Review

Influencing Factors for the Implementation of School-based Interventions Promoting Obesity Prevention Behaviors in Children with Low Socioeconomic Status: A Systematic Review

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Abstract: Background: Health inequity (HI) remains a major challenge in public health. Improving the health of children with low socioeconomic status (SES) can help to reduce overall HI in children. Childhood obesity is a global problem, entailing several adverse health effects. It is crucial to assess the influencing factors for adoption, implementation and sustainment of interventions. This review aims to identify articles reporting about influencing factors for the implementation of school-based interventions promoting obesity prevention behaviors in children with low SES. It aims to critically appraise the articles' quality, assess influencing factors, categorize and evaluate them, and to discuss possible implications. Methods: A systematic search was conducted in 7 databases with the following main inclusion criteria: 1) school-based interventions and 2) target group aged 5–14 years. The Consolidated Framework for Implementation Research, its five domains (intervention characteristics, inner setting, outer setting, characteristics of individuals, process) along with 39 constructs within these domains were used to deductively analyze the data. We grouped the articles with regard to the characteristics of the interventions in *simple* and *complex* interventions. For each domain, and for the groups of *simple* and *complex* interventions, the most commonly reported influencing factors are identified. Results: 6452 articles were screened, and 16 met all eligibility criteria. Included articles applied mixed methods (n=10), qualitative (n=5) and quantitative design (n=1). Of these, five were considered to report *simple* interventions and eleven were considered to report *complex* interventions. In total, 295 influencing factors were assessed. Aspects of the *inner setting* were reported in every study, aspects of the *outer setting* were the least reported domain, and in the group of simple interventions not reported at all. In the *inner setting*, most reported influencing factors were *time* (n=7), *scheduling* (n=6) and *communication* (n=6). Conclusion: This review found a wide range of influencing factors for implementation. Most important influencing factors need to be assessed for every setting. Including all stakeholders involved in the implementation process enhances the prioritization of the most important influencing factors for the specific setting. More empirical research and practical guidance are needed to promote obesity prevention behaviors among children with low SES.

Keywords: health equity; implementation; obesity; systematic review; CFIR; qualitative review; school-based interventions; children; facilitators

1. Background

"Implementation Science could, quite literally, put health equity back on the fast track." Beryne Odeny (1)

Health inequalities exist within and between populations (2). Life expectancy differs between countries as well as within them, such as, for example, between men and women (2). The social determinants of health (SDH) are a powerful driver for health inequalities

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(3-5). Under certain conditions, we no longer speak of health inequalities but of health inequity (HI) (6, 7): If health inequalities arise due to the unequal distribution of the SDH, such as income, wealth, and access to health care (5, 8), and if health inequalities are therefore avoidable and unfair (9). HI is social injustice in health (7).

On an individual level, SDH can be represented by socioeconomic status (SES) (10). SES is a multidimensional concept and incorporates several socioeconomic factors. It can be described by past or current income, family wealth, educational level, occupation and social standing within the community (11). HI follows a social gradient, as groups with a low SES have poorer health (e.g., higher mortality and morbidity) than groups with high SES (5, 12).

It is especially important to protect health of children, as they have less control over their health and the circumstances influencing their health than to adults (13). Negative health influences in childhood can lead to health consequences throughout life (14, 15). Being overweight in childhood, for example, is associated with also being overweight as an adult (16), and diverse adverse health effects such as, cardiovascular diseases or mental disorders, can result from overweight and obesity in childhood (17, 18). The prevalence of obesity in children and youths is increasing globally (19, 20) and therefore, it is important to develop and implement interventions addressing childhood obesity.

Obesity in childhood lead to adverse health effects in adulthood, and in industrialized countries, childhood obesity exhibits HI: low SES is associated with higher rates of obesity among children (21).

Furthermore, due to societal processes, low SES and poor health implicate and maintain each other (7, 10, 22, 23). In their model of child health inequalities, Pearce et al. (13) show that low SES and low child health status are in a mutually reinforcing cycle, conditioning and maintaining each other. To break the cycle health-promoting interventions that improve the health status and therefore help to reduce HI in children may be a suitable entry point (13).

Interventions to prevent obesity among children generally take place in schools (24), and moderate evidence has been found for school-based combined diet and physical activity (PA) interventions (25-27). School-based interventions are a proposed approach for preventing obesity, because in the school setting almost all children in society can be reached (28). Furthermore, it is important to implement those interventions in real-world settings, as the implementation of an intervention influences its effectiveness (29, 30). Improving the reach and the adoption, delivery, and sustainment of effective interventions is the aim of implementation science (31). Because several factors influencing the speed and extent of the adoption, uptake, and use of an intervention (32), a suggested first step in the implementation process is the identification of those influencing factors in order to address them (33).

The influencing factors for the implementation of interventions have been assessed in the school setting, both for PA promoting interventions (30) and for interventions to promote PA and reducing sedentary behavior (34). Barriers and facilitators were assessed for the sustainment of health behavior interventions in schools and childcare settings (35), for PA during school lessons (36), and for the provision of fruit and vegetable in kindergartens and schools (37).

Those reviews present important results, but none of those reviews distinguished between different SES, although this factor is an important differentiator every study should take into account to approach health equity (38). Furthermore, none of the existing reviews assessed the implementation of interventions addressing the combination of the two leading behaviors in obesity development, namely, PA and nutrition (39), in the school setting. From these considerations, it is essential that factors influencing the implementation of school-based interventions be systematically assessed to promote obesity prevention behaviors for children with low SES. These findings can help improving the understanding of specific needs, to guide practice, to improve implementation, and therefore, to enhance the sustainment of effective interventions. This can further contribute to reducing HI in children. This reviews aimed to identify articles reporting about

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influencing factors for the implementation of school-based interventions promoting obesity prevention behaviors for children with low SES. Furthermore, to assess the methodological quality of the identified articles, to categorize and evaluate reported influencing factors, to analyze differences of reported influencing factors regarding *simple* and *complex* interventions, and to discuss possible implications.

2. Methods

To identify, critically appraise, and summarize evidence from the articles conducted, we conducted a systematic review in accordance with established guidelines for such systematic reviews (40), the PRISMA Checklist can be found in the Additional file 1. This review was previously registered at PROSPERO (ID: CRD42021281209).

Information sources and searches

The databases Scopus, PubMed, ERIC, SportDiscus, PsychArticles, Education Source and SocINDEX were searched for relevant articles. The terms shown in Table 1 were used to construct the search term, following database specifications (see Additional file 2). There were no limitations with respect to the publication date of the articles, as no systematic review with the same aim had previously been conducted. The database search was completed on July 2, 2021.

Table 1. Search term.

		AND →						
Population		kid	Child	student	pupil			
Setting		school	education					
Intervention		intervention	program					
Topic of intervention	OR ↓	"health promotion"	obesity	"over weight"	overweight	adiposity	"physical activity"	"physical inactivity"
		"physical active"	sport	sitting	sedentary	"media use"	"screen time"	nutrition
		food	Diet					
Implementation phases		adoption	dissemination	adaptation	implementation	sustainability	maintenance	"process evaluation"
Socioeconomic status		socioeconomic	socio-economic	income				

Eligibility criteria

We adopted the following eligibility criteria:

- Regarding the design, the article had to be an implementation evaluation or process evaluation study, or a hybrid process-effectiveness study as described by Curran et al. (41).
- The article had to investigate an intervention promoting obesity prevention behaviors (e.g., promotion of PA, promotion of health nutrition).
- The intervention reported, had to address children aged 5–14 years exclusively. The youngest age for beginning primary school is five years (42) and 14 years is the last year of childhood, before entering the youth category (43).
- The intervention reported, had to be conducted in a school setting
- The intervention reported, had to be conducted in an area with population of low SES or address children with low SES in particular.
- The article had to report influencing factors for the implementation of the intervention in their results section regarding children with low SES.

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Operationalization of SES

Parental income, parental education and parental occupation are often used to measure children's SES (44). These measures are correlated but not interchangeable (44). Aggregated measures are also used to establish SES for school population or for regions or districts. Aggregated measures are drawn from administrative data and therefore depend on the institutional understanding of SES (44) and the availability of data. In this review, the mention of low SES was considered sufficient, and the specific criteria used to measure SES were not questioned, although this information was extracted from the articles and is shown in the results.

Screening process

After deduplication, two reviewer (FB and JE) independently screened the articles on title and abstract level and in a second step on full text level using the software Rayyan to determine inclusion (45). Conflicts were discussed and resolved between the reviewers. Additionally, all articles included in the review by Cassar et al. (34) were screened at full text level (n=26), as that review had a very similar aim, with the exception of the focus on SES.

Data extraction and synthesis

Article titel, year of publication, country, main outcome of the article, means of data collection, criteria for low SES, and description of the intervention were extracted into an Word file (see Additional file 3) by MS and FB from each article. After the screening process, two reviewers (FB and JE) extracted barriers and facilitators for implementation from the results section of the articles into an Excel file. FB and JE extracted data from two articles independently and then matched their results through discussion. The remaining articles were split between FB and JE for data extraction. Any uncertainties about what details to extracted, were additionally extracted by the second reviewer, matched and resolved through discussion.

The extracted data was coded using MAXQDA (46). The data coding was guided by the *Consolidated Framework of Implementation Research* (CFIR) (47). This comprises the five domains *intervention characteristics, inner setting, outer setting, characteristics of individuals* and *process*, along with 39 constructs within these domains (47). These 39 constructs from CFIR were used as categories for deductively coding the data. Each sense unit was coded into only one category.

FB and JE coded 25% of the data independently, then the codes were reconciled, and the rest of the data was coded by FB. In the next step, all coded segments for each category were reviewed by FB, and if necessary, the coding was adjusted, and additional specifications were developed for the categories for this review to have a clear differentiation between categories (see Additional file 4). To test the specified category descriptions, two reviewers (JE and a student assistant) coded 50% in total of the data again. The double-coded data were compared, and differences were discussed and resolved. All categories that caused more than one disagreement on the segment level were reviewed again for all data by FB. In the last step, all categories were reviewed, and reasonable inductive sub-categories were developed. These sub-categories then were coded again by a student assistant, and any disagreements were discussed and resolved.

For each of the five domains, the average number of articles that reported the (sub-)categories was calculated. (Sub-)Categories reported more than on average are presented in the results section.

We grouped and then compared the articles with regard to the characteristics of the interventions, following the definition for complex interventions by Craig et al. (48). If the intervention met two out of the three following aspects, it was considered to be *complex*, and otherwise it was considered the be *simple*: the intervention 1) addressed more than one obesity prevention behavior, 2) consisted of more than one component (e.g., classroom activities and teacher training), and 3) included parental involvement. We

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analyzed the most frequently reported influencing factors within those groups of *simple* and *complex* interventions.

Methodological Quality assessment

We assessed the methodological quality of the articles using the Mixed Methods Appraisal Tool (MMAT) Version 2018 (49, 50). The MMAT allows the rating of quantitative and qualitative articles in the two separate corresponding categories, and mixed methods articles are rated in both, as well as an additional third mixed methods category.

Two reviewers (FB and JE) individually assessed the methodological quality of three articles, and the results were discussed with a third reviewer (CM). All of the remaining articles were split between two reviewers (FB and JE), and the methodological quality was individually assessed. If any uncertainties arose regarding the methodological quality of any particular, it was assessed and evaluated by the reviewers individually, resulted were discussed and the uncertainties resolved. No overall score was calculated, as recommended by the authors of MMAT (49).

3. Results

Study selection

From 6446 articles screened, 15 articles were identified as meeting all eligibility criteria. Screening the articles included by Cassar et al. (34), one additional article met all eligibility criteria, resulting in 16 articles for inclusion in this review (51-66) (see Figure 1).

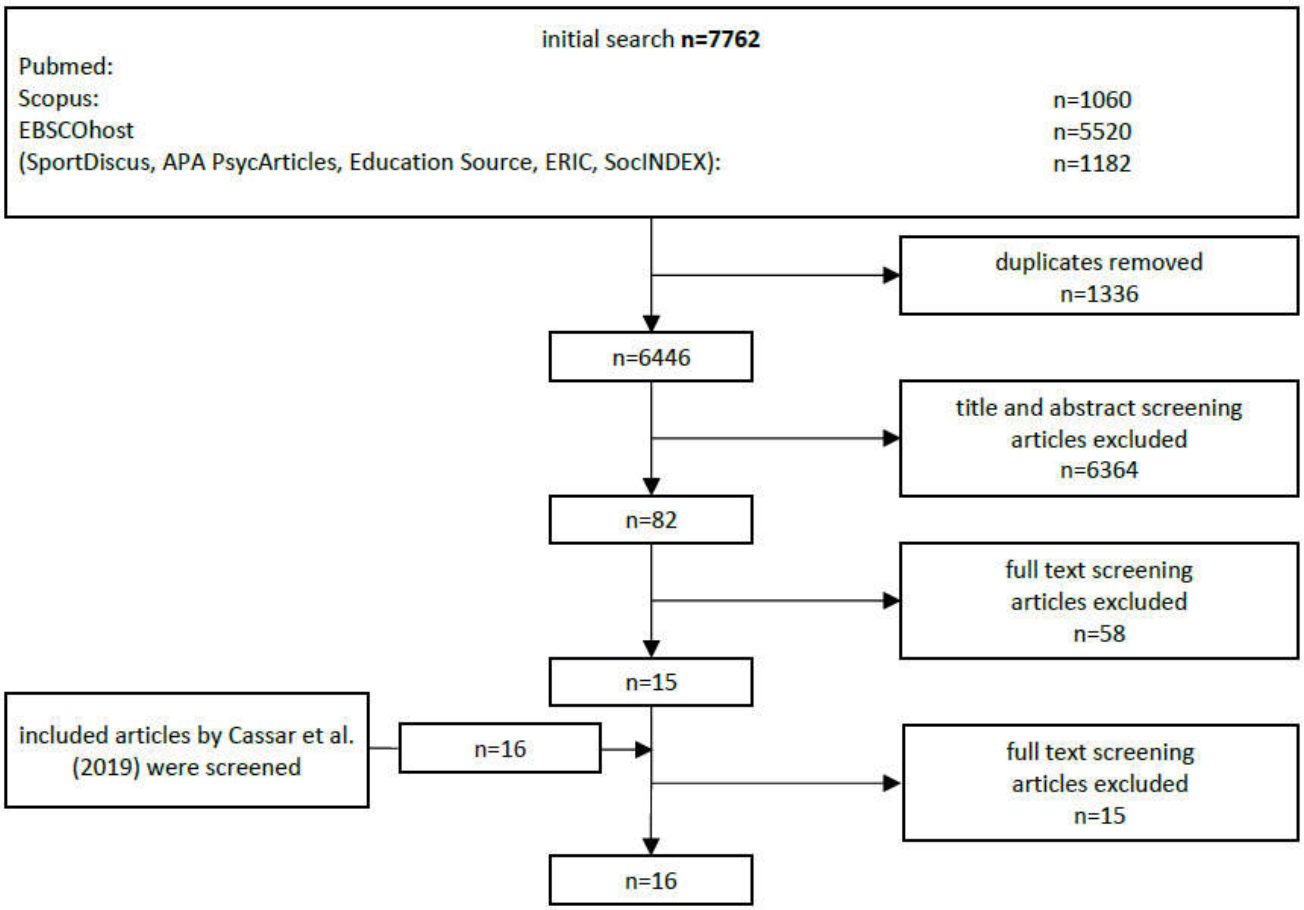

Figure 1. Flow chart of screening.

Study characteristics

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Additional file 3 presents detailed information on the included articles, such as their aim and information on the intervention reported. The aims of ten articles was to assess the implementation of the intervention and additional influencing factors for implementation (51, 53, 54, 56, 57, 59-61, 64, 66). Five articles only assessed influencing factors for implementation (52, 58, 62, 63, 65), and one assessed the influencing factors for implementation, as well as the effectiveness of the intervention (55). The articles applied mixed methods (n=10), qualitative (n=5) and quantitative design (n=1). The interventions reported by the articles promoted PA (54, 55, 59, 64, 66), healthy nutrition (56, 60, 61), PA and healthy nutrition (51, 52, 58, 62, 63, 65), and PA, healthy nutrition and reducing screen time (57) and PA, healthy nutrition, healthy sleep, and reduce screen time (53). In total, 14 independent interventions were reported, and three articles reported on the same intervention (58, 62, 63). Five articles were considered reporting on *simple* interventions (55, 59, 61, 64, 66), eleven articles were considered reporting on *complex* interventions (51, 52, 54, 56-58, 60, 62, 63, 65) (see Additional file 3).

Quality assessment results

Additional file 5 presents the ratings of the methodological quality assessment. Four (52, 58, 62, 63) of the five qualitative articles received a "yes" for all criteria, one articles received a "no" for the criterion "Is the interpretation of results sufficiently substantiated by data?" (65). The only quantitative article recevied a "can't tell" for the criterion "Is the sampling strategy relevant to address the research question?" (61). Of the ten mixed methods articles, five (51, 55, 57, 59, 64) received a "yes" for all qualitative criteria, whereas only one of them received all quantitative criteria rated with "yes" (64). Five (51, 53, 54, 56, 57) of the 10 mixed methods articles received a rating of "yes" for all mixed methods criteria, one article (59) received a "no" for the criterion "Is there an adequate rationale for using a mixed methods design to address the research question?". None of the mixed methods articles received only "yes" ratings for all criteria. In the mixed methods articles, the qualitative items rated lower than the qualitative articles.

Influencing factors for implementation

In the following, selected results are presented to answer the research question what the influencing factors for the implementation of school-based interventions promoting obesity prevention behaviors for children with low SES are.

Table 2 presents all included articles and their reporting of influencing factors in the five domains of CFIR, as well as the assignment to the groups of *simple* or *complex* interventions. The *inner setting* was reported in all articles (n=16), and the least reported domain was the *outer setting* (n=7). The *outer setting* was only reported in the group of *complex* interventions. Every article reported influencing factors in at least three different domains. In the 16 articles, 295 influencing factors were found across 93 (sub-)categories. Additional file 6 presents all influencing factors, categorized in barriers and facilitators, extracted from the articles for each domain and (sub-)category. Of the 39 original CFIR categories, four categories were not reported at all. Additional file 7 presents the most commonly reported (sub-)categories in the group of *simple* and *complex* interventions for each domain.

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Table 2. Reported CFIR domains in included articles.

CFIR domain (number of (sub-)categories in domain) / article	Bartelink (51)*	Bauer (52)*	Blaine (53)*	de Meij (54)*	Gadais (55)°	Lepe (56)*	Lubans (57)*	Malek(58)*	Marchant(59)°	Martens (60)*	Muckelbauer (61)°	Norman (a) (62)*	Norman (b) (63)*	Steward (64)°	Verjans-Janssen (65)*	Wright(66)°	
Intervention characteristics (12)	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Inner setting (32)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
Outer setting (11)	x	x	x	x								x	x		x		7
Characteristics of the individual (17)		x	x	x	x	x	x	x	x	x	x	x	x	x	x		14
Process (21)	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	15
	4	4	5	5	4	4	4	4	4	4	3	5	5	4	5	3	

°group of *simple* interventions
*group of *complex* interventions

The results for each domain are presented below. Figure 2–8 show selected (sub-)categories for each domain, as well as the reported barriers and facilitators in those (sub-)categories. Furthermore, the most reported barrier(s) or facilitator(s) for each group of interventions is marked. Additional file 8 presents all (sub-)categories for each domain, and all the number of articles reporting the relevant barriers and facilitators.

Intervention characteristics

Intervention characteristics were reported by 14 articles, with 3.3 articles on average for each (sub)category. Figure 2 displays the four (sub-)categories that were reported more than averagely. Most articles reported *evidence strengths* (n=7) and *preparation* (n=7) influencing the implementation. Within the group of *simple* interventions, *adaptability* (n=3) was the most reported influencing factor, and within the group of *complex* interventions, *evidence strengths* (n=7) was the most reported influencing factor.

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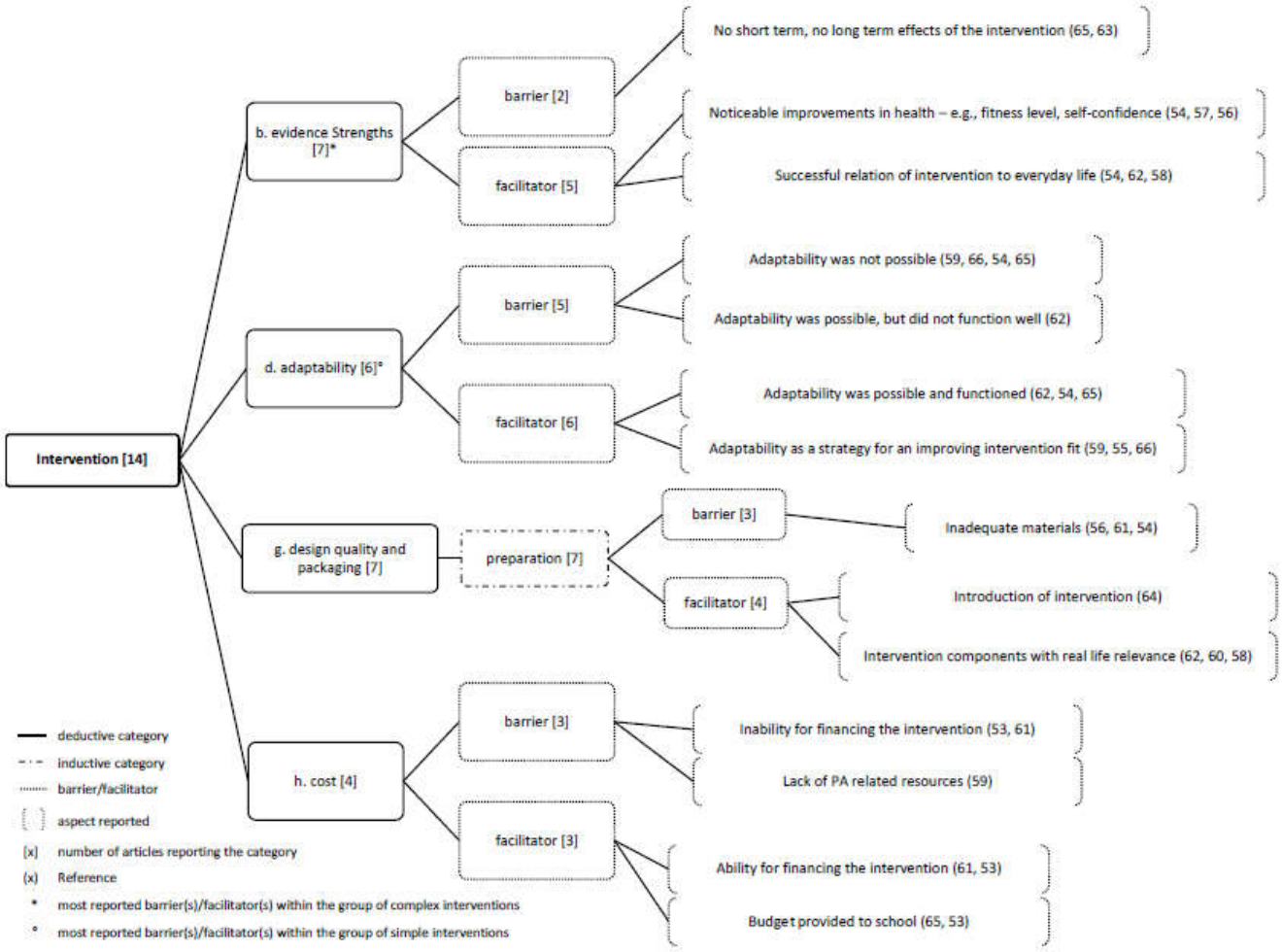

Figure 2. Intervention characteristics and most reported (sub-)categories.

Evidence strengths (n=7) was reported as a barrier, because no short- or long-term effects of the intervention (n=2) were seen. As facilitating for the implementation of the interventions, noticeable improvements in health (e.g., in the fitness level or self-confidence of children) (n=3) and successful connection of intervention to everyday life (n=3) were reported.

The preparation (n=7) of the intervention in the sub-category of design quality & packaging was reported as facilitator as introduction of the intervention (n=1) and intervention components with real life relevance (n=4) e.g., hands-on sessions, real life relevance of intervention components. In n=3 articles, barriers as inadequate intervention materials (e.g., wordiness of lessons) were reported.

Inner setting

All 16 articles reported (sub-)categories of the *inner setting*, with 2.8 articles on average for each (sub-)category. Figure 3 and Figure 4 display the 14 (sub-)categories that were reported more than the average. Most articles reported that *time* (n=7), *scheduling* (n=6) and *communication* (n=6) influenced the implementation. Within the group of *simple* interventions, *communication* and *scheduling* (n=2) were the most reported influencing factors, and within the group of *complex* interventions, *time* (n=6) was the most commonly reported influencing factor.

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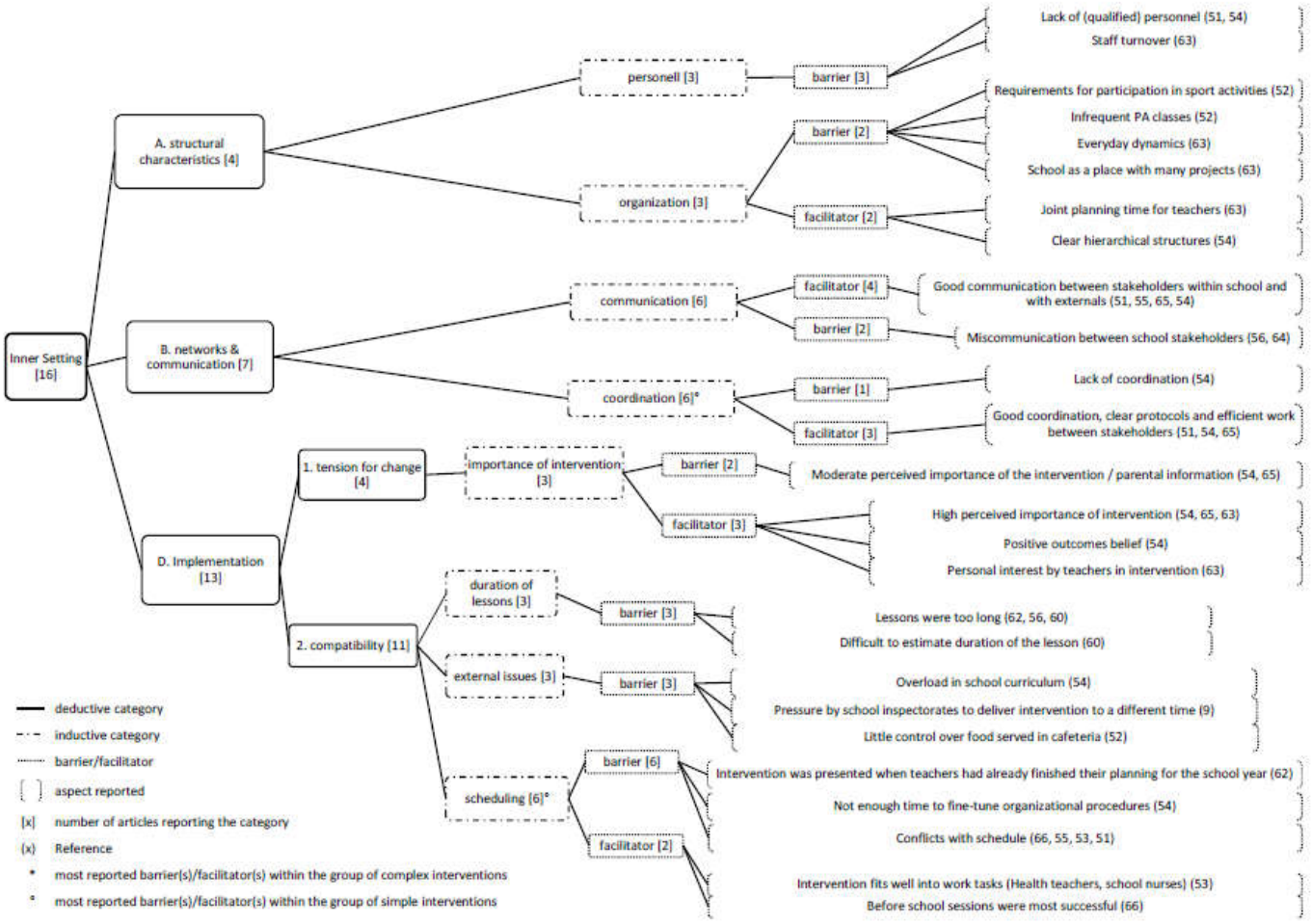

Figure 3. Inner setting (part 1) and most reported (sub-)categories.

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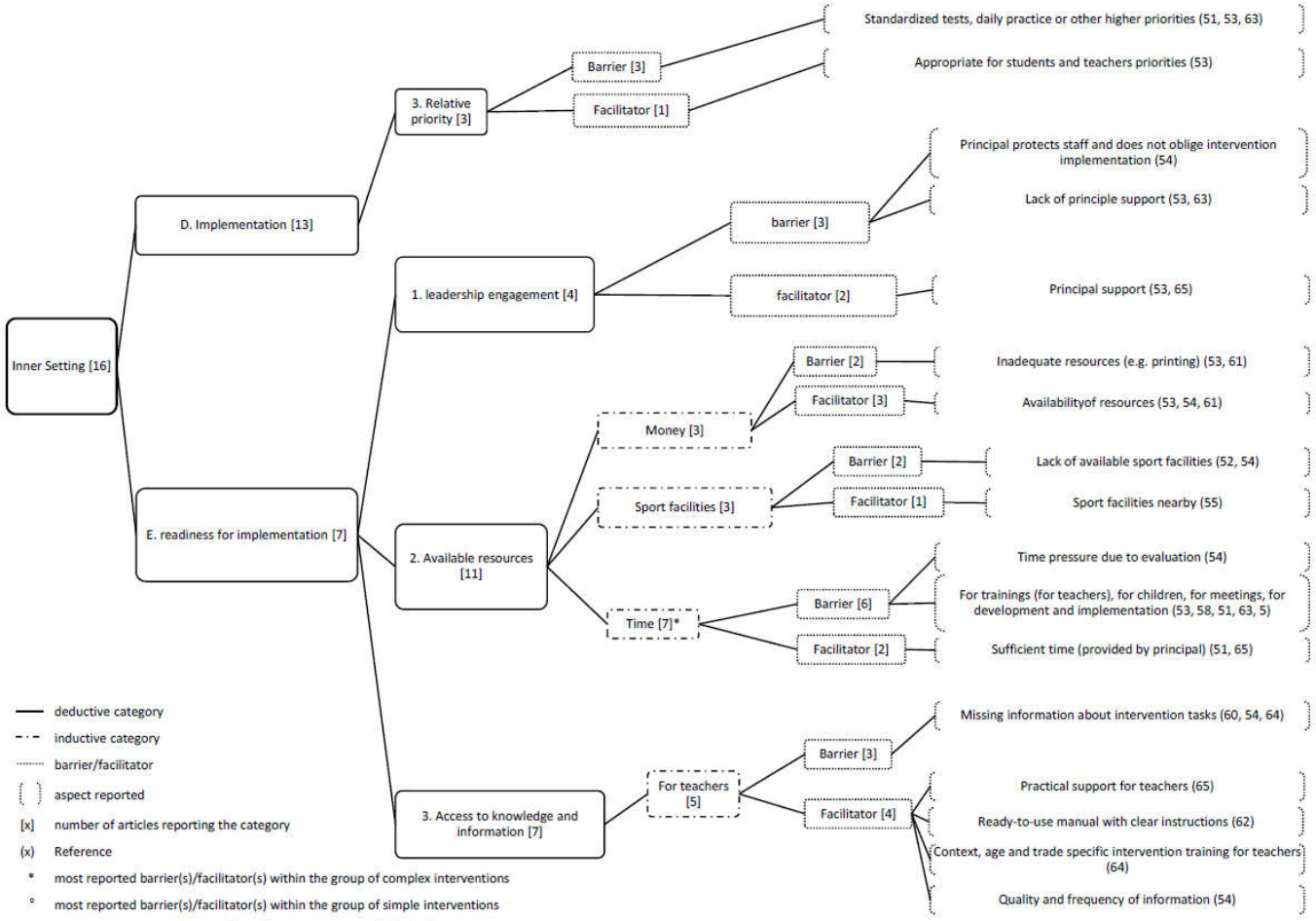

Figure 4. Inner setting (part 2) and most reported (sub-)categories.

The most often reported aspect related to time (n=7), with sufficient time (n=2) facilitating and insufficient time hindering (n=5) for meetings, for training, for the children, for implementation as well as insufficient time due to the evaluation timeline (n=1) was also reported as hindering implementation.

Scheduling (n=6) was reported as a barrier (n=6), due to conflicts with scheduling (n=4), insufficient fine-tuned organizational procedures (n=1) and the school year was already planned, when the intervention was introduced (n=1). As a facilitator, scheduling was reported (n=2) in terms of a good fit of intervention in the work tasks (n=1) and scheduling the intervention activity before school was successful (n=1).

In the sub-category of *communication* (n=6), *good communication between stakeholders within school* and *with externals* was reported as a facilitator (n=5) and *miscommunication between school stakeholders* (n=2) was considered a barrier for implementation.

Outer setting

The *outer setting* were reported by seven articles, with 2.8 articles on average for each (sub-)category. Figure 5 displays the four (sub-)categories that were reported more than the average. *Abilities* (n=4), as a sub-category of *needs and resources of those served by the organization* and *existing policy* (n=4), as sub-category of *external policy and incentives* were the most reported. None of the articles within the group of *simple* interventions reported any influencing factors in the *outer setting*, and within the group of *complex* interventions, *abilities* and *existing policies* (n=4) were the most reported influencing factors.

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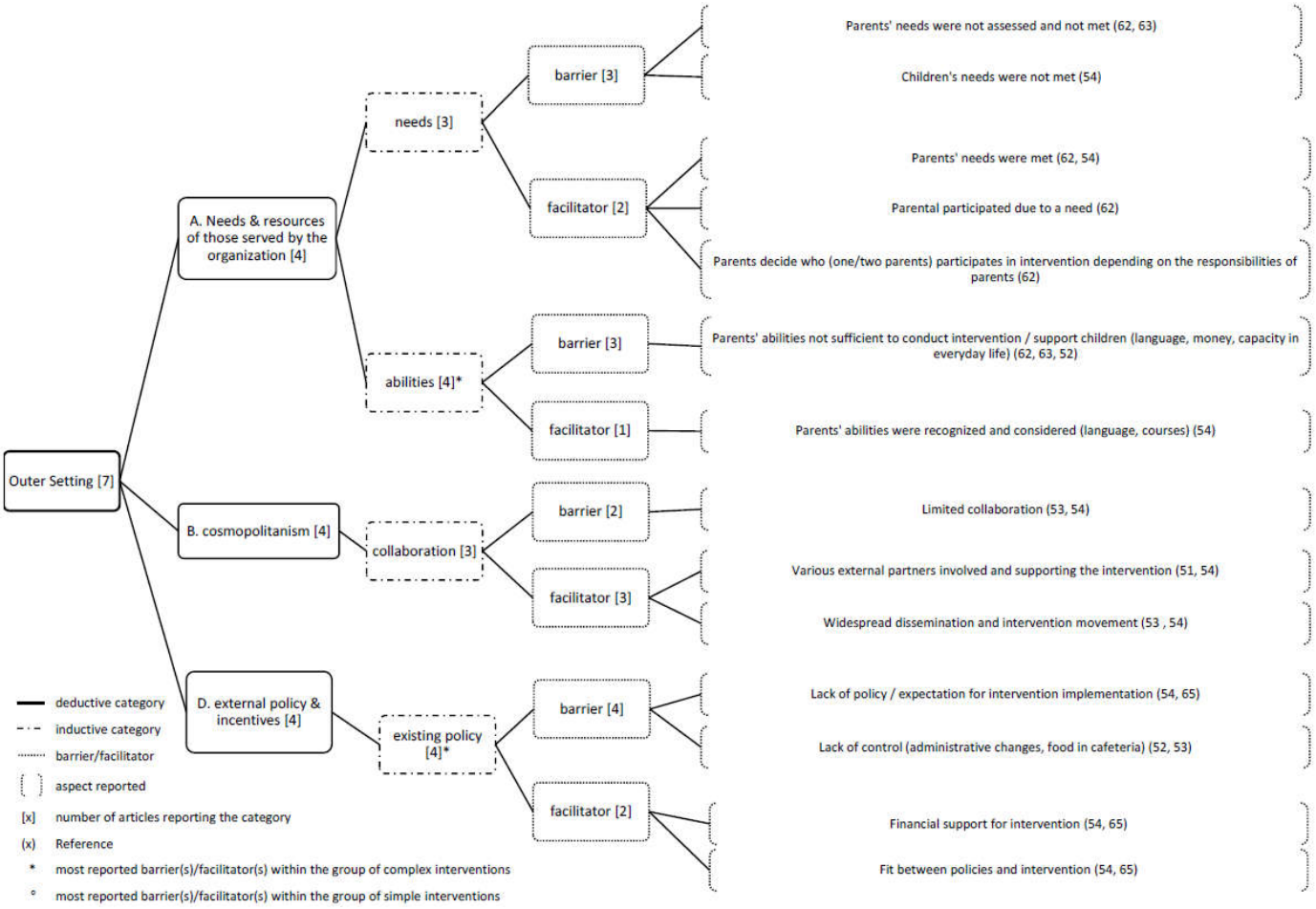

Figure 5. Outer setting and most reported (sub-)categories.

Abilities (n=4) was reported as a barrier, because of lack of sufficient abilities among parents to conduct intervention / support children (n=3), whereas recognized and considered parents' abilities (n=1) facilitated implementation.

Existing policy (n=4), where lack of policy/expectation for intervention implementation (n=2) and lack of control (e.g., over administrative changes, food in cafeteria) (n=2) were reported as barriers. Financial support for the intervention (n=2) and fit between policies and intervention topics (n=2) were reported as facilitators for implementation.

Characteristics of individuals

Characteristics of individuals were reported by 14 articles, with 3.4 articles on average for each (sub-)category. Figure 6 presents the five (sub-)categories reported more than average. The most reported were *intervention strategy* (n=6) as sub-category of *individual stage of change* and *interest in intervention* (n=6) as sub-category of *other personal attributes.* Within the group of *simple* interventions, *effect of stage* (n=2) was the most reported influencing factor, and within the group of *complex* interventions, *character* and *interest in intervention* (n=5) were reported as sub-categories of *other personal attributes* as the most reported influencing factor.

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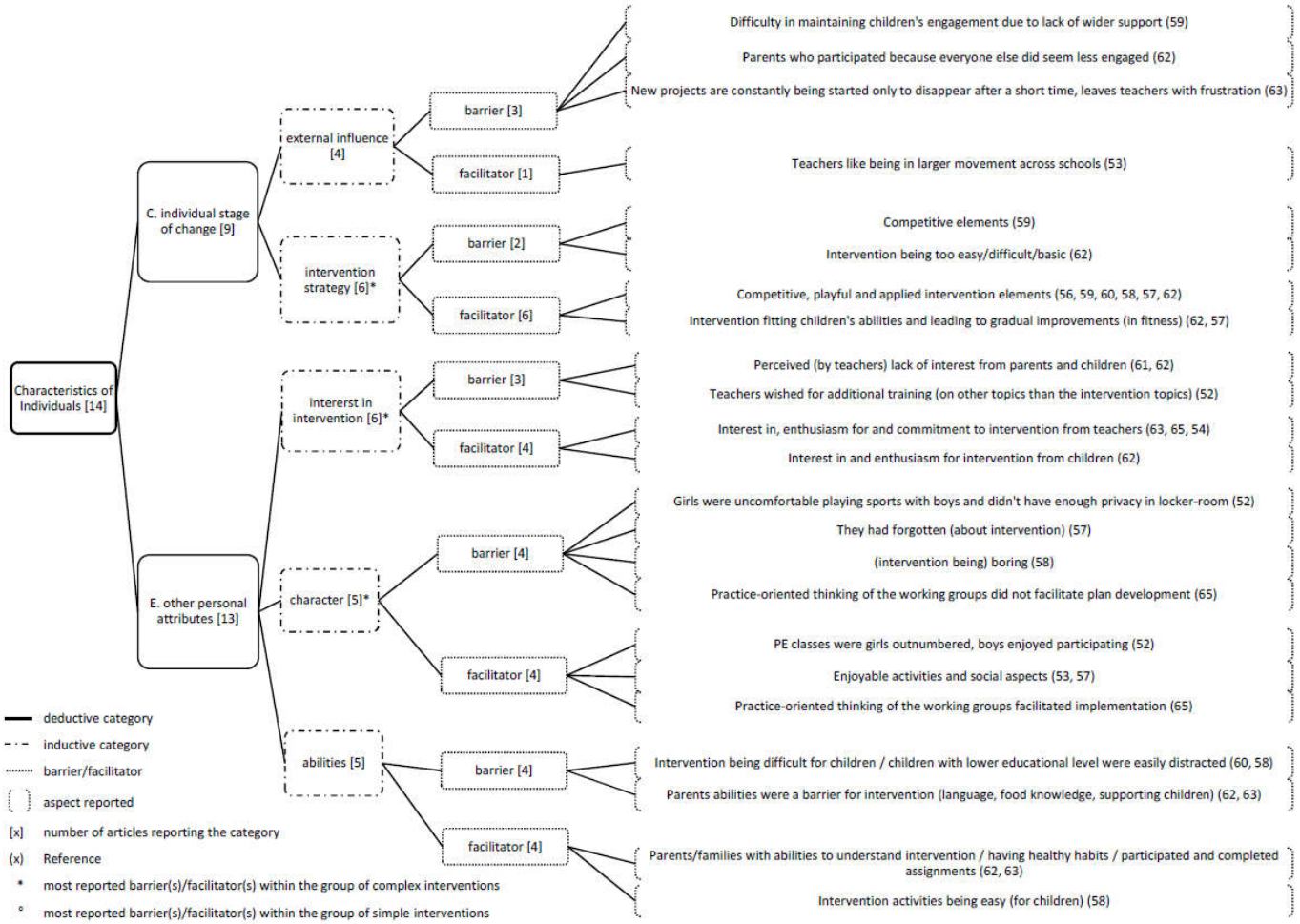

Figure 6. characteristics of individuals and most reported (sub-)categories.

Intervention strategy (n=6) was reported as a barrier due to competitive elements of the intervention (n=1) and difficulty/ease of the intervention (n=1). As Competitive, playful and applied intervention components (n=5), and fitting the intervention to children's abilities and leading to gradual improvement (in fitness) (n=2) were reported as facilitators.

Interest in intervention (n=6) was reported as a barrier, due to a lack of interest by parents and children (n=2) and teachers' wish for additional training on topics other than the intervention topics (n=1). Interest in, enthusiasm for and commitment to the intervention from children (n=1) and from teachers (n=3) facilitated implementation.

Process

(Sub-)Categories in the *process* domain were reported by 15 articles, with 3.75 articles on average for each (sub-)category. Figure 7 and Figure 8 display the seven (sub-)categories reported more than average. The most reported (sub-)category that influences the implementation is *influence on executing* (n=8) as sub-category of *executing*. Within the group of *simple* interventions, *influence on executing* (n=3) was the most reported influencing factor. Within the group of *complex* interventions, *outcome* as a sub-category of *engaging parents, strategy* as a sub-category of *engaging key stakeholders* and *influence on executing* (n=5) were the most reported influencing factor.

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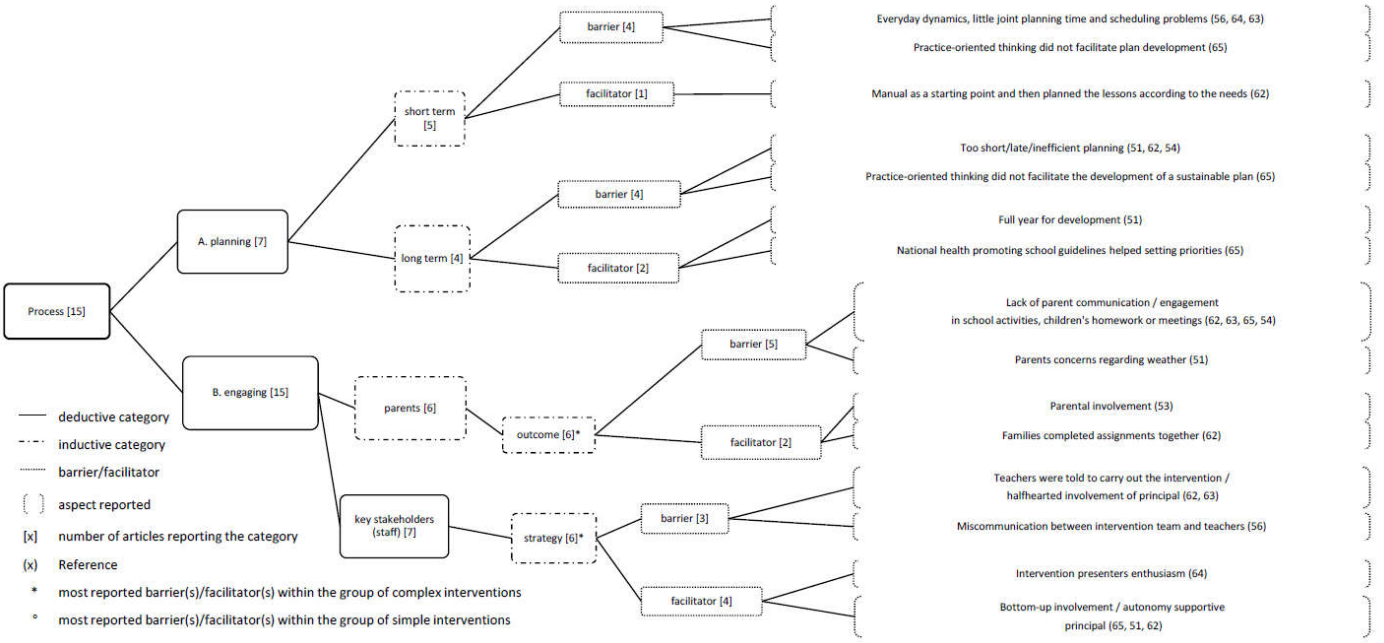

Figure 7. process domain (part 1) with most reported (sub-)categories.

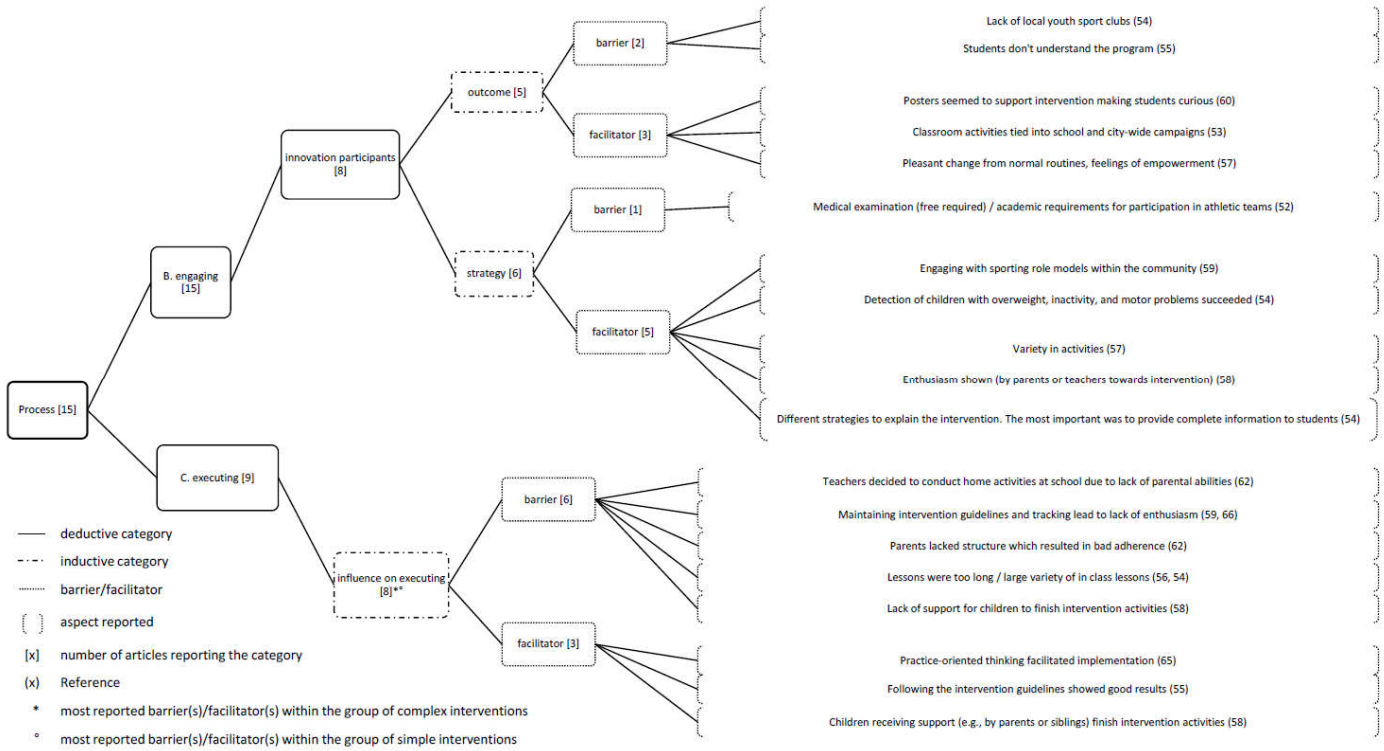

Figure 8. process domain (part 2) with most reported (sub-)categories.

Influence on executing (n=8) was reported as lack of support for children to finish intervention activities (n=1), in-class lessons that were too long or too diverse (n=2), parents lacking structure regarding the intervention (n=1), teachers conducting home activities in school due to lack of parental ability (n=1) and maintaining intervention guidelines leading to lack of enthusiasm (n=1). Practice-oriented thinking (n=1), children receiving support to finish intervention activities (n=1) and following the intervention guidelines (n=1) were reported as facilitators.

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4. Discussion

The review identified, categorized and evaluated influencing factors for the implementation of school-based interventions promoting obesity prevention behaviors in children with low SES. We identified 295 influencing factors reported in 16 articles across 93 (sub-)categories in the five domains of CFIR. The articles examined were grouped in a set of five *simple* and eleven *complex* interventions.

Aspects of the *inner setting* (also referred to as *organizational*) were reported in every article, and aspects of the *outer setting* (also referred to as *context*) constituted the least reported domain. These findings are consistent with the results of comparable reviews that assessed influencing factors on interventions promoting PA (30, 36) and reducing sedentary behavior in school settings (34), as well as the sustainment of health behavior interventions in school settings and childcare services (35). It is likely that the eligibility criteria for 'school-based' interventions lead to the accumulation of factors in the *inner setting*. Furthermore, the *inner setting* is the most comprehensive domain of the CFIR. Although the *outer setting* is of great importance for implementation (29, 67-69), it is the least reported domain and in the group of *simple* interventions it is not reported at all.

On the (sub-)category level, some results are also consistent with the results of comparable reviews (30, 34-36). Yet, a comparison with other such reviews is only limited reasonable. E.g., the sub-category *insufficient time: insufficient time* was also found as barrier for implementation by Naylor et al. (30). However, if we consider the aspects reported in this review in the sub-category *insufficient time,* the five articles that reported this barrier indicated four different aspects where *insufficient time* was felt. For practical application, this means that even though there are consistent results on an aggregated level, the underlying aspects can be very divers.

Influencing factors—for intervention developers

We grouped the articles in a set of *simple* and *complex* interventions, because *complex* interventions might entail a wider range of influencing factors than *simple* interventions. Furthermore, there is moderate evidence that complex interventions are more effective than simple interventions (25-27). Comparing the groups of *simple* and *complex* interventions, one of the most reported influencing factors in the *process* domain was *executing* in both groups. *Executing* (also referred to as *fidelity)* defined as "carrying out or accomplishing the implementation according to plan" (47) and *adaptability* are highly connected. *Adaptability* was indeed the most reported influencing factor within the group of *simple* interventions in the domain *intervention characteristics*. Modifying *executing* is highly related to *adaptations* made, as adaptations mostly decrease the *executing* of an intervention. Adaptations are quite relevant for implementation (70) and *executing* is often used as outcome (71). To analyze the influence of *adaptability* and *executing* on health outcome, it is important to document and consider both (70).

We grouped the articles with regard to the intervention characteristics, following the criteria for *complex* interventions by Craig (48). Still, it seems like every intervention itself can be considered a complex intervention, following different criteria (e.g., synergies between intervention components, degree of flexibility, and multiplicity of mediators or moderators) (72). If the intervention itself is not complex, the school setting, with its context and stakeholders, and the interactions between them certainly can be considered complex (regardless of how simple or complicated the intervention is) (73, 74).

In addition, we noticed that the results of this review and those of other reviews varied. We assume that in school-based interventions, many different influencing factors appear, and every article differs in the degree of detail they use in assessing and reporting them.

Comparable reviews (30, 34-36) did not specifically address the target population of children with low SES. We found different influencing factors for the implementation of interventions for the population of children with low SES than such reviews without the focus on children with a low SES. We cannot evaluate whether these differences due to

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the different target populations. Articles were included in our review, if they reported that their population has a low SES. All included articles measured the SES on an aggregated school or area level, so their comparability is limited. There are children with low SES living in areas where the population is predominantly of a mid to high SES. Those children might have received an intervention, but due to eligibility criteria, these articles are not included in this review. On the other hand, in an area where the population is predominantly of a low SES, not all children necessarily will have a low SES. (75)

The questions now arises, which categories or aspects should be considered when developing new or adapting existing interventions for new settings and scaling them up. Every setting and organization has different needs and resources. The group that receive interventions, such as those of a low SES, must be involved in the uptake of effective health-promoting interventions (76). Participatory approaches can increase the likelihood of successful implementation, and improving the sustainability of interventions and can help balance top-down and bottom-up approaches (77, 78). The intervention mapping approach (79), implementation mapping (33), and the closely related method of co-creation (80) offer guidance for a participatory intervention development and the implementation process.

School setting—for school staff

All organizations require resources to conduct health-promoting activities. A team for implementation, a health supporting culture, and a head teacher, who supports the intervention are likely to be important factors for successful implementation (81).

In the following, we would like to give some suggestions for school (head) teachers, school health-promoter, and social workers: Networks and collaboration can be developed with those who are willing within the school and with other schools and institutions. It is important to be open and willing to try different things, and to be ready to adjust aspects of the intervention, as each institution has different preconditions, needs, and resources. Working with the community is a promising opportunity, as those collaborations can improve the community networks and benefit school and students (82).

For children outside the school, the family is a very important setting. With regard to school-based nutrition and PA interventions, there is no clear conclusion whether parental involvement has a positive influence on the effectiveness of school-based PA and nutrition interventions (83). Regarding school-based nutrition and PA interventions with direct parental involvement (e.g., completing a questionnaire would not count as direct involvement), Verjans-Janssen et al. (84) found mainly positive effects. This may indicate the influence and importance of direct parental involvement in school-based interventions (84), especially in obesity prevention interventions (39) and for children with low SES (75, 85).

Guidance has been created addressed to schools on how to implement health-promoting activities (86, 87). Evidence-informed guidance is of great importance, however those guidance tend to exhibit a quite theoretical perspective. Building on this foundation, there is still a need for empirical tested and actionable strategies the theory practice translation.

Methodological considerations—for researcher

Because a wide variety of implementation frameworks exist (88, 89), this review also indented to help standardize and increases comparability of results in implementation research in general (90) and for school-based/obesity interventions specifically, using CFIR.

CFIR offers several advantages, due to its constant development (91) and its method of rating determinants (92). Furthermore, the CFIR outcome addendum (93), and the CFIR-ERIC (Expert Recommendations for Implementation Change: a summary of 73 implementation strategies) (94) matching tool (95). Identifying and reporting influencing

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factors using CFIR, very detailed information can be presented, using the categories, as well as more generally by using the domains. This offers comparability on different levels.

In this review and in many other instances, the application of CFIR is descriptive and linear. This review focused on identifying and evaluating influencing factors for implementation of school-based interventions preventing obesity prevention behaviors for children with low SES. The search term, and the eligibility criteria were chosen accordingly. There are issues this review could not and would not answer, but future research should address. It is important to quantify the influencing factors (92, 96), and to analyze which influencing factors are interconnected. It is essential to analyze the factors that have an influence on implementation outcomes (97-99) and on health outcomes (100). Choosing appropriate implementation strategies (101) and organizing the whole process with an overall evaluation plan (33) should be the standard in implementation evaluation in general and in children with low SES in particular.

Limitations

There are several limitations to the results of this review. Any intervention automatically does the implementation by conducting the intervention in real-world settings, and the corresponding articles might also report about implementation aspects. Articles in which reported aspects are not labeled as implementation evaluation or process evaluation results though, were not found with the search term and therefore not included in this review, although they might have contained important findings. Due to lack of transparency how the influencing factors were identified, influencing factors must have been reported in the results section. Articles reporting influencing factors only is the discussion were excluded. In addition, some clustering of influencing factors may not have occurred, because the number of 16 articles in total, five in the group of *simple* interventions, and eleven in the group of *complex* interventions, was too small.

5. Conclusion

This review is the first assessing influencing factors for the implementation of interventions promoting obesity prevention behaviors in children with low SES specifically, and contributes to existing literature regarding health equity. We identified influencing factors for implementation and presented them on a very detailed level. This enhances the presentation of results at the most applicable level, and contributes to the translation between theory and practice. This review highlights the need of empirical research investigating the processes and dynamics during the adoption, implementation and sustainment of an intervention as a whole.

List of abbreviations: CFIR: Consolidated Framework of Implementation Research; HI: health inequity; MMAT: Mixed Methods Appraisal Tool; PA: physical activity; SES: socioeconomic status

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List of additional files

Additional file 1

- Word document .docx
- PRISMA guidelines for reporting
- Checklist of PRISMA guidelines for reporting

Additional file 2

- Word document .docx
- Search strategy
- Search strategy and serach term used in the different data bases

Additional file 3

- Word document .docx
- List of included articles
- Description of included articles, with e.g. information about article design, data collection and intervention's description

Additional file 4

- Excel file .xlsx
- Consolidated Framework for Implementation Research Constructs with specifications
- Consolidated Framework for Implementation Research Constructs with specifications made for this review

Additional file 5

- Excel file .xlsx
- Mixed Methods Appraisal Tool ratings
- Methodological quality assessment ratings for each article using the Mixed Methods Appraisal Tool items

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Additional file 6

- Excel file .xlsx
- Extracted and categorized influencing factors
- Extracted and categorized influencing factors for all domains and categories of the Consolidated Framework for Implementation Research Constructs

Additional file 7

- Excel file .xlsx
- Most commonly reported (sub-)categories by group of simple and complex interventions
- The most commonly reported (sub-)categories in the group of simple and complex interventions for each CFIR domain.

Additional file 8

- PowerPoint file .pptx
- Number of reported barriers/facilitators and (sub-)categories for each CFIR domain
- All (sub-)categories for each of the five CFIR domains, and all the number of articles reporting the relevant barriers and facilitators

Figure 2-8 editable

- PowerPoint file .pptx
- Figure 2-8 are procided as PDF as part of the manuscript and they are provided in PowerPoint as editable files.