influences, school, community, and policy involvement) (Davison and Birch, 2001; Krolner et al., 2011). This is consistent with most frequently applied theoretical frameworks for behavior change: the socio-ecological model (Davison and Birch, 2001) and social cognitive theory (SCT) (Bandura, 2004). These two theories postulate that dietary behavior is a function of environmental factors (e.g., barriers, facilitators) and personal factors (e.g., preference) that affect each other in constant reciprocal relationships (Davison and Birch, 2001).

At the home-level, children's consumption was positively associated with their parents' consumption (Rasmussen et al., 2014) because parents' food preference and knowledge affect the availability and accessibility of FVs at home (Patrick and Nicklas, 2005). Although several studies attempted to engage parents (Bere et al., 2006a; Jorgensen et al., 2016; Te Velde et al., 2008), there was likely a proportion of children in disadvantaged areas whose parents would not provide FVs because of lack of awareness, high cost, limited access or resources (Gates et al., 2011, 2012; Jorgensen et al., 2016; Skinner et al., 2012; Hector et al., 2017), social-cultural beliefs (Muellmann et al., 2017; Hayes et al., 2019), socio-economic status (Wind et al., 2008; Jorgensen et al., 2016), and lack of time (Jorgensen et al., 2016). As parental influence is regarded as essential for children's dietary behavior, future interventions should explore potential avenues of incorporating parental components into the existing school structure and systems by identifying effective mechanisms to reach parents (e.g., family tasting events).

At the school level, the greater the school support, the better the implementation and outcomes achieved. Teachers were receptive to the intervention because there was a need; otherwise they would regard it as an additional workload (Jorgensen et al., 2014; Hector et al., 2017). Perceiving the relative advantage of the intervention likely allowed for better adoption, supported buy-in, and facilitated implementation (Durlak and DuPre, 2008; Rogers, 2003). However, lack of and/or insufficient teachers' time was identified as a key barrier to the delivery of the program in classrooms (Gates et al., 2011; Clarke et al., 2009; Reinaerts et al., 2007a; Aarestrup et al., 2015; Jorgensen et al., 2014). For instance, lack of curricular activity implementation in both the Netherlands and Spain is the result of the workload placed on teachers implementing the program (Wind et al., 2008). In addition, teachers' implementation was also challenged by intervention duration (e.g., 1-year) (Jorgensen et al., 2014). Deterioration in implementation over time was a noted challenge demonstrated previously in similar interventions (Wind et al., 2008; Aarestrup et al., 2014, 2015; Jorgensen et al., 2014) despite evidence that longer interventions (i.e., adequate time and duration) are more effective at promoting health and dietary behavior change than those with only one or a few sessions (Wang and Stewart, 2013; Ciliska et al., 2000; Hoelscher et al., 2002).

Health promoters often encounter the problem of motivating schools to participate in such programs because of time constraints. Therefore, school-based interventions that require minimal classroom or teacher time, such as FV distribution, are considered viable (Yeo and Edwards, 2006; Reinaerts et al., 2007). For example, Reinaerts and colleagues found that teachers perceived distribution of FVs as less social pressure and that did not require effort to implement (Reinaerts et al., 2007a). This is consistent with Diffusion of Innovation Theory (DOI), where

initiatives that are perceived as simple (easy to use and understand) and can be conducted on a limited-basis are often more readily adopted (Rogers, 2003).

On the other hand, Aarestrup and colleagues reported that teachers are already overwhelmed with a demanding academic curriculum and the added responsibility of delivering a school food program could prove to be challenging. The authors found that teachers' incapability to deliver the program as intended during the school day contributed to low FVs aesthetics/appearance (e.g., brown apples) and ultimately food waste as children considered FVs as unappetizing to eat (Aarestrup et al., 2014). This indicates the difficulty in designing interventions that are applicable to all schools since each school is context-specific. However, several studies suggested a number of recommendations. First, using trained research staff to implement programs has been proposed as an alternative; however, it has been considered an unrealistic option because of limited resources (Gates et al., 2011; Reinaerts et al., 2007a). A second option, integrating the program into the school curriculum (Aarestrup et al., 2014), will not only ensure children can learn about and consume FVs, but also alleviates teacher burden, as it would become part of their duties and not compete with other curriculum opportunities. Third, providing detailed guidelines on program implementation (Aarestrup et al., 2014; Jorgensen et al., 2014) will improve the efficiency and effectiveness of the program and also motivate program staff to implement the intervention with high fidelity.

The importance of training for teachers' level of implementation is unclear (Sy and Glanz, 2008). Research has shown inconsistent results, with some studies (Jorgensen et al., 2014; Datnow and Castellano, 2000) indicating that teachers value autonomy in the implementation of the program, while other studies demonstrate the importance of training to fidelity of implementation, particularly when curricular innovation is involved (Roccaldo et al., 2017; Story et al., 2000). Therefore, future studies could benefit from involving teachers in the decision of intervention participation as a feeling of ownership among intervention providers is vital for implementation (Durlak and DuPre, 2008). In addition to teachers' training, the importance of prior experience and/or background knowledge in food service operation was also highlighted. Studies have recognized the skills and knowledge needed in the handling, management, and coordination of a food service operation (e.g., purchasing, financial management and human resources) when implementing these types of programs (Jamelske and Bica, 2014; Tsui et al., 2013). This is because these logistic supports would provide school staff with the necessary tools and knowledge to ensure that expectations are managed effectively (Durlak and DuPre, 2008; Carroll et al., 2007).

Furthermore, allowing school staff (e.g., teachers) discretion to tailor the intervention to deal with circumstances as they best fit in with school context (e.g., timetables (Muellmann et al., 2017; Hayes et al., 2019; Jorgensen et al., 2014), children with special needs (Muellmann et al., 2017; Hayes et al., 2019)) will maximize the fidelity of the intervention and support its continuation (Datnow and Castellano, 2000). This is because innovations are seldom implemented exactly as the developers of the interventions intended them to be (Datnow and Castellano, 2000). This is consistent with Implementation Theory (Corbett and Lennan, 2003), which postulates that an on-going customization to the program may contribute to the success of the implementation and that some adaptation regularly occurs and should be evaluated and modified to meet the changing environment/context (Durlak and DuPre, 2008; Corbett and Lennan, 2003; Chambers et al., 2013).

Increasing the awareness about the program was positively correlated with children's interests to participate in the program (Jamelske and Bica, 2014; Potter et al., 2011). Studies have shown that labeling and signage on school premises affect not only children's food choices at schools, but also food purchase requests at home (e.g., asking parents to buy FVs) (Hastings, 2004). However, these promotional activities were typically inadequate because of staff time and/or resources needed to

mount sufficiently intensive efforts to influence children's consumption of FVs (Bai et al., 2011). Therefore, effective promotional campaigns that have been utilized by grocery stores (i.e., advertisements, displays) (Bennett, 1998) are needed to affirm positive messages and to create an environment in which FV consumption is a norm in both school and home environments.

At the community level, children reported being motivated to eat healthier; however, the nutrition environment in remote, isolated, northern communities was not conducive to behavior change (Gates et al., 2011, 2012, 2016; Skinner et al., 2012). For example, the distribution of FVs within the school environment may have provided children with an opportunity to consume FVs, but this does not change the fact that availability and accessibility of food at the community-level makes it extremely challenging, if not impossible to make healthy dietary choices (Gates et al., 2012). This emphasizes the need for community-based interventions (e.g., community gardens, group purchasing) to improve access to affordable, healthy food choices in remote locations.

The prospect of food providers to make connections with the school community acted as a facilitator to delivering FVs to schools (Aarestrup et al., 2014, 2015). Previous farm-to-school programs have found that the primary motivation for farmers to participate in these programs included enhancing economic incentives (e.g., diversifying their marketing strategies) (Izumi et al., 2010b; Joshi et al., 2008), increased market demand (Webb et al., 2013), fostering healthy eating habits among children, supporting the local economy (Izumi et al., 2010a, 2010b; Joshi et al., 2008), and solidifying good public relations (Gregoire and Strohbehn, 2002; Izumi et al., 2006; Marshall et al., 2012). Furthermore, schools benefit from associated savings of purchasing FVs (Webb et al., 2013) and the ultimate beneficiary is the child, whose increased consumption will contribute to better long-term health. However, lack of timely FV delivery was identified as a barrier to the delivery of FVs to schools because of concerns related to limited capacity for supplying, predictability of FV crops, communication and ordering (Aarestrup et al., 2014, 2015), and remoteness (Bouck et al., 2011). Therefore, one promising marketing mechanism is dealing with "major or large scale" value chain (VC) suppliers than traditional supply chains (Webb et al., 2013; Marshall et al., 2012), which include partnerships that contribute to the value of all participants involved, procuring the volume and type of food required for large schools (Conner et al., 2011), and achieving economies of scale in food safety documentation and food costs (Powell and Wittman, 2017; McNicholl et al., 2018). This, however, would require policy changes resulting in significant resources in terms of funding, infrastructure, and staff.

Sustained support for school food programs at the policy-level is a key to successful and sustainable school food programming. Free FV distribution interventions have proven to be effective at increasing children's consumption of FVs (Bouck et al., 2011; Gates et al., 2011, 2012; Reinaerts et al., 2007a; Wells and Nelson, 2005; Skinner et al., 2012) but most studies have identified continuous funding as a necessity to maintain them at the level required to be effective (Hayes et al., 2019; Reinaerts et al., 2007a; Bai et al., 2011; Potter et al., 2011). Specifically, studies have found limited funding to address food costs, inadequate facilities (Gates et al., 2011, 2012, 2016), labouring (Gates et al., 2011, 2012, 2016; Potter et al., 2011), costs associated with serving FVs (Potter et al., 2011), and type of FVs served (Skinner et al., 2012; Gates et al., 2012). For instance, apples, bananas and oranges were most frequently served because they are affordable. Also, "whole" instead of "chopped" fruit was served to reduce waste, increase shelf-life, and reduce costs associated with chopping FVs. Thus, if steps are taken to improve the variety and presentation of FVs, their labor and food costs would be beyond what the program is currently providing, and additional financial resources would be required to make school facilities adequate to store, prepare and serve FVs in a safe and appealing manner.

For example, the "School Fruit Scheme" was passed as a law/policy and was implemented in all Norwegian schools because the political

party supporting the program was in power. However, when the political power shifted in parliament, funding for the program was ended and the law was abolished (Muellmann et al., 2017). This is because government funding often falls short on funding initiatives related to school food programming due to competing priorities (Martorell, 2017). Therefore, adequate policies to introduce mandated standards to make the “healthier choice” easier for children should be the focus of future initiatives, as a positive association exists between policies aimed at improving the food environment in schools and outcomes such as decreased consumption of unhealthful snacks (Asada et al., 2016). This is consistent with Evans and colleagues who found that increasing the availability and accessibility of FVs through stricter nutritional guidelines/policies within the school environment can be effective at changing children’s food choices (Evans et al., 2012). This illustrates the necessity of provision of continuous funds for programs to be effective and sustainable.

This systematic review has several key strengths. First, we utilized a rigorous and comprehensive search strategy of a wide range of bibliographic databases. Second, the use of a broadly defined process evaluation served the exploratory goal of this review, in which we aimed at inclusion rather than exclusion. Third, this is the first systematic review to examine the implementation practices and processes of snack-based FV distribution interventions. This review also has limitations. First, there is a possibility that some studies were missed because the term “process evaluation” was not a MeSH term; however, this is unlikely to happen as both keywords and subject-heading databases were searched. Second, gray literature was not included because the primary focus was on studies with rigorous study designs; a thorough search of gray literature might have provided additional evidence.

## 5. Conclusions

This review sought to obtain an in-depth understanding of the benefits and impacts of snack-based FV distribution interventions, successes of and challenges to the implementation, and possible solutions for the implementation practices and processes of future programming. While studies have identified many challenges that must be considered to maintain the reach, fidelity, and feasibility of the program, they also identified many opportunities to maximize the program’s potential of creating an enabling environment within which positive impacts on children’s food literacy and dietary habits can be promoted.

Evidence from process evaluations can help us understand whether changes in FV consumption are due to the interventions, or the ways in which the interventions are implemented. Future research should not only examine intervention effectiveness, but should consider factors such as sustainability, cost-effectiveness, and the implementation practices and processes of this program. From a research perspective, accounting for the socio-ecological contexts, providing a description of those in charge of delivering and receiving the intervention, in addition to the use of a theoretical framework and employment of rigorous qualitative methods, will generate a comprehensive understanding of the different aspects of the implementation process. In other words, process evaluation should be a piece of research in its own right. From a practical perspective, incorporating the program into the school curriculum and policy, utilizing a “whole-of-school” approach, in addition to recognizing the skills and knowledge needed, will optimize the fidelity of the program. This review offers researchers, child educators, and policymakers valuable recommendations on how to implement snack-based FV distribution interventions in schools for improving children’s overall health and well-being.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2020.101281>.

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