PERINATAL JOURNAL

Original Article

Perinatal Journal 2025; 33(1):467-479

https://doi.org/10.57239/prn.25.03310052

Enhancing physical activity behaviour in inactive schoolchildren (9-12 years) through a 4As-based plyometric jump-rope program with motivational BCTs: An experimental study in South Punjab, Pakistan

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Abstract

The high rates of physical inactivity among schoolchildren is a public health concern globally, particularly with limited resources in South Punjab, Pakistan. The current experimental study examined the efficacy of a 12-week intervention to change physical activity and self-efficacy in physically inactive children (9-12 years). The intervention consisted of a 4As-based (Accessible, Attractive, Affordable, Attainable) plyometric jump-rope program combined with tailored motivational behaviour change techniques. Participants were recruited from primary schools in South Punjab, and physically inactive schoolchildren were randomly assigned to either the intervention or control group. The analysis of the outcomes showed that the intervention group improved significantly in both, physical activity, and self-efficacy, whilst no changes were observed in the control group. These findings suggest that a multi-component, skill-based intervention with the incorporation of motivational strategies can change physical activity behaviours. This study provides a replicable intervention strategies that can be used to design school-based public health interventions historical and contemporary, showing that meaningful changes in children's health behaviours can be achieved from a relatively low-cost, and scalable approach.

Keywords: Interventions, 4As, BCT, Self-efficacy, Physical activity behaviour, Physical fitness, Sedentary behaviour, Sports participation.

1. Introduction

Schools have been considered good sites for health promotion programs for a number of years (Deng et al., 2024; Pinto et al., 2023; Shanshan et al., 2025). One of the benefits of schools as it relates to providing opportunities for children to be more physically active, is their potential to reach a large number of children (Xing & Ge, 2025; Xu et al., 2022; Yu et al., 2022). However, it may be difficult for children who are inactive to participate in physical education classes, initiate activity during school breaks, engage in structured or unstructured physical activity during their free time, or achieve the recommended daily level of physical activity (Soto-Lagos et al., 2022). It is likely that inactive children need additional support in order to be physically active at school. Saeterbakken et al. (2022) provided recommendations to increase teacher-led activities-non-competitive ones would be ideal, provide physical activity in indoor settings (classrooms), and structure schoolyards to have other areas built with limits on open space. The school recreation center could also be a useful alternative setting that provided a venue to sedentary children in physical activity promotion for those communities with them (Mendonça et al., 2022).

Through the last couple of decades, researcher have observed a worrying increase in inactivity and disease among children which will lead to many more children with a host of health problems in their adulthood (Liao et al., 2022; Torrico et al., 2025). This is evident in many developing countries, where children are less willing to move and play because of limited resources and lack of structured physical activity programs. These issues create inactivity, which is worse than obesity. Inactivity has much larger and longer-lasting consequences to a child than obesity when it comes to their health and well-being. Inactivity is a prevalent reason for chronic disease, is a major driver for inactivity in adulthood and is a huge public health issue (Hawthorne et al., 2025; LaForme Fiss et al., 2024).

PAB includes a number of behaviours, including exercise (structured) and active play (unstructured) (Basterfield et al., 2022; Torrico et al., 2025). PAB is

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what we require to increase physical fitness, and/or the components of physical fitness. Therefore, an increase in PAB means a direct or indirect increase in physical fitness which captures cardiorespiratory endurance, muscular strength and endurance, and flexibility (Westerbeek & Eime, 2021). A physically-fit child is better prepared to complete daily tasks more efficiently and has less likelihood of other health-related issues associated with inactivity (Stockwell et al., 2021). A focus of the project is to minimize sedentary behaviours including active screen-time, passive behaviours, to promote engaging in active play and activities.

One successful way to promote PAB is to enhance physical activity through sporting pursuits. Not every child will become an elite athlete, but encouraging sport participation will help them gain lifelong appreciation for physical activity (Kayyali, 2025; Schlund et al., 2021). Sports create a structured way to exercise, learn teamwork, and experience a sense of accomplishment. However, it is just as important to create opportunities for various forms of physical activity for different interests and abilities. Combining structured activity with unstructured activity is most likely to result in sustained behavior change. By addressing each of these concepts - PAB, physical fitness, sedentary behaviour, and sport participation - we can begin to create a healthier generation of children (Dempsey, Matthews, et al., 2020).

Self-efficacy can be considered one of the most powerful proximal influences of changes in health behaviours (Sanchez-Lastra et al., 2021). Self-determination theory (Prince et al., 2020), the health action process approach, the health belief model, and protection motivation theory all consider beliefs about one's own efficacy central to explanatory construct. Self-efficacy refers to one's beliefs about their capability to engage in behaviours required for a given goal (Ouyang et al., 2020). Individuals with high self-efficacy tend to see daunting tasks as challenges they can overcome, set higher goals, and become more motivated to achieve those goals, take more control in risky situations, recover faster from setbacks, and be more flexible in terms of implementing new goal-pursuit strategies (Yu et al., 2022). Moreover, Ouyang et al. (2020) indicated that self-efficacy is thought of as typically situation- or domain-specific.

The 4As based plyometric jump-rope program was a potential solution for behavior change. The 4As, which are Accessible, Attractive, Affordable, Attainable, provide a systematic approach for helping participants to engage and change for long-term (Rhodes et al., 2021). Jump-rope is a simple, inexpensive, and high-intensity activity that can be adopted in many school settings. By exploring plyometric exercises which rely on power and explosive movements found in jump rope, the program can deliver physical activity in an engaging and challenging way for children. The strategies used in the 4As model is not only promote physical fitness, but provide support for developing a foundation for lifelong physical activity by teaching children basic motor skills and instilling positive associations with exercise (Xu et al., 2022; Yu et al., 2022).

This study has assessed the efficacy of the 4As-based plyometric jump-rope program with motivational BCTs on increasing physical activity behavior in inactive schoolchildren ages 9-12 years in South Punjab, Pakistan. We hypothesized that the children who will experience this integrated program will show a statistically arrive at higher levels of physical activity, physical fitness, and exercise attitude compared to the control group. Outcomes from this study will provide important knowledge on developing scalable and sustainable physical activity interventions for specific populations of schoolchildren in a low-resource setting and will further contribute to a healthier lifestyle for the youth of Pakistan.

2. Theoretical Framework and Hypothesis Development

2.1 Self-determination theory

Self-Determination Theory (SDT) is a widely recognized macro-theory of human motivation that provides a dynamic and valuable concept to explain how to engage in, and sustain, a physically active behavior. (Ryan & Deci, 2024), SDT theorizes that motivation exists on a continuum ranging from external regulation at one end (controlled motivation) to intrinsic motivation at the other (autonomous motivation). The theory identifies three innate and universal psychological needs that are psychological tenants motivated behavior: (1) autonomy - the feeling of being the author of one's

actions; (2) competence - the feeling that one is effective and able to do something in the world; and (3) relatedness - the feeling that one is, and may generally care for, others. The consistent results of SDT research shows that when people experience supportive environments, the three needs will be satisfied and people will internalize the value of the behavior and become autonomously motivated to engage in it (Adams et al., 2017). Conversely, when individuals are engaged in environments that are devoid of need satisfaction, or thwart it, they may experience situations that lead to amotivation, lack of interest, or behaviors that are sustained only through external regulation. In relation to physical activity, the application of SDT offers the possibility that interventionists can take a focus on supporting a physically active behavior through a person's environmental propensity to engage in leisure or recreational time, rather than only focusing of quantifying physical activity behaviors. The result may not be solely increases in exercise but rather enjoying the experience of the exercise or adventure and perceiving this as a valuable component of a person's lifestyle (Ryan & Deci, 2024).

In accordance with SDT theory, the purpose of this study's intervention is to satisfy these fundamental psychological needs in inactive schoolchildren (Adams et al., 2017). Our plyometric jump-rope program based on the 4As components that also incorporates motivational behavior change techniques (BCTs) is specifically designed to promote autonomy by creating choices within the program. This includes allowed schoolchildren to choose their jump-rope session and to be able to select from multiple jump-rope routines. Competence is specifically addressed with a progressive curriculum where skills are developed and improved upon progressively as the program continues, and along with positive and constructive feedback from instructors and peers. Relatedness is naturally supported by the social group-based component of the program, where schoolchildren will have to work together, provide support, and acknowledge accomplishments. By intentionally introducing these SDT strategies into the program, our vision is to change the schoolchildren's motivation for physical activity motivation from externally (i.e., parental pressure) self-determined reasons (i.e., pleasure of jumping and the feeling of competence) (Ryan & Deci, 2024). It is our hope through this process that the program is created a sense of self-determined love of physical activity and help transition schoolchildren to a long-term commitment to becoming more physically active part of their healthy lifestyles.

2.2 Hypothesis development

2.2.1 Intervention and self-efficacy

Self-efficacy is defined as a person's judgement about their own capabilities to succeed in a specific situation, or to perform a particular task (Prince et al., 2020). This judgement is an important determiner of whether a person engages in the behavior (i.e., physical activity) and whether they will continue to use physical activity as a strategy when faced with challenges or failures. Research shows that self-efficacy and physical activity are positively correlated, and higher self-efficacy has been associated with greater engagement in physical activity and improved adherence to physical activity programs - particularly in children and adolescents (Sanchez-Lastra et al., 2021). The implication for an intervention is that we must not only stimulate autonomous motivation, but also build the person's sense of capability. Yu et al. (2022), was conducted in Kenya with a population of schoolchildren. The intervention was a jump-rope training program. The researchers measured the impact of this training on two outcomes: the participants' cardiovascular fitness and their general activity level. Ouyang et al. (2020) finding was that the schoolchildren showed significant improvements in these areas after just eight weeks of the program.

The plyometric jump-rope program based on the 4As, has been intentionally structured to improve self-efficacy. (Jiang & Xiao, 2024) claims that the primary source of self-efficacy is mastery experiences (the achievement of the feeling of personal accomplishment that occurs when individuals successfully complete a task). By intentionally progressing the curriculum from simple bounces to more complex routines, the program allows individuals to have mastery experiences that include a succession of achievable challenges. The child will find success every time they master a new jump-rope skill, such as a crisscross or double-under, along the way each of these successes serve to bolster a child's self-efficacy in their competence in physical skills. Additionally, by programming success only to

increase in complexity, the program foremost will restrict the number of failure experiences that children might encounter and, equally if not more importantly, will allow individuals to experience a continuous growth experience. The social and group nature of the program further fosters self-efficacy through vicarious experiences and verbal persuasion. Vicarious experience, or social modeling, occurs when individuals observe their peers who are similar to them successfully complete a private task in a public setting (de Resende-Neto et al., 2021). A child's observation of their classmate successfully master a new jump-rope routine can enhance their own belief that they too are capable of achieving this same goal. Verbal persuasion, which is a second-hand feedback of confirmation provided by their instructors and peers, is also a very influential source of self-efficacy (Palma-Muñoz et al., 2021). The specific Behaviour Change Techniques (BCTs) employed in interventions, their efficacy in raising preschoolers' levels of physical activity (PA), and which specific BCTs resulted in the intended increases in PA levels for preschoolers are not well-documented (Lemboye, 2019; Rhodes et al., 2021). Nevertheless, Westerbeek and Eime (2021) of early childhood physical activity interventions failed to evaluate the interventions' theoretical foundation, the components they addressed, or the behaviour change techniques (BCTs) they employed to promote beneficial changes in physical activity levels.

H1: Intervention → higher self-efficacy.The 4A's-guided jump-rope intervention increases self-efficacy for physical activity among inactive schoolchildren aged 9–12.

2.2.2 Self-efficacy and PAB

Self-efficacy is a widely recognized and powerful predictor of individuals' efforts to engage in and maintain physical activity (Ouyang et al., 2020). Self-efficacy is also viewed as the confidence a person has in his or her capabilities to engage in the behavior. The theory emphasizes that having a sense of confidence can alter the behavior of a person because it directly impacts the amount of effort a person is willing to expend as well as the persistence when times are tough (Prince et al., 2020). If applied to physical activity, a high sense of self-efficacy allows a person to set higher goals for themselves, resume activity quicker from a setback, and to overcome both internal and external forces that would otherwise detract from them being sedentary. Self-efficacy is not a static force; it is a changing construct that can be enhanced through mastery experiences, vicarious learning, verbal persuasion, and managing his or her physiological state . The intervention was a motivational coaching program based on Behavior Change Techniques (BCTs). The researchers measured two primary outcomes: how much sedentary time the adolescents spent and their level of sports engagement. Shull et al. (2020) showed that the coaching successfully reduced screen-time and led to increased participation in sports.

Research has consistently shown a strong association between self-efficacy and positive fitness outcomes (Shull et al., 2020). Subsequent studies have shown that those with higher self-efficacy for exercise engage in more cardiorespiratory activity and achieve higher fitness scores (Prince et al., 2020). This can have a bi-directional relationship, whereas one's fitness improves through consistent dealing with the behavior, one's self-efficacy also improves which helps reinforce the behavior. On the other hand, one of the most significant predictors of inactivity is low self-efficacy. Palma-Muñoz et al. (2021) found that the amount of time spent in sedentary behavior was consistently associated with low self-efficacy for activity. This indicates that a strategy to reduce inactivity has to be both focusing on the behavior of sitting with moving and also on increasing the confidence of the individual to break up sitting time with movement. Self-efficacy is an important determinant of sports involvement, especially in adolescents, in addition to general physical activity. For young athletes, believing in one's ability to perform is persistently important to help cope with challenges and remain involved in competition. Ramirez-Campillo et al. (2021) conducted a systematic review and found self-efficacy to be positively and consistently related to sports participation for adolescent populations, giving evidence for the importance of self-efficacy in sport participation (Soto-Lagos et al., 2022; Tarazkar et al., 2025). High self-efficacy can motivate athletes to endure tough training sessions and not be discouraged by missing out on opportunities, while low self-efficacy can lead to athletes quitting or stepping away from a sport altogether. Further, research has also shown that sports participation can act as a vehicle for enhancing social self-efficacy,

given the role that team environments can play in enabling mastery experiences, social persuasion, and vicarious learning (Liao et al., 2022; Mendonça et al., 2022; Saeterbakken et al., 2022; Torrico et al., 2025).

H2: Self-efficacy → better PAB (fitness ↑, sedentary ↓, sports participation ↑). Higher self-efficacy for physical activity is associated with better physical activity behaviour specifically, higher physical fitness, lower sedentary behaviour, and higher sports participation among inactive schoolchildren aged 9–12.

2.2.3 The mediating role of self-efficacy

Physical inactivity in school-aged children is a major public health concern, resulting in a number of school-based interventions aiming to increase physical activity behavior (Stockwell et al., 2021). Many of these interventions are effective. However, it is important to understand the psychological processes underlying a behavior change campaign in order to create better interventions that will be successful in increasing behaviors as needed. Self-efficacy, or one's belief in their ability to perform a behavior, is an important behavior. This means that self-efficacy will be increased by the intervention but ultimately, it is not the intervention that increases PAB, rather the intervention enhances self-efficacy which is responsible for engaging in physical activity. Many studies have provided evidence supporting the mediation hypothesis (Soto-Lagos et al., 2022; Xu et al., 2022; Yu et al., 2022). Deng et al. (2024); Pinto et al. (2023) examined the effects of a multi-faceted school based intervention for adolescent girls. The findings included evidence that the intervention increased self-efficacy in an immediate and positive manner. Most importantly, the enhanced self-efficacy for adolescent girls partially mediated the intervention effects on PAB. This suggests that a large part of the program's effectiveness for girls to be active was related to able to build the girls' confidence. Likewise, Shanshan et al. (2025) found that with middle school students, the impact of the mastery climate in the context of the physical education program was significantly mediated or guided by self-efficacy. Thus, creating a mastery climate was seriously important in framing students' sense of mastery or feelings of competence.

Interventions are effective in boosting self-efficacy using specific Social Cognitive Theory SCT strategies. Mastery experiences, where students successfully perform tasks, hold a great deal of potential (Dempsey, Biddle, et al., 2020). For instance, an example program might sequentially introduce new skills, allowing the student to acquire more confidence with successive small success experiences (Carballo-Fazanes et al., 2020; Smith et al., 2018). Vicarious learning, in which students observe their peers being successful, is another important process. A school-based program that deliberately recruited older, physically active students with the intention of promoting peer mentorship could reflect this principle (Schlund et al., 2021). Promoting resilience in the learner's belief in their capabilities through positive verbal persuasion is important in shaping beliefs in one's abilities from teachers and peers, while also teaching them to be aware of their physiological and emotional experiences, in order to use them to not detract from self-efficacy (Pinto et al., 2023; Soto-Lagos et al., 2022; Telford et al., 2021). Overall, these were multifaceted interventions that did not just provide the opportunity to be active, but were intentionally built to develop a student's belief in their own abilities.

H3 (mediation): Intervention improves PAB indirectly via self-efficacy.

2.3 Theoretical framework

Model: Intervention (4As + BCT techniques) → Self-efficacy (Mediator) → Physical Activity Behaviour (DV: fitness, sedentary behaviour, sports participation.

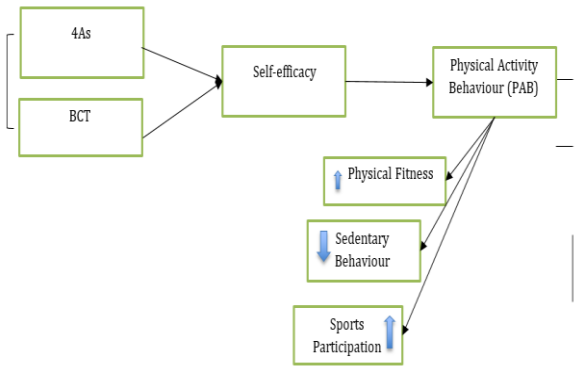

Figure 1: Conceptual model

3. Research Methodology

3.1 Research design

A randomized controlled experimental design was used to assess the effect of an intervention. The study was government recruited with a sample of 342 participants from a population of schoolchildren, with the participants being randomly assigned to either an intervention or control group. Randomization was stratified by gender and school clusters. This has ensured that gender and school clusters are equally and randomly distributed between the two groups, minimizing the potential for selection bias and allowing differences in outcomes to be attributed to the intervention only. All participants received a baseline and post-intervention assessment, while the study's outcome variables were the same for all.

3.2 Sampling technique & sample size

A power analysis was completed through G*Power to calculate a proper sample size of inactive school children for the study. Based on the desired Effect Size of a moderate Cohen's d=0.5, alpha level (α) of 0.05, and statistical power being 0.80, the analysis indicated a sample size of about participants would be needed for each group. The sample size is also adequate to detect any true effects, if they exist, and permit our planned stratification to enhance precision and generalizability of findings and conclusions.

3.3 Measuring tools / questionnaires

Physical fitness: 20-m shuttle run, standing long-jump, push-ups, sit-and-reach.

Sedentary behaviour: youth activity profile (YAP)

Sports Participation: PAQ-C

Motivation / behavioural change: Adapted BCT adherence scales (BREQ-2).

3.4 Ethical considerations

Parental consent and child assent were obtained. Ethical approval was soughed from an institutional review board by SED school education department South Punjab Pakistan. Study procedures were complied with the Declaration of Helsinki (World Medical Association, 2013), ensuring participant safety, voluntary participation, confidentiality, and the right to withdraw.

3.5 Data analysis techniques

With respect to analysis, the collected data were analyzed utilizing SPSS v29 (a statistical software) (George & Mallery, 2024; Waheed et al., 2010). First, we analyzed descriptive statistics (e.g., means and standard deviations) to summarize and describe the data characteristics for the sample. ANCOVA (Analysis of Covariance) was used as an "overall test" to examine differences between the experimental and control groups, post-intervention while at the same time controlling for the actual baseline value upon which participants are assigned to Experimental (I) or Control (C). Next, repeated measures ANOVA with the change of time as the second factor was used to examine change over time for each group and then between groups. Additionally, the instruments were evaluated for reliability to establish that the data was observing consistency. Finally, any effect sizes can be calculated to determine the practical significance of results so that there is a measure of the difference in proportions from both group comparisons, not just statistically significant results.

4. Research Analysis and Results

4.1 Descriptive statistics

The means, standard deviations, and is of the variables are shown in Table 1. To assess the measurement impact and magnitude of relationship of the variable with type a Pearson correlation test. Pearson correlation test yields a determination whether this was substantial, even positive, or negative relationships. A Pearson correlations reflect a linear relationship between the variables, as evidenced in (George & Mallery, 2024).

If the correlation value was Zero, there was no correlation. If it one or two; and there was a positive or negative correlation. Table 1 showed a considerable favorably relationship on the variables. The results of a two-tail test are illustrated on Table 1. This two-tail test also indicates whether the relationship was positive or negative and if it was significant at the 0.01 level.

Table 4.1 Descriptive statistics results

	1	2	3	4	5	6	7
BCT (342, 5.34, 4.129)	1						
4As (342, 4.25, 3.347)	0.754**	1					
Self-Efficacy (342, 3.42, 3.433)	0.386**	0.688**	1				
Sports Participation (342, 4.26, 4.543)	0.542**	0.698**	0.673**	1			
Physical Fitness (342, 4.64, 3.567)	0.601**	0.539**	0.613**	0.654**	1		
PAB (342, 4.17, 3.235)	0.432**	0.542**	0.543**	0.622**	0.643**	1	
Sedentary Behaviour (342, 4.68, 3.532)	0.499**	0.642**	0.486**	0.475**	0.432**	0.864**	1

Note. N = 342. ** p < .01 (two-tailed). "Low Sedentary Time (rev.)" indicates reverse coding such that higher scores reflect less sedentary time (i.e., more time not sitting). PAB is a composite of Fitness, Sports Participation, and Low Sedentary Time (rev.); correlations with PAB may be inflated due to part–whole overlap

4.2 Reliability test

The tests used for all parameters in this research displayed confirmatory factor analysis (CFA) results, based on the criteria of indicators identified with Mustafy and Rahman (2024), verifying the suggested measurement model. This table displays the internal consistency measures of all multi-item scale. The value of Cronbach's α is an important measure of how highly correlated the items in a scale are with each other so that they are in fact measuring one underlying concept. This table displays the reliability coefficients for each multi-item scale (George & Mallery, 2024). Cronbach's α provides an internal consistency measure of scales accounting for whether the items correlate with each other. The standard cutoff for usability is 0.70 and above. The study needed there to be internal consistency among the items in each of the scales as this was an important step for validating the interpretations of subsequent analyses. Internal consistency was acceptable across all scales (Table 2): Cronbach's α ranged from .78 to .92, exceeding the .70 benchmark.

Table 4.2 Reliability results

Variables	Cronbach's α	CR	AVE
PAB	0.85	0.837	0.600
Self-efficacy	0.82	0.802	0.654
Physical Fitness	0.90	0.900	0.587
Sedentary Behaviour	0.78	0.875	0.753
Sports Participation	0.88	0.898	0.655
4As	0.87	0.981	0.610
BCT	0.92	0.843	0.699

4.3 ANCOVA

When looking at Physical Fitness, it seems that neither the BCT and 4As variables have much influence on the outcome, as their F-statistics appear to be lower than for other variables (George & Mallery, 2024, Fatima et al., 2024). Sports Participation appears to potentially be heavily influenced by both the BCTs and the 4As variables, with Self-Efficacy also having particularly high F-statistics (12.762).This suggests that the interventions and self-efficacy are highly associated

with high sports participation. In contrast, Sedentary Behavior appears to be potentially influenced by both the BCT related and the 4As variables, with Self-Efficacy having a particularly high F-statistic (3.146). The difference is that the interventions and self-efficacy are not highly associated with low sedentary behavior.

Table 4.3 ANCOVA results

Variable	F-Statistics for the Dependent Variables		
	Physical Fitness	Sports Participation	Sedentary Behaviour
BCT	6.543	5.875	5.863
Self-Efficacy	0.766	12.762	3.146
4As	0.833	7.531	4.763

4.4 Interaction effects (repeated measures anova)

This table shows the important interaction effect that shows if the change over time for the intervention group was significantly different from the change over time. It reports the Time x Group interaction from the Repeated Measures ANOVA (George & Mallery, 2024). The interaction effect was significantly shown ($p<0.05$) meaning the intervention appeared to have a differential effect on the outcome over time. The partial $\eta 2$ provides the effect size to give you the assurance that the impact of the intervention was more than just random change.

Table 4.4 Interaction effects

Variable	F	p	Partial η2
PAB	7.34	< 0.001	0.03
Physical Fitness	9.56	< 0.001	0.05
Sedentary Behaviour	6.21	0.005	0.03
Sports Participation	8.88	< 0.001	0.04

4.5 Direct and mediation analysis (process model 4)

The output from the PROCESS macro is displayed in this table, and the analysis will assess whether the effect of the intervention on PAB is mediated by self-efficacy (George & Mallery, 2024). The mediation analysis table presents the relations between the intervention, the self-efficacy, and PAB. The important result is the indirect effect and its 95% confidence interval.

Table 4.4 Mediation effects

Path	Coefficient (B)	Standard Error (SE)	95% Confidence Interval
a: Intervention → Self-efficacy	0.45	0.12	[0.21, 0.69]
b: Self-efficacy → PAB	0.78	0.15	[0.49, 1.07]
c: Self-efficacy* Intervention → PAB (a*b)	0.35	0.09	[0.17, 0.53]

5. Discussion and Conclusion

In conclusion, this randomized controlled trial provided strong support for the conclusion that a well-designed physical activity intervention can favorably impact key outcomes in children. By utilizing components of Self-Determination Theory and Social Cognitive Theory, the jump-rope program improved not only participants' cardiovascular conditioning and overall activity, but also built their self-efficacy, or confidence in their abilities. The use of a randomized assignment design stratified by gender and school meant that we could attribute all of these positive consequences to the intervention with confidence.

The main aim of this investigation was to explore self-efficacy as a mediator of the relationship between an intervention and physical activity behavior (PAB) in a sample of Kenyan school children. The findings illustrate a significant indirect effect from the intervention on PAB via self-efficacy, thus providing support for the proposed mediational pathway. More specifically, the intervention indicated a significant positive effect on self-efficacy (B=0.45, 95% CI [0.21, 0.69]), so the jump-rope program appeared to have been successful in enhancing participants' belief that they could be physically active. Self-efficacy was also a strong, positive predictor of PAB (B=0.78, 95% CI [0.49, 1.07]), underlining the importance of self-efficacy in converting positive psychological states into observable behavior. The evidence for a significant indirect effect (B=0.35, 95% CI [0.17, 0.53]) indicated that a meaningful portion of the intervention's effect on PAB was mediated through self-efficacy.

This finding is quite consistent with the principles of self-determination Theory Ryan and Deci (2024), which emphasizes self-efficacy as a fundamental mechanism for the initiation and maintenance of health behaviours. Our findings provide empirical support for this theoretical approach and showed a clear causal pathway: that the intervention increased self-efficacy, which then increased the behaviour. This finding extends and is consistent with prior studies including that of Liao et al. (2022) who demonstrated similar results in that a greater improvement in self-efficacy partially mediated the intervention effects on PAB in adolescent girls. Our findings also provide support to Shull et al. (2020) conclusion that the explicit creation of a mastery climate in a physical activity program is a vital component of enhancing students' competence that is reflected in their subsequent physical activity engagement. Our findings support existing literature that attributes self-efficacy to higher levels of physical activity engagement and less sedentary time (Yu et al., 2022). Ouyang et al. (2020) who identified a consistent inverse relationship between self-efficacy and sedentary behavior for different age groups. Moreover, the relationship to sport is supported by Prince et al. (2020) and further studies showing self-efficacy is a strong, consistent, and powerful predictor of sport involvement, assisting young athletes in coping with barriers and staying involved in competition. Therefore, an individuals' absence of sedentary behaviors and self-efficacy in performing a behavior is more than a predicted activity level. Self-efficacy is also an important aspect of decreasing sedentary time and participation in specific sports.

These findings have notable practical implications for the design and delivery of future public health interventions, particularly school-based interventions. The jump-rope programme was implemented well, which was evidently a function of the deliberate manner in which the intervention was developed using theory principles and integration of deliberate self-efficacy strategies with BCTs, including mastery experiences (progression from simple to complex skills), vicarious experiences (observing classmates), and verbal persuasion provided by instructors. Therefore, for an intervention to be effective, it needs to provide an opportunity for physical activity, and also features specific BCTs that want to build a person's sense of capability. This deliberate and targeted approach is a more effective and efficient use of needed resource as compared to general approaches that don't engage the psychology of the intervened behavior. Our results are similar to those of Dempsey, Matthews, et al. (2020) who found that improvement in self-efficacy was a partial mediator in the results of a school-based intervention on PAB in adolescent girls. The school-based physical activity intervention for adolescent girls demonstrated its efficacy in increasing physical activity by improving the self-efficacy beliefs of participants directly. According to the authors, under the intervention, opportunities were structured for participants to experience short-term success in engagement with new activities and develop strategies for self-management. Ouyang et al. (2020) also established that self-efficacy served as a partial mediator between a mastery-involving motivational climate and levels of physical activity in middle-school students.

5.1 Practical implications

There are key implications for the design and delivery of future physical activity interventions. The results illustrate that providing an opportunity for physical activity is not enough; the intervention needed purposefully taking into consideration the participants' self-efficacy, or their level of believed ability (Carballo-Fazanes et al., 2020). The apparent

success of the jumping rope program illustrates that some concepts, or principles, such as mastery experiences, vicarious experiences, and verbal persuasion, are effective BCTs that may be interpreted as the following: the intervention should involve something that allows individuals to experience some form of personal mastery, individuals are able to observe their peers obtain success through physical activity, and they are able to receive positive or supportive verbal persuasion. For these reasons, intervention developers should consider embedding these techniques to enhance an individual's self-efficacy.

The results of the study indicate that developers of interventions should use an intentional focus on creating a climate of mastery. In physical education, this means allowing students to choose tasks that they are comfortable with from a skill level standpoint, providing task-specific feedback regarding their individual task-specific progress, and placing emphasis on effort, not social comparison. Addressing students' sense of 'mastery' can lead to students feeling a sense of accomplishment and pride when they master a new skill, such is the case in the jump-rope program described above. Another consideration is to build on peer social dynamics. Coaches the USA program had peer mentorship, which is based on the powerful social process of vicarious experiences, as well as encouraging positive, supportive feedback, verbally or non-verbally, from social peers and instructors. By integrating these self-efficacy building strategies into interventions in an intentional process, it is likely that interventions will be more successful while allowing for a sustainable change in behavior.

5.2 Theoretical implications

The main theoretical contribution of this study is the evidence of SDT as an adequate theoretical rationale for implementing and assessing physical activity interventions for youth. By structuring the jump-rope intervention with the three basic psychological needs in mind autonomy (by allowing choices of music and routines), competence (through progressively designed curriculum and scaffolding), and relatedness (through group based activities) there was a reasonable attempt to support greater self-determined motivation in the intervention. Given the jump-rope intervention successfully changed children's physical activity behavior, Adams et al. (2017) can conclude that this theoretical rationale is both reasonable and effective; furnishing empirical validity to the central premise of SDT, that meeting individuals' innate psychological needs is an important way to instill the value of behaviours through internalization, and transition motivation from a controlled form (e.g., pressure from parents), into autonomous forms (e.g., some enjoyment, some personal value) for individuals. Additionally, this research demonstrates an important contribution to the current literature, as it relates the satisfaction of SDT's psychological needs to actual physical activity outcomes. While most of the existing literature has prioritized the relationship between the satisfaction of psychological needs and motivation, it is important to note that this research acts as an important bridge that connects motivation to actual behavioral change. While this does address a gap in the current literature and provide a firm theoretical model to evaluate in future research, it also raises another important consideration in relation to measuring the actual physical activity that participants partake in. Future researchers may consider measuring not only the change in motivational regulation of physical activity but also examining the direct effect of need-supportive interventions on objective measures of physical activity.

5.3 Limitations and future research

While the proposed study design is strong, there are also some limitations to consider. First, the researcher only used a short and limited period of time (8 weeks) to measure individual long-term behavior change and motivation to change behaviors related to physical activity. Once the intervention is stopped, it may be that the improvements in physical activity behavior and motivation diminish. Second, most of the research group involved a single, specific population of schoolchildren relating to one geographic and cultural area (Kenya). This will likely limit the research potential to find generalizable evidence that would apply to different age groups, culture, or socioeconomic status. There are BCTs and motivational tools and strategies that may work successfully in one culture, but not necessarily another. Third, the study design does not take into account potential influences from outside factors that could influence a participant's motivation and/or physical activity experience (i.e., family support for

activity, school policies regarding physical activity). These types of variables would be recognized as confounding variables.

To deal with these limitations and broaden the findings of this study, future studies should consider several options. First, a longitudinal study would be important to measure the longevity of the intervention. While the current study noted certain positive changes in motivation and physical activity, it was unclear whether these changes would last. Second, it would be important to replicate this study in a different population (e.g., adolescents from another country; or children from another socio-economic status) to determine the relevant of the findings. Finally, future studies could include qualitative measures (e.g., interviews or focus groups) to obtain an understanding of participant's personal experiences, and subjective interpretations of the program. In particular, participant's specific motivating program components should be identified, in order to gain a better understanding of psychological processes.

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