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Original Research

Teachers' experiences in co-creating an implementation plan for a public health intervention: a Health CASCADE study

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ABSTRACT

Objectives: When co-creating school-based public health interventions, it is crucial to involve teachers alongside students as they are often deliverers of the school-based intervention (components), and fulfil a key role in the implementation of the intervention. This study investigates teachers' experiences during the co-creation process of developing an implementation plan of a healthy sleep intervention.
Study design: Qualitative observational study.
Methods: Experiences of teachers involved in the action group ($n = 6$) were derived from transcripts of all co-creation sessions ($n = 6$) and one semi-structured focus group. Reflexive thematic analysis (RTA) in NVivo 14 was performed.
Results: The co-creation process took place within the highly demanding school context, which influenced teachers' co-creation experience. Teachers preferred a guided process, to make efficient use of their time. Positive experiences were principal support, the ability to share their opinion, and decision-making power. Negative experiences were inter-role conflict, low group cohesion due to the high absence level, and lacking support of their fellow colleagues. In addition, misunderstanding the aim of the co-creation process impacted teachers' motivation, as they expected to focus on the health problem rather than developing an implementation plan to tackle the health problem among adolescents.
Conclusions: Since teachers are not trained as health promotors, co-creation processes for implementing school-based public health interventions should be guided by researchers. These processes should incorporate capacity-building activities to enhance teachers' knowledge and skills in the health topic and intervention implementation, while minimising time demands to facilitate their participation.

1. Introduction

Transdisciplinary research in public health—integrating natural, social, and health sciences within a broader cultural context[1]—is becoming increasingly common as a way to address real-world problems identified by stakeholders.[2] This approach can also be applied to the development of school-based public health interventions, where co-creation—defined as a collaborative approach of creative problem-solving involving diverse stakeholders throughout all project stages[3]—is now widely used. End-users, usually students, are involved

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throughout the development, implementation, and evaluation to ensure that the intervention is tailored to their needs and characteristics.[4–8] Teachers are important stakeholders too, as they are often responsible for implementing (components of) school-based interventions.[9] Therefore, involving them in co-creation processes could enhance the implementation of school-based interventions. Previous studies indicate that schools often struggle with implementation[10] due to a limited intervention-context fit[11,12] and teachers' limited acceptability of school-based interventions[13]—which are reasons for low fidelity implementation.[14,15] Additionally, teachers often lack skills, interest, or a flexible teaching approach to integrate interventions into their daily proceedings.[16] Competing priorities further challenge the implementation of interventions, as teachers often lack sufficient time for preparation and implementation.[9,16,17] Participatory approaches such as co-creation could address these challenges but are not yet widely adopted in implementation science.[18] Advocating for the involvement of teachers in the development of an implementation plan (i.e., a curated set of implementation strategies to successfully implement all components of a public health intervention)[19] allows these plans to be tailored to their specific needs and school contexts. Consequently, co-creation has the potential to enhance intervention implementation,[20] ultimately benefiting students' health outcomes. However, involving teachers in co-creation processes, is often complex and time-intensive,[21] presenting challenges due to their existing workload.[22–24] To address this, it is essential to evaluate co-creation processes with teachers to identify how such processes can be improved.[25,26] This study seeks to explore teachers' experiences during a co-creation process aimed at developing an implementation plan for a school-based healthy sleep intervention.

2. Methods

This study is part of a research project focused on adapting, implementing, and evaluating a school-based intervention to promote healthy sleep among adolescents, using co-creation with both teachers and students. Students' experiences during this co-creation process are reported elsewhere.[27] The research project is part of the overarching Health CASCADE project aimed at providing an evidence-base for co-creation for public health.[28] The Journal Article Reporting Standards for Qualitative Primary Research (JARS-Qual) were applied.[29]

2.1. Participants

Schools were recruited through contacting school principals via email and phone. Contacted schools adhered to the following selection requirements: offer vocational (i.e., a curriculum focusing on learning practical skills) and general education (i.e., a curriculum providing foundational knowledge across diverse subjects), an equal distribution of girls and boys, and located in Flanders (Belgium) within a 40 min driving radius from Ghent. Fifteen schools were contacted of which three schools agreed to participate. In the co-creative implementation school, teachers co-created an implementation plan, in the standard implementation school, teachers received a researcher-developed implementation plan, and in the control school, no intervention was implemented. However, for the present study, only data from the co-creative implementation school were used since there was no co-creation process in the other two schools. We adopted a voluntary sampling method to recruit teachers for the action group (i.e., the group co-creating the implementation plan). At the end of school year 2021–2022, two researchers (JB and LRD) gave a presentation about the research aim and co-creation process. Teachers interested in participating in the action group completed a Google Form whereupon they were contacted by the researchers. Five teachers engaged in the co-creation process, one teacher dropped out after the first session, while another joined the co-creation process from session three onwards. Table 1 provides an overview of the individuals involved in the co-creation process. Ethical approval was granted by the Committee for Medical Ethics of Ghent University (ONZ-2022-0174) and the study is registered as a clinical trial (NCT05838339). Teachers provided written consent to participate in the study.

Table 1
Individuals involved in the co-creation process (i.e., action group).

Name	Biological sex	Age	Profession	Work experience in current profession (in years)	Attendance log co-creation sessions (session number)
Frank[a]	Male	43	Teacher (7th to 10th grade)	21	1, 3, 4[b], 5[b], 6, F
Yara[a]	Female	53	Teacher (7th and 8th grade)	18	1[b], 2, 4, 5, F
Carlos[a]	Male	40	Teacher (7th grade to 12th grade)	11	1, 2[b], 3, 4, 5[b], F[b]
Joan[a]	Female	Not reported	Teacher (7th grade to 12th grade)	Not reported	1
Ashwin[a]	Male	43	Teacher (7th grade to 12th grade)	20	1[b], 2, 3[b], 4[b], 5, 6[b], F
Ted[a]	Male	41	Teacher (9th grade to 12th grade)	14	3, 4, 6, F
Janneke	Female	32	Researcher and facilitator	2	1, 2, 3, 4, 5, 6, F
Lea Rahel	Female	27	Researcher and facilitator	2	1, 2, 3, 4, 5, 6, F

Abbreviations: F – focus group.
[a] Names represent pseudonyms.
[b] Session partly attended.

2.2. Co-creation process

The co-creation processes with teachers and students ran parallel, with students starting their process a few weeks earlier. Students' co-adapted the original healthy sleep intervention for which teachers co-created an implementation plan. Six co-creation sessions (duration: 40 min) were conducted between December 2022 and February 2023, of which one session was jointly conducted with the student action group. The co-creation process was structured using Implementation Mapping,[30] which aims at directing the development of multi-level public health interventions and implementation strategies.[31] Implementation Mapping expands on step 5 of Intervention Mapping which focuses on the development of strategies to strengthen the adoption, implementation, and sustainability of evidence-based interventions.[32–34] Since the co-creation process with teachers aimed to develop an implementation plan, only strategies to strengthen the implementation were applied. Implementation Mapping encompasses five tasks,[30] which are reported in Table 2 concurrently with a detailed overview of how these tasks were integrated in the co-creation process. One of the sessions, session 2, was not grounded in Implementation Mapping but focused on sleeping behaviour on teachers' request.

2.3. Data collection

All co-creation sessions were audio-recorded. A semi-structured focus group (duration: 40 min) was conducted at the end of the co-

Table 2
Overview of the co-creation process with integrated Implementation Mapping Tasks.

Session number	Task Implementation Mapping[a]	Performed by	Key points and activities
1	Tasks 1 and 2	Teacher action group	**Goal:** Identify barriers and enablers for implementation and determine deliverers **Activities:** • Setting ground rules to create a safe space • Discussing teachers' expectations of the co-creation process • Conducting a needs assessment through two envisioning exercises: oSuccess scenario: Identifying factors that enable implementation oFailure scenario: Identifying factors that hinder implementation • Clustering enabling and hindering factors • Identifying key implementation determinants, including: oOutcome expectations oSchool culture (i.e., subjective norm) oTime oKnowledge for implementation oHelp from others (i.e., support) • Rating the identified determinants based on importance and changeability
2	Capacity building	Teacher action group	**Goal:** Increase knowledge about healthy sleeping behaviour in adolescents **Activities:** • Conducting a quiz on healthy sleeping behaviour • Facilitating a group discussion on the provided answers and reasoning • Sharing scientific information to enrich the discussion
3	Task 2	Teacher action group	**Goal:** Assess how the selected determinants from session 1 influence the intervention components and define clear performance objectives **Activities:** • Assessing the feasibility of implementing each component of the original healthy sleep intervention, considering the selected determinants identified in session 1 • Formulating performance objectives
In between sessions	Task 3	Researchers, due to the need for specialised knowledge and insufficient time to train teachers	**Goal:** Select theoretical methods and design implementation strategies **Activities:** • Selecting theoretical methods • Designing implementation strategies
4	Tasks 1, 2 and 4	Teacher action group	**Goal:** Finalise performance objectives, assign deliverers, and create necessary implementation materials **Activities:** • Reviewing and finalising performance objectives • Identifying deliverers for each performance objective • Evaluating implementation strategies designed by researchers • Specifying the implementation materials required
5	Tasks 2 and 4	Teacher and student action group	**Goal:** Develop new intervention components targeting school stress, with a focus on their implementation feasibility **Activities:** • Brainstorming solutions to address school stress among students • Assessing the feasibility of implementing each newly developed component, based on the selected determinants from session 1 • Defining the necessary implementation materials for these new components
In between sessions	Task 3	Researchers	**Goal:** Design and create implementation protocols, materials, and activities to support intervention implementation **Activities:** • Reviewing suggestions for necessary implementation protocols, materials, and activities • Developing the required implementation protocols, materials, and activities
6	Tasks 4 and 5	Teachers action group	**Goal:** Evaluate the alignment of the developed implementation materials with expectations and create an evaluation plan for the implementation process **Activities:** • Evaluating whether the developed implementation materials meet expectations • Developing an evaluation plan for the implementation process

[a] **Task 1** aims to conduct a needs assessment to identify barriers and enablers (i.e., determinants) for implementation and to determine the deliverers of the intervention; **Task 2** aims to identify implementation outcomes, performance objectives (i.e., "What do deliverers need to do to implement the intervention components?"), and determinants (i.e., "Why would a deliverer implement the intervention as planned?"), and to create matrices of change (i.e., "What has to change in this determinant to achieve the performance objective?"); **Task 3** aims to choose theoretical methods to influence the determinants of implementation and to select or design implementation strategies; **Task 4** aims to develop implementation protocols, activities and/or materials using iterative feedback; **Task 5** aims to plan the evaluation of the implementation outcomes.[30]

creation process, to evaluate teachers' experiences. We developed an interview guide (see supplementary file) including questions about the foundational psychological constructs of the Self-Determination Theory (SDT),[35,36] specifically focusing on teachers' level of autonomy, competence, and relatedness during the co-creation process. These constructs correspond to feelings of ownership (autonomy), belonging

(relatedness), connectedness (relatedness), and growth (competence), as well as perceiving the co-creation process as meaningful and valuable (autonomy).[37] The relevance of the SDT to the interview guide stems from its emphasis on social situations that offer choice and ownership, such as a co-creation process, which foster feelings of autonomy and competence.[38] These constructs are considered essential to human experience.[39]

2.4. Analysis

The co-creation sessions and focus group were transcribed verbatim and analysed in NVivo 14 to extract teachers' experiences, using Reflexive Thematic Analysis (RTA).[40,41] Co-creation experiences were defined as stakeholders' psychological states, feelings, and perceptions related to their involvement and interaction with other stakeholders throughout the entire co-creation process.[42] Epistemological considerations for this analysis were constructionist, as meaning and meaningfulness of the data were a central criterion during the coding process while addressing the importance of recurrent patterns. An experiential orientation to data interpretation was adopted, prioritising an examination of how a situation might be experienced by the teachers. Sticking to the interpretative nature of RTA,[40] the analysis was mainly conducted by one researcher (JB) (see supplementary file for researcher reflexivity). RTA was conducted using the six phase analysis process.[43] During phase one the researcher (JB) familiarised herself with the data by reading all transcripts. Initial codes were generated during phase two using open-coding. Primarily an inductive approach was employed, implying that data were open-coded to highlight teachers' interpretations of the co-creation process. However, deductive coding was adopted to secure that open-coding contributed to producing themes that were meaningful to the research question, and to ensure that teachers' interpretations emphasised were relevant to the research aim. Both semantic and latent coding were used, therefore data could be double-coded if the semantic meaning communicated by the teacher and the latent meaning interpreted by the researcher were of interest.[44] During phase three, codes were modified, if needed, and organised into initial themes. Initial themes were sense-checked by LRD, which led to modification of the themes. LRD had been present during the co-creation sessions and focus group discussion and could therefore offer valuable interpretations that enriched the interpretation of meaning of the data. Themes were modified by JB and LMcC, who has expertise in co-creation experiences in adults. LMcC's interpretations of the data, when modifying the themes, enriched the themes even more. Subsequently, the modified themes were reviewed and further adjusted by JB during phase four resulting in five themes and two subthemes (Fig. 1). During phase five themes were defined and named and a report was written during phase six.

3. Results

The co-creation process took place in the school context, which had a major influence on teachers' co-creation experience. Therefore, all themes must be understood within this context.

3.1. Expectations about co-creation

Teachers had certain expectations about what co-creation was before the co-creation process started. One teacher described co-creation as *"a process of controlled chaos leading to sustainable solutions" (Carlos)*. Another teacher envisioned co-creation to be the world upside down. *"Well, now we are higher ranked than the students, but for once students are rising above" (Frank)*. The same teacher therefore expected *"that the students put in more effort, because it [the intervention] is for them" (Frank)*. Other teachers stated that the intervention was something that belonged to the students; therefore, they anticipated having a mainly supportive role for the students. The integration of practical and scientific knowledge is something all teachers expected, *"I think you provide the scientific knowledge and we provide the [contextual] data" (Ashwin)*. This approach was perceived promising for the development of the implementation plan.

3.2. Motivation to participate

Teachers voluntarily participated in the co-creation process, motivated by either personal or collective objectives. Most teachers' motivations were personally oriented, since the majority revealed having sleeping problems, mentioning that *"the topic should appeal to you to engage in co-creation" (Frank)*. Teachers expected to learn more about sleep, causing a misalignment between the aim of the co-creation process and their motivation to participate. Teachers who did not indicate having sleeping problems participated for other reasons. One teacher mentioned conducting research as his main motivation to participate: *"I would love to invent something, test it, implement it, and see how it goes" (Ted)*. Another teacher, having a collective oriented motivation, believed that she had to represent the interests of 7th and 8th grade students.

3.3. Group dynamics in co-creation

Group dynamics, defined as the underlying mechanisms that generate a set of norms, roles, relationships, and shared goals characterising a specific social group,[45] impacted teachers' co-creation experience within the teacher action group (i.e., intragroup dynamics) as well as between the teacher and student action group (i.e., intergroup dynamics).

3.3.1. Intragroup dynamics

Researchers aimed to avoid being seen as leaders and to give everyone an equal voice in the process; however, teachers still expected guidance from the researchers. *"I do not believe that it is our task to determine the order or content of the research steps or anything … I believe that you guys do the agenda setting, and just within your agenda we can add things … but that you guys are leading it [the co-creation process] a bit" (Ashwin)*. Since teachers perceived researchers as leaders, they expected them to finish tasks outside of sessions therewith minimised their project-related workload. Teachers were acquainted because they often collaborate, mentioning *"we sit together in so many meetings" (Ted)*, which became clear from the way they easily chatted and felt at ease sharing their thoughts. Although teachers were acquainted, they did not operate as a group, which was probably a result of the high absence rate during the process caused by overlapping obligations. These job-related obligations created a constant feeling of stress and caused that teachers forget to respond to emails, which harmed open communication outside the sessions influencing the decision-making process and process in general. Occasionally the school context influenced teachers' behaviour in that they treated researchers like students by pointing out their (spelling) mistakes and disagreeing on the scientific knowledge that was shared. *"No, in my opinion the average [recommended sleep duration] is not correct" (Ashwin)*. This created a power imbalance between teachers and researchers.

3.3.2. Intergroup dynamics

In the beginning teachers doubted whether their students were able to adapt an intervention that fitted their and their peers' needs, mentioning, *"… is it going to work, is it [the intervention] not going to be too childish" (Frank)*. This changed to a feeling of contentment by seeing what students established. Teachers experienced the collaboration with students positively, they *"enjoyed seeing the students engaged in a different way compared to a classroom situation" (Frank)*. Moreover, they appreciated the open dialogue to create knowledge, mentioning *"we always look at it from our side and they from their side, but it is nice to hear each other's opinions" (Yara)*. However, session recordings also indicated that

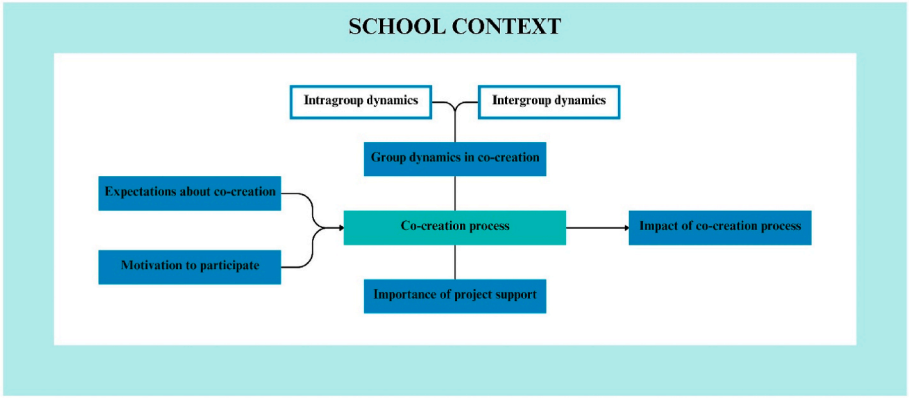

Fig. 1. Thematic framework.

teachers were critical about students' perspectives and let limited space for students to share their opinion or to finalise their sentences. Although some ground rules for collaboration (e.g., equality, listening to each other, respecting each other's opinion) were discussed at the start of the co-creation process, some teachers corrected students or approached them in a manner maintaining the school hierarchy. Nevertheless, teachers experienced a more equal partnership between themselves and the students compared to when they were in class.

3.4. Importance of project support

Teachers involved in the co-creation process recognised the importance of their role in the overall success of the intervention and, as a result, felt engaged and motivated to support its implementation, especially after the time they invested in co-creating the implementation plan. *"If we do not do our job, then your project does not succeed either … and then I think it is stupid, you have been sitting here all these weeks for [silence], because you support it" (Frank)*. However, teachers indicated that engagement was more difficult for their fellow colleagues who were not involved in the co-creation process. They also mentioned being disappointed in the number of colleagues who attended the mandatory intervention training they had established. Nevertheless, teachers experienced support from their principal. *"Well, the principal is definitely going to support this [the project]. He is interested and immediately started thinking along with us about ways to improve it" (Frank)*.

3.5. Impact of co-creation process

Teachers experienced the impact of the co-creation process as both positive and negative. Teachers became aware of the value of co-creation and how it differs from consulting mentioning, *"I am thinking, students often have a say but consulting is another thing than co-creation" (Ashwin)*. Therefore, they started questioning if they could apply co-creation to their own school projects by actively collaborating with students, including sharing decision-making power. Moreover, teachers indicated that they experienced personal development as they gained knowledge *"on how to approach something together with students and the execution of their project, that a lot [of the ideas] can come and did come from the students" (Frank)*. All teachers appreciated that they had a voice and indicated the importance of participation and shared decision-making during the process, mentioning *"… of course you cannot approach us with scientifically proven things and say (…) that's how we are going to do it" (Carlos)*. Even though teachers perceived their contribution as important, they often mentioned their lack of time to participate due to the highly demanding school environment. *"A lot is changing, new school regulations and lesson plans … more project-based work, more events, and the administrative part is getting bigger" (Carlos)*. This might also explain why most teachers did not experience a feeling of ownership and referred to the co-creation process as *"your project"*. Only one teacher showed some degree of ownership during certain parts of the process, by suggesting to arrange project-related matters during staff meetings. Teachers chose to meet during the lunch break, although this time was often used for ad hoc meetings with students or other unforeseen tasks. Therefore, teachers experienced stress during the sessions, caused by inter-role conflict *"… you also see how the meetings go, we have to eat, we have to [silence], actually it's a bit in between everything" (Ashwin)*.

4. Discussion

This study aimed to explore teachers' experiences in co-creating an implementation plan of a school-based healthy sleep intervention in order to enhance future co-creation processes of public health interventions. To assess teachers' co-creation experiences, the interview guide incorporated questions grounded in the SDT.[35,36] These questions explored teachers' levels of autonomy, competence, and relatedness, as these fundamental psychological needs are associated with feelings of ownership, belonging, connectedness, growth, and the perception of the co-creation process as meaningful and valuable.[37] The latter elements were reflected in the themes that were developed. The rational for conducting co-creation with teachers was to enhance the implementation process of a school-based healthy sleep intervention. Involving teachers in a co-creation process where they have a voice and decision-making power is intended to foster teacher's commitment to implement the public health intervention, which is crucial for ensuring intervention effectiveness.[46] Challenges encountered during the co-creation process, such as inter-role conflict, arose from the school context itself and therefore closely resemble challenges found in implementation processes.[17,47] The school context is indeed highly demanding for teachers, with limited time available for implementing interventions,[9] however, schools remain a popular context for public health interventions[48–52] due to their ability to effectively reach youth from diverse sociodemographic backgrounds.[53] This means it is important to take these aspects into account when designing a co-creation process for teachers.

Teachers highlighted that they would prefer a guided co-creation process in which the researchers are responsible for agenda setting, determining the steps that have to be taken, and deciding on the content of the sessions. Since teachers are not trained as health promotors,[54] guided co-creation processes can support them in implementing public health interventions, with capacity building exercises serving as practical training on the health topic and intervention implementation. Moreover, research shows that teachers are in need of more knowledge about interactive classroom activities that enhance students' health learning outcomes[55,56]—a need that aligns with the principle of co-learning towards innovation[57] and can be seamlessly integrated into a co-creation process. In exchange, teachers can offer researchers

valuable contextual knowledge to inform the development of the implementation plan of public health interventions.[57] This guided approach to co-creation makes the process participatory and rewarding, while also being less time-intensive and more manageable for teachers to integrate into their busy schedules.

Teachers saw their co-creation process aiming to collaboratively develop an implementation plan as supportive of the student co-creation process in which a healthy sleep intervention was adapted. This subordinate role might have harmed the manifestation of ownership,[25] a key factor in the sustainable implementation of public health interventions.[58] When teachers experience a sense of ownership, they are committed to implement school-based health promotion initiatives sustainably, which is a central aim of public health.[59] Another reason why teachers may have lacked a sense of ownership is that most of them were primarily motivated to participate out of the desire to learn more about sleeping behaviour, having the expectation of improving their own sleep. However, they misunderstood the aim of the co-creation process, as it did not focus on sleeping behaviour but on the development of an implementation plan to address sleeping behaviour among adolescents. This might have resulted in declined motivation as they could no longer achieve their anticipated outcome of improving their own sleeping behaviour, which might also explain why one of the teachers dropped out after the first session. Therefore, to align expectations and motivations it is essential to communicate clearly that teachers serve as intervention deliverers, responsible for implementing public health interventions targeting students' health behaviours—without necessarily focusing on changing their own.

Teachers felt supported by their school principal, who acknowledged their involvement and provided ideas and resources to strengthen the implementation plan of the healthy sleep intervention. Principal support is crucial for any school-level change, as principals hold decision-making power and influence over teachers, students, parents, and the overall school environment.[60,61] This influence is critical for fostering a culture of health promotion within schools. Adopting a whole school approach is recommended to improve school-based health promotion. This approach encourages shared responsibility among various stakeholders—including school staff, families, community members, and society at large—who work collaboratively to promote healthier lifestyles.[46] Such collaboration has been shown to increase the success and effectiveness of school-based public health interventions.[46,62–64] Engaging multiple stakeholder groups to promote healthy behaviour is best achieved through participatory approaches such as co-creation. When promoting healthy sleeping behaviour within the school context, using a whole school approach is particularly beneficial.[65]

To optimise co-creation with teachers for public health purposes, future research should ensure co-creation processes are well-guided, time-efficient, and supportive of teachers' needs. Such processes should aim to strengthen teachers' health promotion skills, enhance their ability to motivate students towards healthier behaviours, and foster their commitment to implementing school-based interventions. In the next phase, it should be examined whether co-creating an implementation plan with teachers improves the implementation of school-based public health interventions. An optimal co-creation process not only holds the potential to improve the implementation of public health interventions, but also contributes to broader public health goals by embedding health promotion within educational settings, thereby reaching a large and diverse youth population.

4.1. Strengths and limitations

Strengths of this study include the active involvement of teachers in the co-creation process, ensuring their lived experiences and expertise informed the implementation plan. In addition, Implementation Mapping provided a structured, evidence-based framework for the co-creation sessions. However, tight project timelines meant co-creation sessions occurred during busy periods for teachers, limiting participation in these sessions. Some sessions proceeded with few attendees due to unforeseen events, affecting shared decision-making and potentially impacting the implementation plan. Furthermore, the small sample of teachers ($n = 6$) participating in the co-creation process is a limitation of this study. Although in qualitative research, there is no definitive guideline for sample size.[66] Nevertheless, considering that a scoping review on teachers' co-creation experiences found similar results,[67] our findings might indicate potential transferability.

Author statements

Ethical approval

Ethical approval was granted by the Committee for Medical Ethics of Ghent University (ONZ-2022-0174).

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Competing interests

The authors declare that they have no competing interests.

Data availability

Transcripts analysed during the current study are available from the corresponding author on reasonable request.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to identify grammatical errors and enhance the writing style of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Appendix A. Supplementary data

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