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Exploring Acceptability, Implementation, and Contextual Factors in a School-Based Physical Activity Intervention: Qualitative Process Evaluation from a Feasibility Trial in Yangzhou, China

Victor Manuel Rojas[1]*, Daniel Esteban Paredes[1]

[1]Department of Management, Pontificia Universidad Católica del Perú, Lima, Peru.

***E-mail** ✉ v.rojas.pucp@gmail.com

Abstract

Increasing physical activity among children in China remains a pressing concern. We designed a 16-week school-based program aimed at changing behaviors, drawing on the Behavior Change Wheel and the Theoretical Domains Framework. Subsequently, a cluster feasibility non-randomized controlled trial (RCT) was carried out with children in Yangzhou, China. This qualitative process evaluation, conducted alongside the cluster feasibility non-RCT, sought to: (1) understand how participants and providers experienced the intervention and trial; and (2) develop recommendations to guide a future, larger cluster RCT. Semi-structured interviews were conducted with 20 children (10 in the intervention group, 10 in the control), 20 parents, and 2 health education staff across two public schools in Yangzhou. All interviews were audio-recorded, fully transcribed, and translated from Mandarin into English. Thematic analysis was applied to identify patterns in the data. Analysis revealed eight main themes reflecting participant experiences: (1) strong perception of intervention components as effective in promoting activity, (2) appreciation of the program's design, (3) factors supporting or hindering attendance and delivery, (4) positive emotions experienced during data collection, (5) satisfaction with trial management, (6) effects of personal beliefs and emotional reactions, (7) influence of social relationships on decision-making, and (8) key recruitment challenges. The program and trial procedures were generally acceptable to children, parents, and providers. School-based behavior interventions appear promising for enhancing physical activity among children aged 10–12 in China. Future cluster RCTs should address obstacles to participation and implementation to better evaluate effectiveness.

Keywords: Physical activity, Qualitative study, Process evaluation, Interviews, Children, China

Introduction

Physical activity is critical for maintaining both physical and mental health [1-3], yet globally, 81% of school-aged children do not meet activity recommendations [4]. In China, children aged 5–17 are advised to engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily while reducing sedentary time [5]. Despite these guidelines, over 84% of children fail to reach the recommended activity levels [4]. Notably, activity levels tend to drop between ages 10 and 12 [6, 7], making early intervention especially important [8]. Research on promoting physical activity among Chinese children has grown in the past 20 years, with evidence showing benefits for activity patterns and weight management [9-12]. However, reports indicate a persistent decrease in children's activity over time [6], alongside declines in fitness (e.g., endurance, strength) and increases in overweight and obesity [13, 14].

Schools typically offer health education and structured exercise sessions, delivered orally or in written form, to help children achieve recommended intensity and duration targets. Promoting physical activity effectively requires understanding the factors driving or limiting behavior [15, 16]. Evidence suggests, however, that

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existing programs rarely address children's intrinsic motivation or activity outside school hours, such as during weekends or holidays [17]. Many past interventions in China also lacked theoretical foundations to target key behavioral determinants [18, 19]. For example, a systematic review highlighted that most programs were not designed or evaluated using structured frameworks, such as the UK Medical Research Council (MRC) framework for complex interventions [20]. Approximately 80% of these programs were deemed low quality. Intervention quality could be enhanced by involving experts and engaging children, families, and the public (PPIE) in program development and implementation, but this has often been neglected [21]. Barriers may include cost, tight timelines, limited awareness of PPIE's value, or word limits in publications. Our Joanna Briggs Institute (JBI) qualitative systematic review on physical activity in ethnic Chinese children synthesized four major themes: personal, sociocultural, environmental, and policy/program influences [22, 23].

Process evaluations constitute a core component of multifaceted behavior change programs [15], enabling systematic monitoring of delivery mechanisms, reach (the proportion of intended recipients who participate), fidelity (the degree of adherence to the original protocol), and overall implementation quality [24]. Despite their importance, process evaluations have frequently been overlooked or insufficiently documented in earlier school-based physical activity initiatives targeting Chinese children [25]. This gap limits insight into how participants perceive and experience both the intervention and their involvement in research trials. Gaining a detailed understanding of stakeholders' views is critical for optimizing recruitment and retention rates, as well as for identifying the elements that contribute to an intervention's acceptability and effectiveness.

The UK Medical Research Council (MRC) framework for the development and assessment of complex interventions advocates for a dedicated feasibility and piloting stage following initial intervention design [15]. During this phase, process evaluation plays a key role in assessing practicality and refining the program structure and its evaluation strategy. Moore *et al*. further emphasized that process evaluation serves formative objectives, allowing researchers to pilot specific intervention components, assess their viability, and introduce necessary modifications to achieve optimal dose, fidelity, and acceptability before proceeding to large-scale rollout [24]. Depending on the developmental phase of the intervention, different process evaluation elements can be prioritized. Such evaluations are particularly valuable in the feasibility testing of behavioral programs, as they reveal how the intervention functions within a trial environment and collect constructive input from participants, facilitators, and other relevant stakeholders to enhance content and strengthen its capacity to promote lasting behavior change [26]. The data obtained can directly inform strategies to improve enrollment procedures, boost retention, increase session attendance, and refine the intervention before launching a fully powered definitive trial [26, 27].

Interventions grounded in behavior change theories have demonstrated favorable impacts on children's health-related behaviors, including physical activity participation [16]. Nevertheless, there remains a notable shortage of evidence concerning the feasibility, effectiveness, and evaluation methodologies of theory-driven physical activity interventions designed specifically for children in China. To address this, we implemented a cluster feasibility non-randomized controlled trial (non-RCT) to evaluate the practicality of a 16-week behavior change program aimed at elevating physical activity levels among children in Yangzhou, China [28]. The trial generated essential quantitative benchmarks (such as recruitment rates, retention, preliminary effect sizes, and other feasibility metrics) required for planning a subsequent fully powered cluster RCT; these results are presented in detail elsewhere [28]. In summary, preliminary findings suggested that the program may enhance children's self-efficacy, enjoyment of physical activity, and perceived social support. Despite achieving excellent recruitment (100%), follow-up (100%), data completion (100%), and intervention attendance (100%) in the cluster feasibility non-RCT, further investigation is required to examine delivery processes, contextual influences, relative strengths and weaknesses of specific components, and potential refinements that could better support the intended behavioral outcomes.

The present study therefore conducted a qualitative process evaluation with two primary objectives: (1) to investigate the experiences and views of participants and implementers regarding both the intervention itself (intervention-specific topics, limited to those in the intervention arm) and the trial procedures (feasibility-trial-specific topics, applicable to both intervention and

control arms); and (2) to formulate evidence-based suggestions for refining the intervention and designing a future definitive cluster RCT. This qualitative work was embedded within our preceding cluster feasibility non-RCT, which assessed the overall viability and acceptability of proceeding to a main trial with Chinese school-based participants and providers [28].

Materials and Methods

Study design, setting, timeframe, and reporting standards

This qualitative investigation took place in two public primary schools located in Yangzhou, China [28]. One school implemented the 16-week intervention alongside participants' regular physical education activities, while the second school maintained only their usual physical education routine. Semi-structured interviews were carried out with children, parents, and health education teachers upon completion of the intervention period (September–October 2020, scheduled in advance). The reporting of this qualitative component adheres to the 32-item Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [29].

The behavior change intervention

The intervention was systematically designed using the Behavior Change Wheel (BCW), Theoretical Domains Framework (TDF), and insights obtained through patient and public involvement and engagement (PPIE) activities [16]. Its goal was to motivate children to increase activity during school hours and to raise overall daily physical activity, including after-school and weekend activity. Because children's activity tends to be sporadic and unstructured, conventional approaches such as formal exercise sessions may not fully address it. Therefore, part of the intervention focused on modifying the school environment to create additional opportunities for movement, complementing mandatory and high-quality physical education. During the development phase, a behavioral diagnosis identified several key TDF domains influencing children's physical activity in China: environmental context and resources, social influences, beliefs about consequences, memory, attention and decision processes, emotion, and beliefs about capabilities [30]. The intervention prioritized promoting active behavior (i.e., achieving at least 60 minutes of MVPA per day) rather than emphasizing specific exercise types. Full details of the development process are reported elsewhere [30].

The intervention included three main components: (a) health education, (b) family engagement, and (c) school environment support. Health education consisted of four group sessions and printed materials, such as activity diaries. Key strategies included: providing information on health and emotional benefits to enhance understanding; demonstrating physical activity examples to encourage participation; reinforcing prior successes and children's abilities to boost voluntary engagement; and facilitating goal-setting and action planning. Family engagement involved an online session and a physical activity booklet for parents, aiming to foster positive feelings and support for their child's activity. Parents were also encouraged to provide both emotional support (e.g., partnering with their child in activities) and practical support (e.g., preparing sports equipment). School support focused on modifying the environment, including posting motivational materials, providing equipment and pedometers, and offering verbal praise or tangible rewards such as stickers to reinforce activity.

Study participants and recruitment

All children, parents, and teachers involved in the cluster feasibility non-RCT were eligible for interviews. Child-parent interviews were conducted in pairs, with participants purposively selected and contacted by an independent teacher. Two health education teachers—one from each school—participated in individual interviews. Children aged 10–12 provided verbal assent, and parental consent was obtained. Health education teachers and parents provided both verbal assent and informed consent before their interviews.

Sample size

The cluster feasibility non-RCT recruited 64 child-parent dyads, 32 per group. Interviews continued until data saturation was reached, defined as the point when no new themes emerged [31]. Prior studies suggest that six to seven interviews are often sufficient to capture most themes in a homogeneous sample (around 80% saturation) [32]. In this study, saturation was achieved after 10 interviews in each group, as no additional insights were identified. Only two health education teachers participated, one from the intervention school and one from the control school**. Table 1** summarizes the characteristics of the interviewees.

Table 1. Participants' and providers' characteristics by group

Characteristic	Control	Intervention
Children, n	10	10
Age in years (range, mean)	10–12, 11.2	10–12, 11.2
Gender		
Female, n (%)	4 (40%)	5 (50%)
Male, n (%)	6 (60%)	5 (50%)
Parents, n	10	10
Mother, n (%)	8 (80%)	6 (60%)
Father, n (%)	2 (20%)	4 (40%)
Education level		
High school or equivalent (0–12 years), n (%)	8 (80%)	5 (50%)
University or equivalent (>12 years), n (%)	2 (20%)	5 (50%)
Employment status		
Employed, n (%)	10 (100%)	10 (100%)
Health education teachers, n	1	1
Gender		
Female, n (%)	1 (100%)	1 (100%)
Education level		
University or equivalent (>12 years), n (%)	1 (100%)	1 (100%)

Interview guides

The current study applied the process evaluation framework proposed by Reelick *et al*. [27], which was chosen for its structured approach suitable for feasibility-stage interventions. This framework examines three central areas: (a) the effectiveness of recruitment and characteristics of the sample, (b) the procedures used to collect data, and (c) the implementation quality of the intervention. Each of these domains can be evaluated using multiple indicators **(Table 2)**. Accordingly, three semi-structured interview guides were developed, customized for children, parents, and health education teachers, and adapted from previous feasibility research [33, 34]. The guides were translated into Mandarin and checked for accuracy by a bilingual team member (HW).

The interview guides included questions common to all participants that explored their experiences and views on the intervention (for example, reflections on educational sessions, frequency and timing of activities, and interactions with intervention staff; intervention-specific questions were directed only to the intervention group) as well as questions related to the feasibility trial (for example, understanding recruitment materials, the information sheet, and data collection procedures; these were asked to both intervention and control participants). Additional questions were tailored to each group, such as inquiries regarding children's use of the activity diary and parents' engagement with the physical activity booklet.

Table 2. Process-evaluation components and related process measures of a complex intervention

Process	Components / Process Measures
Study population	1. Recruitment and enrollment rate 2. Challenges and enabling factors in the recruitment and selection process 3. Follow-up: dropout/attrition rate 4. Challenges and enabling factors for participant follow-up
Multiple components	1. Quality of implementation of the intervention components 2. Barriers and facilitators affecting delivery of intervention components 3. Participant adherence to intervention components 4. Barriers and facilitators related to adherence to intervention components 5. Experiences of participants and instructors with the intervention components
Evaluation data	1. Outcome assessment: extent to which intervention components were covered 2. Completeness of collected data 3. Challenges and enabling factors for data collection

Interview procedures, transcription, and translation

Before starting, participants were briefed on the interview's objectives and procedures. They were

informed that participation was entirely voluntary and could be stopped at any time. HW, a male researcher trained in qualitative research, conducted all interviews. Participants had no prior contact with the interviewer. Interviews were performed in Mandarin over the phone due to COVID-19 social distancing, lasting on average 20 minutes (range: 15–25 minutes); face-to-face interviews had originally been planned.

Open-ended questions were used to encourage detailed responses, and participants were reminded that there were no right or wrong answers. The researcher took notes during interviews to record observations and emerging points for later coding and thematic analysis. With consent, all sessions were audio-recorded. The recordings were imported into NVivo 12 (QSR International) for organization and analysis [35]. Transcripts were not returned to participants; however, measures were taken to ensure accuracy. Audio files were encrypted and sent to a professional service for verbatim transcription and translation into English under a nondisclosure agreement. HW and YZ reviewed all transcripts alongside the audio to verify completeness and accuracy.

Ethics

Ethical approval for this study was granted by the Faculty of Medicine and Health Sciences Research Ethics Committee, University of Nottingham, UK (reference 255-1902).

Data analysis

The interview transcripts were examined using thematic analysis [36, 37], combining both inductive and deductive strategies. Initially, an inductive approach was applied, allowing codes to emerge directly from the data to ensure no relevant insights were overlooked. Simultaneously, theory-driven codes (deductive approach) were incorporated, enabling the analysis to be informed by prior knowledge. For example, early codes such as "fun," "personal interest in physical activity," and "curiosity about physical activity knowledge" were theory-derived, reflecting evidence that intrinsic motivation can facilitate children's engagement in physical activity. Data analysis was iterative rather than strictly sequential, with codes refined throughout the process as new insights arose.

Two researchers (HW/YZ) independently reviewed all transcripts multiple times to enhance credibility. Initial coding was developed collaboratively through discussion and applied to a subset of transcripts, allowing iterative refinement. Each transcript was then coded independently, and any discrepancies were resolved through discussion until consensus was reached. Children's transcripts were analyzed first, followed by those of parents and teachers. Codes that were similar across children, parents, and teachers were then grouped, leading to the development of overarching themes and subthemes. Additionally, codes specific to individual groups (e.g., activity diary for children, physical activity booklet for parents) were collated based on similarity in meaning to form group-specific themes and subthemes.

Efforts to reduce bias included: (a) involving researchers (HB, KC) who had not conducted interviews in analytic decisions, (b) applying reflexivity (HW) and reviewing reflective notes (HW, YZ) during analysis, and (c) engaging a researcher (YZ) who had no role in intervention delivery or study design. Participants and providers did not review the findings.

Results and Discussion

Eight main themes emerged from the analysis, reflecting participants' and providers' experiences and perceptions of the intervention and trial. Within these themes, 32 subthemes were identified. Details of themes, subthemes, and illustrative quotes are presented in **Tables 3 and 4.**

Table 3. Experiences and perceptions of participating in the intervention

Themes	Subthemes	Verbatim Quotes
Theme 1: Perceived high efficacy of the intervention components to help children become more active	(1.1) Activity diary facilitates reviewing behavior goals	(1.1.1) "I try to spare time daily to read them, and if I find something useful, I do it; otherwise, I make slight adjustments." (Child 3, Male, Intervention group) (1.1.2) "My favorite is the exercise diary because I can record daily steps and adjust my exercise accordingly." (Child 4, Female, Intervention group) (1.1.3) "The daily physical activity plan and steps log motivate me to exercise." (Child 5, Male, Intervention group)

	(1.2) Positive effect of group activity sessions on physical activity beliefs	(1.2.1) "The course is helpful. It explains how physical activity benefits the body and warns about harmful behaviors." (Child 1, Female, Intervention group) (1.2.2) "They help to some extent; attending sessions helps parents understand the importance of physical activity." (Parent 7, Father, Intervention group) (1.2.3) "Participation positively motivates him; teacher guidance works better than parental guidance for recording steps." (Parent 2, Father, Intervention group) (1.2.4) "Writing physical activity knowledge on posters aids understanding and self-reflection." (Child 1, Female, Intervention group) (1.2.5) "The handwritten newspaper activity was engaging and made exercise more interesting." (Child 9, Female, Intervention group)
	(1.3) Greater awareness of ways to engage in physical activity	(1.3.1) "We use suggestions from the materials during spare time or after work, both at home and outside, which are instructive." (Parent 4, Father, Intervention group) (1.3.2) "Parents initially unaware become able to guide children in physical activities after reading the materials." (Parent 6, Father, Intervention group)
	(1.4) Increased self-monitoring through pedometers	(1.4.1) "Having pedometers reminds me to exercise more." (Child 4, Female, Intervention group) (1.4.2) "The child enjoyed the pedometer and would go outside for exercise, even on reluctant days." (Parent 3, Mother, Intervention group) (1.4.3) "He checks his steps and goes for walks if insufficient, providing invisible supervision." (Parent 10, Mother, Intervention group) (1.4.4) "Children were motivated by step counting and competed with each other, enhancing participation." (Teacher, Female, Intervention group)
	(1.5) Sports equipment supports unstructured and intermittent physical activity	(1.5.1) "The pedometer and skipping rope encouraged daily exercise and motivated participation." (Child 3, Male, Intervention group) (1.5.2) "The equipment is convenient; if time allows, we'd enjoy using them at home as well." (Parent 8, Mother, Intervention group)
Theme 2: Appreciation of the intervention features	(2.1) Understanding of intervention materials	(2.1.1) "It's fine; the materials explained previously unknown information about body activity." (Child 1, Female, Intervention group) (2.1.2) "From my non-professional perspective, everything including examples is good." (Child 7, Father, Intervention group)
	(2.2) Satisfaction with venues	(2.2.1) "Face-to-face lectures are easier because I can ask questions anytime." (Child 1, Female, Intervention group) (2.2.2) "It's better not to use PE class time; use class meetings or reading time instead." (Child 4, Female, Intervention group) (2.2.3) "Online format is convenient; offline meetings are limited in time and frequency." (Parent 6, Father, Intervention group)
	(2.3) Researcher characteristics in delivering the intervention	(2.3.1) "The course is interesting due to friendly and vivid language." (Child 10, Female, Intervention group) (2.3.2) "Communication with the researcher is tacit." (Parent 2, Father, Intervention group)
	(2.4) Acceptability of group activity sessions' duration, frequency, and timing	(2.4.1) "The arrangement is appropriate; no need for changes." (Child 3, Male, Intervention group) (2.4.2) "Four classes are too many; two or three would be acceptable." (Child 1, Female, Intervention group) (2.4.3) "A slight increase is acceptable, but not too much." (Child 4, Female, Intervention group) (2.4.4) "The schedule is reasonable; parents often underestimate children's effort." (Parent 10, Mother, Intervention group) (2.4.5) "Twice per semester would be better." (Parent 5, Mother, Intervention group) (2.4.6) "One class is long; splitting it into two shorter sessions would help busy parents." (Parent 2, Father, Intervention group)
	(2.5) Social interaction and engagement	(2.5.1) "I want everyone to enjoy exercise and healthy growth together." (Child 5, Male, Intervention group) (2.5.2) "Many parents

		misunderstand physical activity; sessions help expand understanding." (Parent 7, Father, Intervention group)
Theme 3: Factors that facilitated or impeded intervention attendance and delivery	(3.1) Support from schools and education departments	(3.1.1) "The school and education department's support is crucial; relying only on parents is ineffective." (Parent 8, Mother, Intervention group)
	(3.2) Provision of electronic materials	(3.2.1) "Electronic versions are preferable; official accounts could push content regularly." (Parent 6, Father, Intervention group) (3.2.2) "Audio and video materials could help children understand exercise better." (Parent 9, Mother, Intervention group) (3.2.3) "Children can use technology to access videos and examples to learn about sports and health at home." (Teacher, Female, Intervention group)
	(3.3) More physical activity options	(3.3.1) "Exercise should include higher-intensity movements, not just skipping ropes." (Parent 6, Father, Intervention group)
	(3.4) More instruments for self-monitoring	(3.4.1) "Pedometers are helpful; other similar devices would be even better." (Parent 5, Mother, Intervention group) (3.4.2) "Providing daily measurable metrics, such as pulse devices, would let children observe changes and engage more." (Parent 7, Father, Intervention group)

Table 4. Experiences and perceptions of participating in the trial

Themes	Subthemes	Verbatim Quotes
Theme 4: Positive experiences and feelings gained through data collection process	(4.1) Comprehension of the translated Mandarin information sheets	(4.1.1) "It was very easy to understand." (Child 10, Female, Intervention group) (4.1.2) "No improvements needed; everything is clear and easy to follow." (Child 2, Female, Control group) (4.1.3) "All content is fine and simple to understand." (Parent 2, Father, Intervention group) (4.1.4) "Some parts are difficult due to our limited education; certain information is beyond our understanding." (Parent 9, Mother, Control group) (4.1.5) "Everything is very clear, including the informed consent and affiliations, which builds trust and willingness to cooperate." (Teacher, Female, Intervention group) (4.1.6) "It is easy to understand, even children can comprehend it." (Teacher, Female, Control group)
	(4.2) Feeling of "burden-free" completion of self-reported questionnaires	(4.2.1) "I felt no burden; everything was acceptable." (Child 3, Male, Intervention group) (4.2.2) "Easy to understand; nothing was difficult." (Child 6, Male, Control group)
	(4.3) Positive self-reflection from seven-day step measurement	(4.3.1) "It's great; I can track my progress and my PE score is improving." (Child 5, Male, Intervention group) (4.3.2) "Steps were fun to monitor with the pedometer while walking!" (Child 2, Female, Control group)
	(4.4) Anthropometric measurements encourage self-monitoring and positive emotional response	(4.4.1) "Measurements help me officially understand my weight and height, aiding self-awareness." (Child 1, Female, Intervention group) (4.4.2) "It was quite comfortable." (Child 1, Male, Control group)
	(4.5) Satisfaction with the organization of data collection	(4.5.1) "Very satisfied; measurements were quick, allowing me to return to class promptly." (Child 1, Female, Intervention group) (4.5.2) "The process was well organized." (Child 3, Female, Control group)
Theme 5: Satisfaction regarding the organization and	(5.1) Satisfaction with trial content, organization, and engagement	(5.1.1) "Most content was satisfactory; nothing was dissatisfying." (Child 2, Male, Intervention group) (5.1.2) "I am satisfied; school-organized events benefit students." (Child 1, Male, Control group) (5.1.3) "The child was excited to participate and share the small presents received; overall, it

implementation of the trial		was positive." (Parent 7, Mother, Intervention group) (5.1.4) "Everything is fine; no improvements needed." (Parent 7, Mother, Control group)
	(5.2) Meaningful and novel experience	(5.2.1) "It's a new teaching approach, valuable for both children and parents." (Parent 1, Mother, Intervention group) (5.2.2) "I hoped it would support the child's learning." (Parent 9, Mother, Control group) (5.2.3) "Participating was a positive experience for students, teachers, and parents, with educational and practical benefits, including sports health awareness and parental involvement." (Teacher, Female, Intervention group) (5.2.4) "The activity was meaningful: it allowed children to develop interest in sports, understand their health, and improve physical fitness." (Teacher, Female, Control group)
Theme 6: Influences of personal beliefs and emotional responses to the trial	(6.1) Personal motivation for physical activity	(6.1.1) "I like sports, running, and football; the pedometer helps me track my steps." (Child 5, Male, Control group) (6.1.2) "It's a good opportunity for exercise." (Child 1, Female, Intervention group) (6.1.3) "As a teacher, I enjoy participating in children's activities, even if I don't fully understand them; it has become a hobby." (Parent 7, Father, Intervention group) (6.1.4) "I was happy about the opportunity for children to engage in physical activity; it's rare." (Teacher, Female, Control group)
	(6.2) Curiosity about trial content	(6.2.1) "I participated out of curiosity and to improve my health through physical activity." (Child 5, Male, Intervention group) (6.2.2) "I joined because I had never experienced such activities before." (Child 10, Male, Control group) (6.2.3) "I was interested in learning about the study content." (Parent 9, Mother, Intervention group) (6.2.4) "We wanted to understand more about our child through the trial." (Parent 3, Mother, Control group)
	(6.3) Desire to increase knowledge of physical activity	(6.3.1) "I joined because children nowadays lack exercise; I wanted to learn about physical activity and child fitness." (Parent 1, Mother, Intervention group) (6.3.2) "We want our children to be healthy and understand how to improve their body through nutrition and exercise." (Parent 6, Father, Intervention group) (6.3.3) "For the child's education and growth." (Parent 10, Father, Control group) (6.3.4) "Children today lack awareness of active exercise; this trial helps improve their activity and reduce resistance." (Parent 2, Mother, Control group)
	(6.4) Perceived physical-activity-related benefits	(6.4.1) "I stayed home too much; I believe physical activity will make me healthier." (Child 1, Female, Intervention group) (6.4.2) "Exercise is beneficial; I wanted to try it." (Child 1, Male, Control group) (6.4.3) "We value our child's health; the study allows for exercise despite academic pressures." (Parent 4, Father, Intervention group) (6.4.4) "I am overweight and want my child to start exercising early." (Parent 8, Father, Control group) (6.4.5) "The principal supported the study; it promotes student health and participation." (Teacher, Female, Intervention group) (6.4.6) "As teachers, we should focus on physical development as well as academics." (Teacher, Female, Control group)
	(6.5) Use of vivid expressions and appealing advertising materials	(6.5.1) "Use engaging, slightly humorous language and illustrative posters to attract interest; text-only materials may cause boredom." (Child 10, Female, Intervention group)
Theme 7: Social influences on participatory decision-making	(7.1) Interpersonal influences by children and teachers	(7.1.1) "Introduced by the headteacher, followed by the child; we were excited to receive the invitation." (Parent 5, Mother, Intervention group) (7.1.2) "The teacher contacted and introduced me to the study." (Parent 4, Mother, Control group)
	(7.2) Preferred recruitment through the school context	(7.2.1) "School recruitment ensures personal information is safe." (Child 1, Female, Intervention group) (7.2.2) "I am satisfied." (Child 6, Male, Control group) (7.2.3) "Recruitment via school is convenient and

		acceptable to parents." (Parent 4, Father, Intervention group) (7.2.4) "I prefer not to risk non-school recruitment." (Parent 1, Mother, Control group) (7.2.5) "Recruitment through school provides formal guarantees for children." (Teacher, Female, Control group)
	(7.3) Influence of the school curriculum	(7.3.1) "If the school values this activity, parents will cooperate; coordination ensures smooth promotion." (Parent 4, Father, Intervention group)
Theme 8: Key barriers to consider regarding the recruitment of participants	(8.1) Academic pressure faced by children	(8.1.1) "Classmates may not participate due to study commitments." (Child 9, Female, Intervention group) (8.1.2) "Many find it useless, and heavy homework limits participation." (Parent 7, Father, Intervention group) (8.1.3) "Some students are slow with homework and may miss the interview." (Child 5, Male, Control group) (8.1.4) "Children face high homework pressure despite lacking exercise." (Parent 6, Mother, Control group)
	(8.2) Time constraints on parents	(8.2.1) "Parents have limited time to engage in activities and rely on children for information." (Parent 9, Mother, Intervention group) (8.2.2) "Evening calls are better due to daytime work commitments." (Parent 2, Mother, Control group)
	(8.3) Lack of emphasis on physical activity at parental, school, and education department levels	(8.3.1) "Some parents prioritize study over exercise, creating obstacles." (Child 5, Male, Intervention group) (8.3.2) "Parents follow the school's lead; attention from the education department is crucial for parental cooperation." (Parent 8, Mother, Intervention group)

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Topic 1: participants' and providers' experiences and perceptions of participating in the intervention

Theme 1: Perceived high efficacy of the intervention components in promoting children's physical activity

This theme examined whether participants and providers considered the intervention components effective in supporting children to be more physically active in daily life. Five subthemes highlighted the components that contributed to maintaining activity.

(1.1) Activity diary as a tool for reviewing behavior goals

Children valued the activity diary highly. All participants reported that it increased their awareness of physical activity and its benefits. Some noted that recording activity plans and steps reinforced motivation and encouraged continued engagement in physical activity **(Table 3)**, quotes 1.1.1–1.1.3).

(1.2) Group activity sessions reinforcing beliefs about physical activity

Both children and parents perceived that attending group sessions enhanced understanding of physical activity and encouraged greater participation. Several parents observed that their children became more active following these sessions **(Table 3)**, quotes 1.2.1–1.2.3). During the third session, a poster-making activity allowed children to reflect on the knowledge gained and reinforce their understanding through creative expression. Overall, children described this session as enjoyable and "stress-free," fostering intrinsic motivation for activity **(Table 3)**, quotes 1.2.4–1.2.5).

(1.3) Enhanced awareness of activity strategies

Parents frequently highlighted that examples and illustrations in the physical activity booklet were useful for guiding and supporting their children's participation **(Table 3)**, quotes 1.3.1–1.3.2).

(1.4) Self-monitoring through pedometers

Pedometers were well-received by children, who used them to track daily and weekly step counts, promoting motivation to increase activity **(Table 3)**, (quote 1.4.1). Parents and teachers noted that pedometers provided "invisible" supervision, helping children self-monitor while introducing a competitive element by comparing daily steps among peers **(Table 3)**, quotes 1.4.2–1.4.4).

(1.5) Positive effects of sports equipment on children's unstructured and intermittent physical activity

Both children and parents reported that having access to sports equipment encouraged children to engage in physical activity whenever they wished. They appreciated the ease of availability, allowing children to be active at their convenience **(Table 3)**, quotes 1.5.1–1.5.2).

Theme 2: Appreciation of the intervention features

Overall, children and parents considered the intervention acceptable, particularly valuing how it was organized and delivered, including materials, venues, and opportunities

for participation. Five subthemes emerged regarding perceptions of the intervention's acceptability.

(2.1) Comprehension of intervention materials (activity diary, physical activity booklet)

Children and parents felt that the written materials were clear, well-designed, informative, and easy to understand **(Table 3)**, quotes 2.1.1–2.1.2).

(2.2) Satisfaction with session venues

Most children reported high satisfaction with the venues, highlighting the convenience of holding sessions within the school setting. However, one child suggested scheduling sessions at different times rather than using health education periods. Being able to interact face-to-face with the study team was also appreciated. Parents mentioned that holding parental sessions online was advantageous, allowing flexible time management **(Table 3)**, quotes 2.2.1–2.2.3).

(2.3) Characteristics of the researcher delivering the intervention

Participants spoke positively about the researcher's personality and professionalism, describing them as motivating, supportive, and approachable. Communication during group activity sessions was reported as smooth and encouraging **(Table 3)**, quotes 2.3.1–2.3.2).

(2.4) Acceptability of session duration, frequency, and timing

Children generally considered the duration of the sessions appropriate. Opinions on frequency were mixed; some desired more sessions while others preferred fewer per semester **(Table 3)**, quotes 2.4.1–2.4.3). Parents similarly had varied views, with most finding the session frequency and duration suitable, though a few suggested shortening sessions or adding more throughout the semester **(Table 3)**, quotes 2.4.4–2.4.6).

(2.5) Social interaction and engagement

Several children and parents expressed interest in acting as future ambassadors for the intervention, wishing to share their experiences and knowledge from the group activities with peers and friends **(Table 3)**, quotes 2.5.1–2.5.2).

Theme 3: Factors facilitating or hindering intervention attendance and delivery

This theme explored participants' experiences to identify potential enablers and barriers affecting intervention participation and delivery. Four subthemes were highlighted.

(3.1) Support from schools and education departments

Participants positively evaluated the intervention's organization and diversity of components. However, parents emphasized that scaling the intervention would require collaboration and approval from schools and education authorities **(Table 3),** quote 3.1.1).

(3.2) Availability of electronic materials

One parent suggested that electronic versions of the materials might be easier to store and access than paper copies. Both parents and teachers discussed alternative formats, such as audio or video resources, or sharing via social media platforms **(Table 3),** quotes 3.2.1–3.2.3).

(3.3) Expanding physical activity options

While sports equipment was seen as helpful in promoting activity, one parent recommended including additional types of activities to cover a broader range of physical exercise options **(Table 3)**, quote 3.3.1).

(3.4) Additional self-monitoring tools

Parents acknowledged that pedometers were effective for children's self-monitoring of daily activity. They suggested the provision of more user-friendly devices to help children track their physical activity levels (**Table 3)**, (quotes 3.4.1–3.4.2).

Topic 2: participants' and providers' experiences and perceptions of participating in the trial

Theme 4: Positive experiences and feelings during the data collection process

Participants and providers generally demonstrated a clear understanding of the trial's objectives. They valued the information provided about children's physical activity and considered it useful for children to track their own activity levels. Five subthemes emerged regarding experiences and feelings associated with data collection.

(4.1) Comprehension of the Mandarin-translated information sheets

Participants and providers shared a broadly positive view regarding the information sheets. Most found the materials and explanations clear, informative, and easy to understand. One parent suggested that simplifying some sections could improve clarity. All teachers considered the sheets to provide sufficient details for participants to understand the study **(Table 4)**, (quotes 4.1.1–4.1.6).

(4.2) "Burden-free" completion of self-reported questionnaires

Children reported that the questionnaire items were easy to understand and helped expand their knowledge about different types of physical activity and ways to engage in them. Completing the self-report was described as

straightforward and low-burden **(Table 4)**, quotes 4.2.1–4.2.2).

(4.3) Reflection and self-feedback from seven-day step monitoring

Children spoke positively about measuring their steps over seven days using the pedometer. They found it engaging and motivating to observe their progress. The portability of the device was also appreciated **(Table 4)**, quotes 4.3.1–4.3.2).

(4.4) Anthropometric measurements as a tool for self-monitoring and positive emotional response

Children considered anthropometric assessments acceptable, reporting that it helped them understand their bodies better. No negative emotions or experiences were associated with these measurements **(Table 3)**, quotes 4.4.1–4.4.2).

(4.5) Satisfaction with the organization of data collection

Children described the data collection process as well-organized and enjoyable. Many highlighted its convenience and that it did not interfere with school schedules, contributing to a positive experience **(Table 4)**, quotes 4.5.1–4.5.2).

Theme 5: Satisfaction with trial organization and implementation

Two key subthemes were identified regarding participants' and providers' perceptions of the trial. Overall, participants highlighted enjoyment and satisfaction derived from the experience and social interactions.

(5.1) Content, organization, and engagement satisfaction

All children and parents reported a positive experience participating in the trial. Children emphasized enjoyment, while parents expressed motivation and encouragement from observing their children and interacting with them during the trial **(Table 4)**, quotes 5.1.1–5.1.4).

(5.2) Meaningful and novel experience

Parents and teachers agreed that participation offered a valuable and novel opportunity for children's development. They highlighted the trial as introducing a fresh approach to physical activity education for children, parents, and teachers. Teachers also felt it promoted children's interest in physical activity and enhanced their understanding of the subject **(Table 4)**, quotes 5.2.1–5.2.4).

Theme 6: Influence of personal beliefs and emotional responses on trial participation

Understanding the motivators for participation can inform future recruitment strategies for intervention trials. In general, participants and providers expressed enthusiasm for involvement. Five subthemes captured key facilitators for participation.

(6.1) Personal motivation to engage in physical activity

Children were pleased to be invited to participate and viewed the trial as an opportunity to increase their activity levels and gain insight into their physical activity patterns **(Table 4)**, (quotes 6.1.1–6.1.2). Parents and teachers noted that their encouragement stemmed from a lack of sufficient physical activity programs for children in China **(Table 4**), (quotes 6.1.3–6.1.4).

(6.2) Curiosity about the trial content

Some children and parents expressed strong interest in the trial content after enrollment, reporting excitement about engaging in physical activity as part of the study **(Table 4),** (quotes 6.2.1–6.2.4).

(6.3) Motivation to enhance knowledge about physical activity

Several parents noted that they felt encouraged to participate because it offered an opportunity to contribute to scientific understanding of children's physical activity and to receive guidance on supporting their children's fitness **(Table 4),** (quotes 6.3.1–6.3.2).

(6.4) Perceived benefits of physical activity

Children highlighted the health advantages of being active and described their motivation to join the trial as stemming from a desire to improve well-being. Parents suggested that physical activity participation could help reduce academic stress and promote better health for their children, while teachers viewed the trial as beneficial for children's overall personal development **(Table 4)**, quotes 6.4.1–6.4.6).

(6.5) Use of engaging language and appealing visuals

Some children suggested that recruitment and engagement could be enhanced by including lively expressions and cartoons in trial materials. They believed that combining text with illustrations would attract more children to participate in similar trials in the future **(Table 4)**, (quote 6.5.1).

Theme 7: Social influences on participation decisions

Decisions to participate were influenced not only by personal beliefs but also by social factors at the interpersonal and school levels. Three subthemes were identified regarding social influences on trial participation.

(7.1) Interpersonal influence from children and teachers

Following recruitment with the help of school headteachers, children shared trial information with their parents, and teachers also communicated details to

parents. Parents reported that teacher recommendations played a significant role in their decision to participate **(Table 4)**, quotes 7.1.1–7.1.2).

(7.2) Preference for school-based recruitment

Schools were identified as the most effective setting for reaching children and parents. This context provided a safe, formal way for obtaining parental consent, which encouraged participation **(Table 4)**, quotes 7.2.1–7.2.5).

(7.3) Influence of school curriculum on participation

Parents valued the inclusion of physical activity in the school curriculum and suggested that their children's participation would be more likely if schools prioritized structured physical activity programs **(Table 4)**, (quote 7.3.1).

Theme 8: Key barriers to participant recruitment

Although children and parents showed interest, several potential obstacles to future participation were identified, grouped into three subthemes.

(8.1) Academic workload of children

Given the emphasis on academic performance in China, both children and parents noted that heavy schoolwork could limit participation. Many children spend most of their free time completing assignments, presenting a barrier to recruitment in future trials **(Table 4)**, (quotes 8.1.1–8.1.4).

(8.2) Parents' time limitations

While parents recognized their role in supporting children's physical activity, lack of available time was a frequent reason for non-participation, suggesting future studies should consider accommodating parental schedules **(Table 4),** (quote 8.2.2).

(8.3) Low prioritization of physical activity at home, school, and the education system levels

A general lack of emphasis on children's physical activity was noted among parents, schools, and the education department. Children indicated that parents often prioritized academic success over physical activity, while parents recommended that schools and education authorities adopt a top-down approach to highlight the importance of activity for children **(Table 4)**, (quotes 8.3.1–8.3.2).

To the best of our knowledge, this study represents the first qualitative process evaluation of a school-based physical activity intervention in China. Using a standardized framework, the study explored the experiences and perceptions of both participants and providers regarding the intervention and feasibility trial. These insights can be directly applied to inform the design of the main cluster randomized controlled trial.

All elements of the intervention were well-received by children, their parents, and the health education teachers. Children valued the guidance provided on maintaining physical activity and enjoyed tracking their steps in the activity diary, which promoted engagement in physical activity and encouraged self-monitoring of daily step counts [33]. Similarly, previous studies have emphasized the significance and positive effects of supplying physical activity–related educational resources for children in intervention programs [9, 10, 33, 38]. In our study, the poster-making sessions were perceived as beneficial because they offered children opportunities to reflect on their understanding of physical activity while stimulating interest and enjoyment [10]. This aligns with literature reporting that engaging, playful activities within interventions enhance children's enjoyment and motivation to participate in physical activity [9, 10]. Children's personal interests, positive attitudes, and enjoyment derived from the poster-making sessions further reinforced their willingness to be physically active [39].

Parents particularly valued the group activity sessions as an opportunity to learn how children could engage in physical activity effectively and how to support their child's active behaviors. Previous research has highlighted the role of group activities in promoting social support networks among parents and fostering parental involvement in children's physical activity [10, 33]. These findings underscore the need for multicomponent interventions to provide resources that engage families [40]. Strategies such as environmental restructuring, goal-setting, and self-monitoring have been recognized in systematic reviews as effective behavior change techniques for motivating children to participate in physical activity [41, 42]. Furthermore, parents in our study expressed interest in more objective tools (e.g., pedometers, tracking devices) that deliver immediate feedback on children's activity levels to support goal attainment. This supports prior research suggesting that wearable activity tools may reduce participant drop-out [23, 30] and aligns with studies recommending the use of wearable technology (e.g., wrist trackers) for physical activity monitoring to meet technological expectations of children and parents [38].

These qualitative insights indicate that the intervention increased the frequency of children's physical activity, potentially raising their overall daily activity levels. This

may suggest a dose-response effect, where higher engagement in the intervention is linked to higher physical activity, though further evaluation in a full-scale trial is required. Future research should also examine the relationship between children's intervention engagement, physical activity, and academic performance [43].

Our findings revealed that participants and providers appreciated both the written materials (activity diary, physical activity booklet) and verbal instructions (communication among the study team, parents, and teachers). Parents and teachers suggested that providing materials digitally, potentially with videos, website links, or official accounts for self-directed exploration, could be more effective. These suggestions align with evidence supporting the use of digital technologies to deliver health information, enhance participant knowledge, improve communication, and facilitate behavior change [38, 44]. The inclusion of mobile and social elements in interventions has been increasingly used in physical activity promotion literature to enhance outcomes [45-47].

Regarding the structure of group activity sessions (venues, timing, frequency), participant opinions were mixed. Similar observations have been reported in other physical activity studies incorporating education components, where some participants found session duration and timing acceptable, while others did not [9, 33]. Specifically, some parents suggested shorter, more frequent sessions to improve engagement. This reflects findings from our previous intervention development work, where parental time constraints due to work commitments limited participation and support during group activities [23, 30]. Collectively, these results highlight the practical challenges of organizing and delivering group activity sessions for both children and parents.

Overall, both participants and providers regarded their involvement in the trial as meaningful and rewarding. In this study, a participatory recruitment approach was adopted, engaging health education teachers to facilitate trial promotion within schools for children and their parents. Despite challenges posed by the COVID-19 pandemic, findings suggested that recruitment through teachers was preferred, as it provided a sense of safety and formality in the school context. However, our results differ from previous family-focused physical activity interventions, which reported difficulties in recruiting families within pre-set timeframes [48, 49]. For instance, a systematic review and Delphi survey examining efficient strategies for recruiting families into health-promoting interventions identified 49 eligible studies, of which only 33% (n = 16) achieved their target sample size [49]. Among these 16 studies, just 62% recruited sufficient participants, and a subsequent Delphi survey involving 107 experts revealed that only 38% met their recruitment target within a median of 12 weeks. In 33% of the studies, recruitment periods were extended, with a median extension of 20 weeks [49]. This underscores the role of contextual factors in improving recruitment outcomes. Our findings indicate that schools are effective sites for recruiting children and parents in China [50], though this may not generalize to other regions due to cultural and contextual differences.

Although recruitment rates in our study were high, future strategies could be strengthened by incorporating engaging visuals and clear, child-friendly language to enhance participation. Participants are more likely to engage if the study team effectively communicates the importance of physical activity and explains the research procedures and intervention content [22, 23]. Feedback from participants also suggests that gaining support from schools and health education authorities, and promoting the value of physical activity within schools, is necessary to ensure successful implementation of a future cluster RCT [10]. Regarding data collection, our methods were well-received by children, reflected in the high response and completion rates observed in our trial [28]. Only one parent reported difficulty in understanding study materials; this could be mitigated in future studies by allowing face-to-face discussions about trial procedures, which were limited due to COVID-19 restrictions. Expanding recruitment materials to include both in-person and written formats may further optimize participation rates and satisfaction in future cluster RCTs.

Strengths and limitations

We acknowledge that researchers' preconceptions may have influenced data collection and interpretation. Nevertheless, the involvement of a multidisciplinary team (specialists in physical activity, behavior change, health psychology, and sociology) in designing, conducting, and analyzing the study enhances the credibility of our findings. The qualitative thematic analysis yielded rich, in-depth data on the experiences and perceptions of children, parents, and teachers. Reflexivity was maintained throughout data collection and analysis to minimize potential biases. Participation

was voluntary, so the sample may have included families with more positive perceptions of the intervention, potentially leading to over-reporting of favorable experiences. Although external transcription and member-checking were employed, minor inaccuracies in transcripts may remain undetected. The interview guides included reminders that there were no right or wrong answers, helping to capture a broad range of experiences. Limitations include the geographic specificity of the sample and the employment status of parents; future studies should examine engagement in more diverse populations, including lower-income families, children of varying ages, and those from rural areas. While this study did not assess long-term outcomes, key indicators of acceptability and short-term intervention success were identified, supporting future evaluation and implementation phases in line with the MRC framework for complex interventions.

Conclusion

A cost-effectiveness analysis conducted across four non-The intervention and trial procedures were acceptable to children, parents, and health education teachers. School-based behavior change programs were viewed as an effective strategy to increase physical activity among children aged 10–12 years in China. Participants noted increased frequency of children's activity as a result of the intervention, which could contribute to meeting the recommended 60 minutes of MVPA per day. Nevertheless, potential barriers to intervention delivery and engagement should be addressed when designing a future cluster RCT to evaluate the intervention's effectiveness.

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