










GENERAL ARTICLE

Understanding the Benefits of Brief Classroom-Based Physical Activity Interventions on Primary School-Aged Children's Enjoyment and Subjective Wellbeing: A Systematic Review

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ABSTRACT

BACKGROUND: Engaging in classroom-based physical activity (PA) breaks may help increase children's subjective wellbeing and enjoyment of PA, important precursors for children to remain engaged in PA. We conducted a systematic review to investigate the effect of brief classroom-based PA interventions on primary school children's subjective wellbeing and enjoyment of PA.

METHODS: Databases were reviewed between the earliest date of records and April 2020. Eligibility criteria included peer-reviewed empirical quantitative or mixed methods studies reporting enjoyment of PA or wellbeing outcomes of participating in a brief classroom-based PA program. Fifteen papers were included. Interventions supported 7022 child participants enrolled at baseline and 6286 children analyzed in interventions across 148 schools.

RESULTS: Thirteen studies examined the effect of brief classroom-based PA interventions on subjective wellbeing. Four found a significant positive effect for children in the intervention group (specifically for children's self-efficacy in learning with video exercises, quality of life, and self-confidence). Eight studies examined the effect of brief classroom-based PA interventions on enjoyment of PA. Five studies reported a positive effect for children in the intervention group and only 1 study found a negative effect for 1 grade level of children in the intervention group. The remaining studies with wellbeing and/or enjoyment outcomes reported no significant effect.

CONCLUSIONS: Findings from these studies indicate that the integration of brief PA breaks may support PA enjoyment and specific self-beliefs and quality of life perceptions that contribute to children's subjective wellbeing. However, more research is needed to confirm this effect.

Keywords: exercise; active breaks; self-efficacy; self-confidence and QoL.

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INTRODUCTION

Children's participation in physical activity (PA) can have positive impacts on their psychosocial functioning and subjective wellbeing (SWB).¹ Indeed,

a "whole child" approach to child development through PA can benefit children's physical, cognitive, social, and motor development, as well as other areas of functioning.² Previous studies have emphasized the impact of PA on cognitive and academic functioning.^{1,3}

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and 1 study focused on how PA interventions promote social competence in schools.⁴

Classroom-based PA in the form of brief active breaks may provide an opportunity to increase children's enjoyment of PA and SWB. However, the promotion of children's enjoyment of PA and SWB in primary school classrooms is commonly overlooked in favor of the physical, cognitive, and academic improvements that come with increased PA.^{1,3} As a result, there is currently a dearth of knowledge about the types of classroom-based PA programs that increase children's enjoyment of PA and SWB in primary schools and their flow-on effects, such as, increased PA and behavioral benefits. By flow-on effects, we refer to indirect effects of actions that arise when immediate results cause similar effects in other situations and settings. The purpose of this review is to examine the impact of brief classroom-based PA programs on children's SWB and enjoyment of PA.

LITERATURE REVIEW

The Influence of PA on Subjective Wellbeing

Wellbeing is a holistic assessment of a person's quality of life, sense of fulfillment, and life satisfaction based on their own experiences of positive and negative affect in their life.^{5,6} In this systematic review, we chose to use SWB as the most inclusive dimension and definition of wellbeing. SWB encompasses all aspects of people's lives,⁷ this includes interpretation of people's feelings and real-life experiences in direct ways.⁸ SWB has been described as involving "a multidimensional evaluation of life, including cognitive judgments of life satisfaction and affective evaluations of emotions and moods."⁸ In this systematic review, we define SWB as encompassing a diverse range of concepts that a myriad of factors can impact.^{6,7} This includes resilience, sense of competence, self-esteem, vitality, self-determination, positive relationships, mood enhancement, self-efficacy, positive mental health and emotion, worthwhile-ness, life satisfaction, happiness, mindfulness, and quality of life (QoL).^{5,7-9} PA has been shown to have a positive relationship with SWB as it can help to meet psychological

needs.¹⁰ Additionally, from a neural perspective, it has been proposed that PA may activate the brain in a range of regions (eg, the prefrontal cortex, caudate nucleus, and hippocampus^{11,12}) that are implicated in emotional processing. Therefore, PA may be an attractive mechanism to help children adaptively cope when faced with psychological stressors.¹³

The Role of Enjoyment in Promoting PA

Enjoyment is understood to be a positive psychological affect that reflects feelings such as happiness, pleasure, enthusiasm, liking, excitement, and fun.¹⁴⁻¹⁶ In relation to children's enjoyment of PA, enjoyment can be interpreted as a multidimensional structure that relates to cognitions such as, children's perceptions of attitude and competence toward PA.^{15,17} Children are more likely to take part in PA and engage in sustained PA participation if they find it enjoyable.^{17,18} Indeed, The Youth Physical Activity Promotion model¹⁹ suggests that enjoyment is a key factor that can predispose children's PA behavior.

Classroom-Based PA

Exploring opportunities to foster SWB and enjoyment of PA for children through classroom-based PA may be particularly beneficial due to primary school classrooms being well positioned to target children's PA, as most children attend school and spend most of their time at school.²⁰ Providing regular classroom-based PA experiences that are enjoyable for children may also increase the likelihood of them maintaining PA outside of school.²¹ However, barriers to successful classroom-based PA interventions have been identified, including challenges with (a) the school "delivery system" such as support, coordination, staffing capacity, and time^{22,23} due to curriculum pressures; (b) staff engagement and training or professional learning; and (c) intrapersonal factors of teachers, such as, their views on PA, level of experience, and confidence in delivering PA.^{23,24} As such, teachers have reported a preference for short PA breaks during class time²⁵ as they are often under time pressure. Brief classroom-based PA breaks are typically 2-10 minutes

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in duration. They are designed to support and promote PA in classrooms and increase energy expenditure. They generally consist of simple, fun, and enjoyable PA activities and exercises that can be easily undertaken in classrooms or outside as a whole class group.²⁶

Physically active classes are associated with improvements in children's physical and educational outcomes overall, academic achievement, behavior, and cognitive function.^{3,27} A recent systematic review and meta-analysis found improved academic performance as well as enjoyment in physically active classrooms compared to traditional classrooms.³ However, many classroom-based PA reviews remain centered around the physical and/or cognitive impact of PA interventions on children^{1,28-30} or focus on academic content that is taught through PA (ie, active lessons) and not on PA breaks (see, eg, a systematic review and meta-analysis³).

Purpose

The purpose of this systematic review is to identify empirical studies that have evaluated the impact of brief classroom-based PA breaks on children's SWB and enjoyment of PA in mainstream primary schools. By "mainstream," we refer to schools from a general education system that receive most children. In this systematic review, 2 research questions are considered:

1. What classroom-based PA interventions have a positive impact on children's subjective wellbeing?
2. What classroom-based PA interventions have a positive impact on children's enjoyment of PA?

Methods

This review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.³¹ The review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on November 9, 2018. Registration number: CRD42018114360.

Eligibility Criteria

Studies were included if they met the following criteria: (1) included primary or elementary school-aged children (ie, foundation to grade 6), (2) evaluated PA breaks that were implemented regularly (ie, daily or weekly) in a mainstream classroom during general classroom instructional time, (3) included a SWB or enjoyment of PA outcome that was measured by a recognized quantitative method or measure, (4) the study was peer reviewed, and (5) the article was written in English. Multicomponent programs (ie, those that combined PA with another type of activity such as nutrition education) were eligible, provided they met the above criteria. With regards to outcomes, the

term "subjective wellbeing" was used to refer to a broad spectrum of concepts such as, self-efficacy, self-determination, life satisfaction, QoL, positive mental health, mood enhancement, worthwhile-ness, happiness, self-esteem, and resilience.^{5,9} "Enjoyment of PA" referred to positive affect or emotions associated with PA.^{14,32} Exclusion criteria included qualitative studies, systematic reviews, protocol papers, studies where the intervention was conducted during specialist class time (eg, physical education [PE]), and studies that evaluated active lesson intervention programs.

Identification of Relevant Studies

To identify relevant studies, electronic database searches were individually conducted in Academic Search Complete, CINAHL Complete, Education Source, ERIC, Global Health, MEDLINE Complete, PsycINFO, and SPORTDiscus with Full Text via EBSCO. A search of Embase was also conducted. There were no date restrictions applied for any of the searches. That is, searches were conducted from the earliest date of the database until the date the searches were performed (August 13, 2018). Relevant limiters were applied to searches to restrict results to only peer reviewed papers in each electronic database (eg, "Scholarly [Peer Reviewed] Journals" for Academic Search Complete and Education Source, and "Peer Reviewed" for CINAHL Complete, ERIC, PsycINFO, and SPORTDiscus with full text). No limiters were applied to restrict to only peer reviewed papers in the Global Health, MEDLINE Complete, or Embase databases, as a "peer reviewed" limiter was not available in these databases. Searches were also restricted to English language only in all databases. Additionally, reference lists of included studies were searched. Searches were rerun on April 8, 2020 to source updated literature.

Search Strategy

Keywords relating to 5 concepts were included in the search strategy for each database. These concepts related to the participants (ie, children), the setting (ie, classrooms), the environment (ie, primary school), the type of intervention (ie, PA), and the outcomes (ie, SWB and enjoyment of PA). For each keyword, appropriate truncation was applied, and subject headings were obtained from each database. Each keyword was searched for title and abstract and combined using the "OR" Boolean operator (see Appendix for an example). All concepts were then compiled to search the electronic database.

Study Selection and Data Extraction

Results from the electronic searches were combined in Endnote and duplicates were removed. Duplicated results were dual screened by title and abstract in Rayyan using the criteria discussed

above. Two researchers (N.P. and C.E.) independently reviewed the remaining results in full-text and gave a reason for exclusions. One author independently extracted the data from the included studies, and this was reviewed by a second author. Extracted data included study aim and design, participant information, intervention features, measures used, and primary outcomes. Authors of included studies were contacted for extra information if necessary. Studies were grouped into 2 tables according to whether they measured SWB or enjoyment of PA outcomes to facilitate our analysis.

Quality Assessment

The Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields measure³³ was used to assess the quality of each of the studies included in this review. The measure consists of 14 domains, which were assessed in each study by 2 authors (N.P. and L.O.) independently (see the results section for a description of the 14 domains assessed). Authors assigned a score to each of the domains according to whether the criteria were met (2 = yes, 1 = partially met, 0 = no) or “NA” if the domain was not applicable to the study. These scores were used to calculate a total score presented as a percentage, with higher total percentage scores reflecting higher quality. Authors met to discuss results and resolve any inconsistencies. Interrater reliability for the 15 studies and across 14 quality assessment criteria was 94.7%, with 100% agreement after arbitration on studies where discrepancies existed.

RESULTS

Search Results

A total of 15 empirical studies of classroom-based PA interventions in primary schools were included in this systematic review (see Figure 1 for an overview of the study selection process), comprising 13 studies that evaluated children’s SWB and 8 studies that evaluated children’s enjoyment of PA, as detailed below in Tables 1 and 2. Six interventions investigated both SWB and enjoyment outcomes.³⁴⁻³⁹ A total of 7022 child participants were enrolled in the studies at baseline and 6286 children were analyzed in the interventions across 148 primary schools. Three papers⁴⁰⁻⁴² were from the same study and included the same participants, therefore the child participants and schools were accounted for just once. While intervention measures included teacher surveys, questionnaires and in 1 case, interviews, teachers were not mentioned as participants in all but one of the studies, where 6 teachers were included as participants.⁴³ The age of the student participants ranged from 6-12 years. Most studies were designed

as cluster randomized control trials.^{34,40-42,44,45} Three studies^{35,38,39} used quasi-experimental design, 3 used pre-post design,^{37,43,46} 1 used longitudinal repeated measure design,³⁶ 1 employed a randomized control trial,²⁶ and 1 was a controlled intervention pilot study.⁴⁷ Six studies evaluated multicomponent interventions, where PA was used in conjunction with food service and information for families,²⁶ information about sedentary and dietary behaviors,³⁴ or classroom curriculum on healthy lifestyles,⁴⁵ adaptation of playgrounds, and PA homework.⁴⁰ PA exercises were also used alongside student’s being encouraged to stand in classrooms during lessons⁴⁴ and enhanced PE classes.⁴⁶ Classroom-based interventions tended to last between 2 and 10 minutes and were offered between 1 and 30 times a week for a period of 12-18 weeks in 3 cases.^{35,36,46} Most programs continued for between 4 and 10 months,^{37-45,47} with 1 lasting 20 months,³⁴ and 1 for a period of 3 years.²⁶

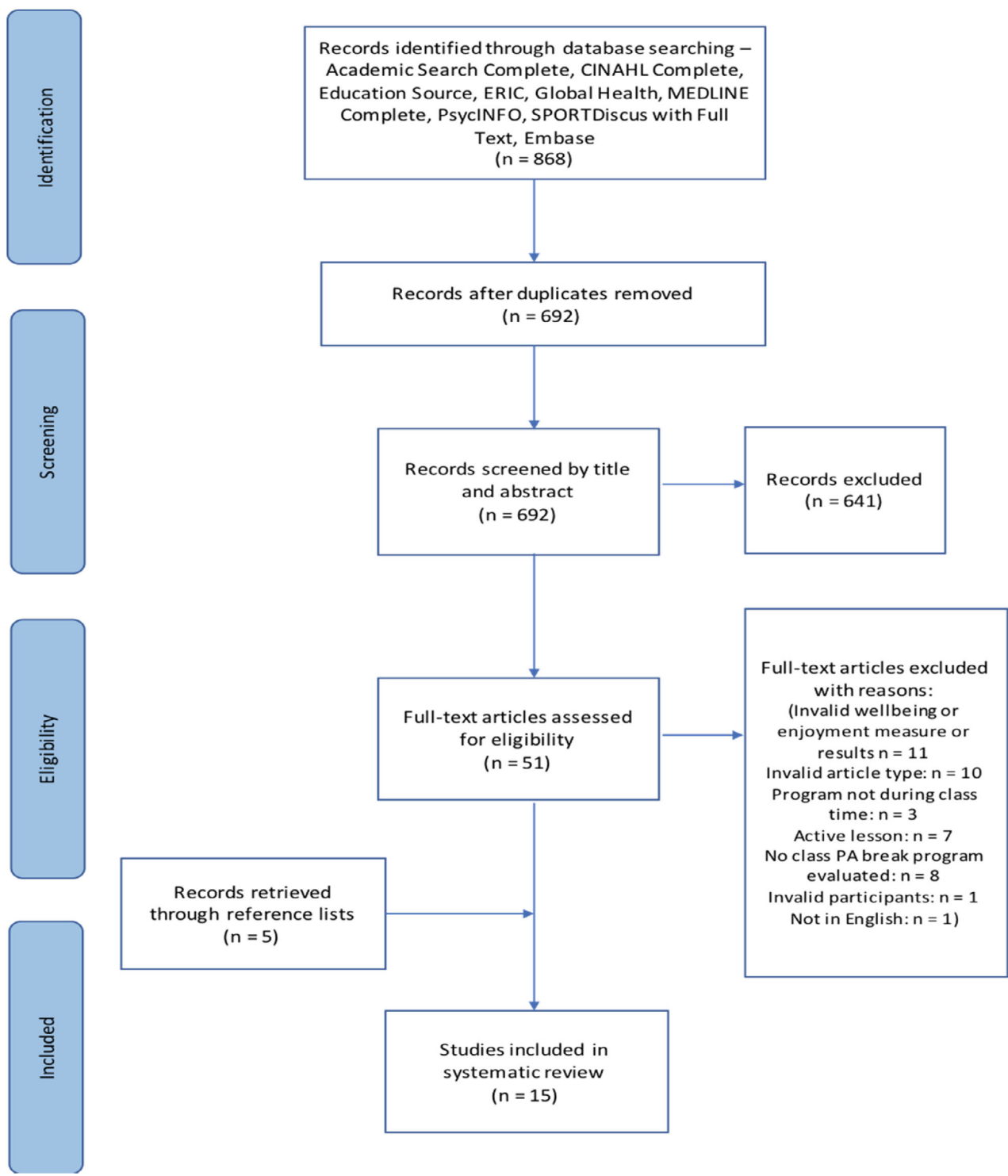
Quality Assessment Results

While the total quality assessment scores of the studies ranged from 45% to 95%, most studies were of high quality, with 13 scoring above 70%. All studies (n = 15) clearly demonstrated an appropriate study design and had well-defined and robust outcome and exposure measures. Most (n = 14) reported results in sufficient detail, with only 1 study not reporting this. Most studies (n = 14) also described appropriate analytic methods, with 1 study providing partial information. Despite the relatively high-quality ratings, some weaknesses were identified. For example, no studies reported blinding of subjects where this was possible (n = 8) and only 3 out of 8 studies where blinding of investigators was possible reported this information. Additionally, while 7 studies described an appropriate method of subject/comparison group selection or source of information variables, 8 studies reported only partial information for this domain or described a selection strategy that was only somewhat appropriate. Refer to Table 3 for all quality assessment results.

Types of Classroom-Based PA Interventions and Training Provided for Delivery

Tables 1 and 2 describe the features of the classroom-based PA interventions, including characteristics of the PA activities and experiences and the length and frequency of both the activities and the intervention. Eleven studies focused on solely classroom-based interventions,^{35-40,42-44,46,47} and 6 studies focused on multicomponent interventions that included classroom-based activities.^{26,34,40,44-46} Six interventions integrated dance,^{37-40,47,48} with 5 of these interventions using dance videos and aerobic exercise videos.^{35-38,45} Six interventions used video

Figure 1. Flow Diagram of the Study Selection Process³¹



games or clips to lead PA.^{35-39,45} Three interventions used yoga,^{35,36,43} including yoga through YouTube videos in 2 studies.^{35,36} Most interventions were delivered by classroom teachers except for a yoga intervention, which was solely delivered by external

yoga teachers who were experienced in teaching yoga with children.⁴³ Additionally, 2 studies were delivered by nonclassroom teachers from the school for part of the intervention. One⁴⁰ engaged expert PE teachers to teach classroom teachers, with expert

Table 1. Overview of Studies Evaluating Subjective Wellbeing Outcomes

Study, Country	Design	Aim	Participants	Intervention	Characteristics of PA Intervention	Length and Duration	Measure of Wellbeing	Primary Outcome(s)
Bergh et al. (2012), Norway	Cluster randomized controlled trial	To assess the impact of the Health in Adolescents (HEA) intervention on psychological and environmental determinants of physical activity and sedentary behavior.	Enrolled at baseline: N = 1580. Analyzed: N = 1384. Grade 6 students. INF: n = 499; CON: n = 885.	Intervention consisted of one 90-minute classroom lesson that was theoretically driven, short physical activity breaks, campaigns promoting active commuting, play equipment to encourage physical activity at recess, fact sheets for parents and a course for physical education teachers.	Short physical activity breaks administered once a week during lessons.	A modified version of the "self-efficacy related to barriers for physical activity" scale from previous research.	There was a borderline significant effect of the intervention on children's self-efficacy related to barriers for physical activity at 8 months follow up ("mid-way," p = .05), reflecting a slightly larger increase in self-efficacy in the intervention group.	
Caballero et al. (2003), USA	Randomized controlled trial	To investigate the effectiveness of a multicomponent intervention at school in preventing weight gain in school aged children.	Enrolled at baseline: N = 1760. Analyzed: N = 1409. Children enrolled at the end of grade 2.	"The Pathways Study" intervention which targeted: (1) Food service; (2) Physical activity; (3) Classroom curriculum on a healthy lifestyle; (4) A family-based program	The classroom physical activity component aimed to increase energy expenditure in the classroom and involved simple indoor and outdoor exercises.	A scale developed in the feasibility phase of the Pathways Study about children's diet and physical activity related knowledge, attitudes and behavior.	No significant changes were observed for physical activity self-efficacy.	
Ehud et al. (2010), Israel	Pre-post study	To investigate the impact of a yoga intervention in war affected school children.	Enrolled at baseline and analyzed: N = 122. School children aged 8-12 years.	13 yoga sessions during the school day over 4 months that comprised of a combination of breathing and physical exercises.	Yoga type movements.	13 yoga sessions conducted by yoga instructors during the school day over a period of 4 months.	A questionnaire based on the WHO (5) Well-Being Index (1998).	No difference in pre-post intervention scores on the WHO (5) Well-being Index.
Fu and Burns, (2018), USA	Quasi-experimental design	To investigate health-related fitness, school day step count, and motivation effects of an active video game classroom curriculum program in sixth-grade students.	Enrolled at baseline: N = 66. Analyzed: N = 65. Sixth-grade students (M = 30, F = 36; Mean _{age} = 11.6 y). INF: n = 33 (M = 15, F = 18); Mean _{age} = 12.0 y. CON: n = 32 (M = 16, F = 17); Mean _{age} = 11.6 y.	Each session in the active video game classroom curriculum involved 15 minutes of "GoNoodle," 10 minutes of "Adventure to Fitness" and 5 minutes of "Cosmic Kids Yoga" during class time, in the classroom. Sessions were supervised by the classroom teacher and a trained graduate assistant.	The active video games included activities such as dance, aerobics, locomotor skill games and video adventures of different parts of the world.	Three, 30-minute sessions per week for 18 weeks.	Self-efficacy was measured using a 6-item self-report questionnaire with a 5-point Likert scale previously used by Gao et al.	No significant changes were observed for self-efficacy.
Fu et al. (2019), USA	Longitudinal repeated measure design	To explore trends of children's sedentary behavior, physical activity and motivation during a 12-week active video game program in the classroom.	Enrolled at baseline and analyzed: N = 16. Elementary school students (Mean _{age} = 7.1 y; M = 10, F = 6).	Three 10-minute active video game sessions per school day for 12 weeks. Each session was led by the classroom teacher and involved 5 minutes of "GoNoodle," 2-3 mins of "Adventure to Fitness" and 2-3 mins of "Cosmic Kids Yoga."	Each of the active video games were comparable in intensity, difficulty and category. The games involved a range of activities including dance, aerobic workouts, race competitions, locomotor skills games and active video clips of several situations.	Three 10-minute sessions per school day for 12 weeks.	A 6-item scale previously used by Gao et al. was used to measure children's self-efficacy.	No significant trends were observed for children's self-efficacy across the program.

Table 1. Continued

Study, Country	Design	Aim	Participants	Intervention	Characteristics of PA Intervention	Length and Duration	Measure of Wellbeing	Primary Outcome(s)
Gapa et al. (2018), Poland	Pre-post study	To explore the impact of Brain Breaks® Physical Activity Solutions on children's attitudes toward physical activity.	Enrolled at baseline: N = 400 Analyzed: N = 326. Grade 3 to 5 children (M = 170; F = 156) aged 9-11 years. INT: n = 264; Mean _{age} = 9.6 years. CON: n = 62; Mean _{age} = 10.1 years.	Brain Breaks Physical Activity Solutions. The breaks aim to motivate children to enhance their physical activity.	Children have the opportunity to learn new motor skills, coordination, and dance.	3-5 minute breaks performed by children 2 times per day over the duration of 4 months.	The APAS. Specifically, the "self-efficacy in learning with video exercises," and "self-confidence on physical fitness" scales.	Children in the intervention reported significantly higher scores on the "self-efficacy in learning with video exercises" scale at post-test than the control group (F = 7528, $\eta^2 = 0.19$, p < .01). No significant differences in other subscales (ie, self-confidence on physical fitness) were found.
Härtmann et al. (2010), Switzerland	Cluster randomized controlled trial	To assess whether a school-based physical activity program has an impact on children's physical and psychosocial quality of life.	Enrolled at baseline: N = 540. Analyzed: N = 411. First-grade (aged 6-8 years) and fifth-grade (aged 10-12 years) children. First grade: INT: n = 111; Mean _{age} = 6.9 years. CON: n = 69; Mean _{age} = 6.9 years. Fifth grade: INT: n = 146; Mean _{age} = 11 years. CON: n = 85; Mean _{age} = 11.3 years.	The Kinder Sportstudie (KISS) intervention comprised of two 45 minute physical education lessons per week, led by experts in addition to the usual 3 physical education lessons given by classroom teachers, daily classroom-based physical activity breaks, adaptation of playgrounds to promote physical activity as well as physical activity homework.	Several short activity breaks were introduced to academic lessons (approx. 2-5 minutes in duration) throughout the day.	The Child Health Questionnaire (German version) was used to measure QoL.	There was a significant effect of the intervention on children's psychosocial QoL in first graders (F = 0.32, p < .05). There was no significant effect of the intervention on first-grade children's physical QoL or fifth-graders psychosocial or physical QoL.	
Koch et al. (2019), USA	Cluster randomized controlled trial	To evaluate outcomes of the Food, Health & Choices intervention.	Enrolled at baseline: N = 1366. Analyzed: N = 769. Fifth-grade students (M = 369; F = 400). Curriculum: n = 225 (M = 101, F = 124). Wellness: n = 167 (M = 83, F = 84). Curriculum + Wellness: n = 233 (M = 109; F = 124). Control: n = 144 (M = 76, F = 68).	A multi-component intervention called Food, Health & Choices. This program involved a classroom curriculum program which includes 23 science lessons, a classroom wellness program which includes a healthy eating component ("Think Before You Bring Food Policy") and a physical activity component using dance breaks, and family newsletters.	The dance breaks were led by teachers and involved a warm-up, 2 songs worth of dancing and a cool down. Research staff trained the class in choreography of 2 new songs every 4 weeks.	A 10-minute dance break was conducted daily for the duration of a school year.	The Food, Health & Choices Questionnaire was used to measure self-efficacy for 6 target behaviors ("do more" fruits and vegetables and physical activity, and "do less" consumption of sweetened beverages processed and packaged snacks, fast food, and recreational screen time).	No significant changes were observed for self-efficacy.
Kriemler et al. (2010), Switzerland	Cluster randomized controlled trial	To investigate the effectiveness of a school-based physical activity program on primary school aged children's physical and psychological health.	Enrolled at baseline: N = 540 Analyzed: N = 502. First- and fifth-grade children. First grade: Mean _{age} = 6.9 years. Fifth grade: Mean _{age} = 11.1 years.	A multicomponent physical activity intervention which consisted of an additional 2 physical education lessons per week (taught by physical education teachers), daily short activity breaks during academic lessons, and physical activity homework.	The break consisted of motor skill tasks (such as jumping and balancing) and games.	2-5 minute activity breaks; 3-5 times a day administered in class time.	QoL (physical and psychological) assessed by the Child Health Questionnaire.	No significant changes were observed.

Table 1. Continued

Study, Country	Design	Aim	Participants	Intervention	Characteristics of PA Intervention	Length and Duration	Measure of Wellbeing	Primary Outcome(s)
Meyer et al. (2014), Switzerland	Cluster randomized controlled trial	To report a 3-year follow-up study that compares a modified school-based physical activity program to a traditional physical education program.	Enrolled at baseline: N = 502 (INT: 297, CON: 205). Analyzed: N = 289. First graders: INT: n = 108; Mean _{age} = 6.9 years. CON: n = 65; Mean _{age} = 6.9 years. Fifth graders: INT: n = 81; Mean _{age} = 10.9 years. CON: n = 35; Mean _{age} = 11.1 years.	The intervention consisted of 2 additional physical education sessions lasting 45 minutes each (led by physical education teachers), activity breaks conducted during class time and 10 minutes of physical activity for homework daily.	Motor activities such as balancing and jumping.	2-5 minute activity breaks were conducted 3-5 times every day during class time.	The Child Health Questionnaire.	Compared to baseline, no significant difference in physical or psychological QoL was reported at 3 years follow-up from the end of the intervention.
Popeska et al. (2018), Macedonia	Quasi experimental	The aim was to investigate the effects of Brain Break activities on children's interest and motivation for physical activity and the impact of these activities on children's learning about health and development.	Enrolled at baseline and analyzed: N = 283. Grade 3, 4, and 5 students. INT: n = 152; Mean _{age} = 9.24 years. CON: n = 131; Mean _{age} = 9.18 years.	Brain Breaks Physical Activity Solutions videos.	Each Brain Break video consists of different videos integrating basic movements, sport elements, games and dance. Videos also include healthy living information and nutrition, environmental, academic and cultural content.	3-5 minute breaks were performed by children each school day (5 times per week) for the duration of 3 months.	The APAS. Specifically, the "self-efficacy in learning with video exercises," and "self-confidence on physical fitness" scales.	There was no significant interaction effect for self-efficacy in learning with video exercises or self-confidence on physical fitness.
Uzunoz et al. (2017), Turkey	Quasi-experimental	To investigate the effects of Brain Break activities on children's interest in physical activity, physical fitness, self-efficacy, knowledge of the importance and benefits of physical activity and the role of physical activity in learning about health.	Enrolled at baseline and analyzed: N = 300. Grade 3-5 students (Mean _{age} = 9.55 years). INT: n = 193; CON: n = 107.	Brain Breaks Physical Activity Solutions videos.	Web-based physical activity breaks that are structured to enhance children's health and learning. Children can develop new motor skills and learn about health, music, art, environmental protection, curricular topics, language and cultures, for example.	3-5 minute activity breaks at various intervals during each school day for 4 months.	Turkish version of the APAS. Specifically, the "self-efficacy in learning with video exercises," and "self-confidence on physical fitness" scales.	The intervention group made a significantly larger gain from pretest to posttest on the "self-efficacy in learning with video exercises" scale than the control group (partial $\eta^2 = 0.306$, $p < .01$). The intervention group made a significantly larger gain from pretest to posttest on the "self-confidence on physical fitness" scale than the control group (partial $\eta^2 = 0.113$, $p < .01$).
Witt et al. (2005), Germany	A controlled intervention pilot study	To assess the effects of qigong lessons on children's social behavior, general health and school achievement.	Enrolled at baseline and analyzed: N = 40. Elementary school students [†] (n = 20 per class, 1 class INT, 1 class CON). Mean _{age} = 7.4 years.	Children participated in qigong lessons.	Consists of upper and lower body simple physical exercises, basic movements, mental exercises, and breathing techniques.	Qigong exercises were conducted for 15-20 minutes, at least twice per week for the duration of 6 months.	QoL using the KINDL Questionnaire. The wellbeing subscale of a standardized parent-report questionnaire.	A significant difference was found on the psychological well-being subscale of the KINDL QoL questionnaire for elementary students, with an increase in the control group. No significant difference was found for the overall QoL KINDL questionnaire. No significant difference was found for parent-reported child wellbeing.

APAS, Attitudes toward Physical Activity Scale; CON, control group; F, female; INT, intervention group; KINDL, Child Quality of Life Questionnaire; M, male; WHO, World Health Organization.

* We included participants and data from the 8 months follow up only as children would have been in grade 7 (high school) and received a different intervention at 20 months.

[†] High school students were also included but not reported in the current review.

Table 2. Overview of Studies Evaluating Enjoyment of PA

Study, Country	Design	Aim	Participants	Intervention	Characteristics of PA Intervention	Length and Duration	Measure of Enjoyment	Primary Outcome(s)
Bergh et al. (2012), Norway	Cluster randomized controlled trial	To assess the impact of the Health in Adolescents (HEIA) intervention on psychological and environmental determinants of physical activity and sedentary behavior.	Enrolled at baseline: N = 1580. Analyzed: N = 1394. Grade 6 students. INT: n = 499; CON: n = 885.	Intervention consisted of one 90-minute classroom lesson that was theoretically driven, short physical activity breaks, campaigns promoting active commuting, play equipment to encourage physical activity at recess, fact sheets for parents and a course for physical education teachers.	Short physical activity breaks administered once a week during lessons.	A modified version of the "enjoyment of physical activity" scale from previous studies.	There was a small significant effect of the intervention on children's enjoyment at 8 months follow-up ($p = .03$), reflecting a small increase in the intervention group and a slight reduction in the control group.	
Carson et al. (2013), Australia	Cluster randomized controlled trial	To assess mediating effects on children's sedentary time in the Transform-Us! study.	Enrolled at baseline: N = 599. Analyzed: N = 293. Children aged 7-10 years.	The Transform-Us! intervention, consisting of 3 arms. The Sedentary Behavior arm aimed to reduce the amount of time children spend being sedentary. The Physical Activity arm aimed to increase children's MWPA participation. The Sedentary Behavior and Physical Activity arm provided children with a combination of both arms described previously. These programs involved actions such as the administration of learning messages, standing lessons, newsletters, providing sports equipment, promoting physical activity and light intensity activity breaks.	Two-minute duration, every 30 minutes during 2-hour teaching periods.	Children's enjoyment of standing in class using a 5-point Likert scale.	Children in the Sedentary Behavior group reported higher enjoyment of standing in class at mid-intervention (5-9 months) than children in the control group ($\beta = 0.88$ 95% CI [0.36-1.41], $p < .05$).	
Fu et al. (2016), USA	Pre-post repeated measures study	To investigate the effect of a comprehensive school physical activity program (CSPAP) on children's physical activity enjoyment.	Enrolled at baseline: N = 758. Analyzed: N = 738. Grade 3, 4, 5, and 6 students.	This program aimed to improve the quality of physical education lessons, provide physical activity opportunities at recess and lunch times and encourage teachers to integrate physical activity into the classroom.	Classroom physical activity breaks included stretching, jumping, walking, squats, push-ups, sit-ups, and/or ball activities in the classroom.	5-minute activity breaks administered 2-3 times throughout the day for 12 weeks.	Children's enjoyment of physical activity was measured using the Physical Activity Enjoyment Scale (PACES).	There was a significant grade x time effect ($p = .001$). For the whole sample, enjoyment scores significantly increased from baseline to follow-up, (mean difference = 0.14, $p < .05$, $d = 0.26$). Grade 3 displayed the only decrease in enjoyment (mean difference = -0.2, $p < .001$, $d = 0.31$). Grade 4 showed a significant increase in enjoyment (mean difference = 0.25, $p < .001$, $d = 0.28$) as did grade 5 (mean difference = 0.23, $p < .001$, $d = 0.32$) and grade 6 showed the greatest increase in enjoyment (mean difference = 0.49, $p < .001$, $d = 0.63$) from baseline to follow-up.

Table 2. Continued

Study, Country	Design	Aim	Participants	Intervention	Characteristics of PA Intervention	Length and Duration	Measure of Enjoyment	Primary Outcome(s)
Fu and Burns, (2018), USA	Quasi-experimental design	To investigate health-related fitness, school day step count, and motivation effects of an active video game classroom curriculum program in sixth-grade students.	Enrolled at baseline: N = 66; Analyzed: N = 65. Sixth-grade students (M = 30, F = 36; Mean _{age} = 11.6y). INT: n = 33 (M = 15, F = 18); Mean _{age} = 12.0y. CON: n = 32 (M = 16, F = 17); Mean _{age} = 11.6y.	Each session in the active video game classroom curriculum involved 15 minutes of "GoNoodle," 10 minutes of "Adventure to Fitness" and 5 minutes of "Cosmic Kids Yoga" during class time, in the classroom. Sessions were supervised by the classroom teacher and a trained graduate assistant.	The active video games included activities such as dance, aerobics, locomotor skill games and video adventures of different parts of the world.	Three 30-minute sessions per week for 18 weeks.	The Sport-Enjoyment Scale was used to measure children's self-reported enjoyment.	No significant changes were observed for enjoyment.
Fu et al. (2019), USA	Longitudinal repeated measure design	To explore trends of children's sedentary behavior, physical activity and motivation during a 12-week active video game program in the classroom.	Enrolled at baseline and analyzed: N = 16. Elementary school students; Mean _{age} = 7.1y (M = 10, F = 6)	Three 10-minute active video game sessions per school day for 12 weeks. Each session was led by the classroom teacher and involved 5 mins of "GoNoodle," 2-3 mins of "Adventure to Fitness" and 2-3 mins of "Cosmic Kids Yoga."	Each of the active video games were comparable in intensity, difficulty and category. The games involved a range of activities including dance, aerobic workouts, race competitions, locomotor skills games and active video clips of several situations.	Three 10-minute sessions per school day for 12 weeks.	The Sport-Enjoyment Scale was used to measure children's enjoyment.	Enjoyment significantly increased across the 12-week program (b = 0.24, 95% CI [0.00-0.48], p = .047). Specifically, enjoyment increased from 3.6 to 3.9 (p = .232, d = 0.31) to 4.1 (p = .047, d = 0.56) at weeks 1, 6 and 12, respectively.
Gapa et al. (2018), Poland	Pre-post study	To explore the impact of Brain Breaks Physical Activity Solutions on children's attitudes toward physical activity.	Enrolled at baseline: N = 400. Analyzed: N = 326. Grade 3 to 5 children (M = 170, F = 156) aged 9-11 years. INT: n = 264; Mean _{age} = 9.6y. CON: n = 62. Mean _{age} = 10.1 years.	Brain Breaks Physical Activity Solutions. The breaks aim to motivate children to enhance their physical activity.	Children have the opportunity to learn new motor skills, coordination, and dance.	3-5 minute breaks performed by children 2 times per day over the duration of 4 months.	The APAS questionnaire. Specifically, the "exercise motivation and enjoyment" scale.	No significant difference in the exercise motivation and enjoyment scale was found.
Popeska et al. (2018), Macedonia	Quasi-experimental	The aim was to investigate the effects of Brain Break activities on children's interest and motivation for physical activity and the impact of these activities on children's learning about health and development.	Enrolled at baseline and analyzed: N = 283. Grade 3, 4, and 5 students. INT: n = 152. Mean _{age} = 9.24 years. CON: n = 131; Mean _{age} = 9.18 years.	Brain Breaks Physical Activity Solutions videos.	Each Brain Break video consists of different videos integrating basic movements, sport elements, games and dance. Videos also include healthy living information and nutrition, environmental, academic and cultural content.	3-5 minute breaks were performed by children each school day (5 times per week) for the duration of 3 months.	The APAS. Specifically, the "exercise motivation and enjoyment" factor.	There was no significant interaction effect for exercise motivation and enjoyment.
Uzunoz et al. (2017), Turkey	Quasi-experimental	To investigate the effects of Brain Break activities on children's interest in physical activity, physical fitness, self-efficacy, knowledge of the importance and benefits of physical activity and the role of physical activity in learning about health.	Enrolled at baseline and analyzed: N = 300. Grade 3-5 students (Mean _{age} = 9.55 years). INT: n = 193; CON: n = 107.	Brain Breaks Physical Activity Solutions videos.	Web-based physical activity breaks that are structured to enhance children's health and learning. Children can develop new motor skills and learn about health, music, art, environmental protection, curricular topics, language and cultures for example.	3-5 minute activity breaks at various intervals during each school day for 4 months.	Turkish version of the APAS. Specifically, the "exercise motivation and enjoyment" factor.	The intervention group made a significantly larger gain from pre-test to post-test on the "exercise motivation and enjoyment" scale than the control group (partial $\eta^2 = 0.139$, p < .01).

APAS: Attitudes toward Physical Activity Scale; CON, control group; F, female; INT, intervention group; M, male; MVPA, moderate-vigorous physical activity.

*We included participants and data from the 8 months follow-up only as children would have been in grade 7 (high school) and received a different intervention at 20 months.

Table 3. Quality Assessment

Article	Question/ Objective Sufficiently Described?	Study Design Evident and Appropriate?	Method of Subject/ Comparison Group Selection or Source of Information/Input Variables Described and Appropriate?		Subject (and Comparison Group, if Applicable) Characteristics Sufficiently Described?	If Interventional and Random Allocation was Possible, was it Described?	If Interventional and Blinding of Investigators was Possible, was it Reported?	If Interventional and Blinding of Subjects was Possible, was it Reported?
			Information/Source Variables Described and Appropriate?	Group Selection or Source of Information/Input Variables Described and Appropriate?				
Bergh et al. (2012)	2	2	2	2	2	2	n/a	0
Caballero et al. (2003)	1	2	2	2	1	2	2	0
Carson et al. (2013)	1	2	2	2	2	2	0	0
Ehud et al. (2010)	1	2	1	1	1	n/a	n/a	n/a
Fu et al. (2016)	2	2	1	1	2	n/a	n/a	n/a
Fu and Burns (2018)	2	2	1	1	2	n/a	n/a	n/a
Fu et al. (2019)	2	2	1	1	2	n/a	n/a	n/a
Glapa et al. (2018)	2	2	1	1	2	1	n/a	0
Hartman et al. (2010)	2	2	2	2	2	1	0	0
Koch et al. (2019)	1	2	2	2	2	1	0	n/a
Kriemler et al. (2010)	2	2	2	2	2	2	2	0
Meyer et al. (2014)	2	2	2	2	2	2	2	0
Popeska et al. (2018)	2	2	1	1	2	n/a	0	n/a
Uzunoz et al. (2017)	2	2	1	1	2	n/a	n/a	n/a
Witt et al. (2005)	2	2	1	1	2	n/a	0	0

Article	Outcome and (if Applicable) Exposure Measure (s) Well-Defined?	Sample Size Appropriate?	Analytic Methods Described/Justified and Appropriate?	Some Estimate of Variance is Reported for the Main Results?	Controlled for Confounding?	Results Reported in Sufficient Detail?	Conclusions Supported by the Results?	Total Score/ Possible Maximum Score, %
Caballero et al. (2003)	2	2	2	2	2	2	2	85.71
Carson et al. (2013)	2	2	2	2	2	2	2	82.14
Ehud et al. (2010)	2	1	1	0	0	0	1	45.45
Fu et al. (2016)	2	2	2	2	2	2	2	95.45
Fu and Burns (2018)	2	2	2	2	2	2	2	95.45
Fu et al. (2019)	2	0	2	2	0	2	1	72.73
Glapa et al. (2018)	2	2	2	2	0	2	2	76.92
Hartman et al. (2010)	2	2	2	2	2	2	2	82.14
Koch et al. (2019)	2	2	2	0	2	2	1	73.08
Kriemler et al. (2010)	2	2	2	2	2	2	2	92.86
Meyer et al. (2014)	2	2	2	2	2	2	2	92.86
Popeska et al. (2018)	2	2	2	2	2	2	2	87.50
Uzunoz et al. (2017)	2	1	2	2	2	2	2	90.91
Witt et al. (2005)	2	1	2	2	0	2	2	69.23

Studies were scored based on the extent to which they met each criteria (2 = yes fully addressed, 1 = partly addressed, 0 = not addressed). Criteria not applicable to a particular study were classified as "N/A." A total score was calculated for each study by summing the scores for all applicable criteria and dividing by the total score possible for all applicable criteria. A full outline of the description of criteria and scoring guidelines can be found in Kmet et al.

PE teachers running 1 PA aspect of the intervention. Another intervention employed wellness coaches to run an introductory 45-minute session with children and visit the class once a week to conduct 15-minute dance breaks, with the classroom teacher leading short dance breaks daily when the wellness coach was not in the classroom.⁴⁵ Another intervention involved Qigong teachers initially for the first months of the intervention while the Qigong teachers trained and later mentored classroom teachers in Qigong.⁴⁷

Most interventions briefly mentioned the inclusion of professional learning or training for teachers prior to the commencement of the intervention, with some undertaking training while involved in the intervention. Some teachers were introduced to the intervention via 1 meeting, and sent monthly email reminders,³⁴ others were trained with a once off 6-hour workshop⁴⁵ or half-day training,⁴⁴ others weekly for 90 minutes over a period of 8 weeks,⁴⁷ others monthly,⁴⁶ and, in 1 case, annually in a 3-year intervention.²⁶ In 1 intervention, trained yoga teachers led children and teachers for the entirety of the intervention⁴³ and another was initially led by trained Qigong teachers, who supervised classroom teachers who later led the intervention.⁴⁷ In 2 interventions, classroom teachers were trained to deliver the intervention themselves by research assistants.^{37,38} In 1 study, teachers were provided content by trained PE teachers.⁴⁰⁻⁴² Lastly, teachers were not trained at all in 3 interventions^{35,36,39} but instead, they put video clips or games on for children to engage in PA.

Impact of Brief Classroom-Based PA Interventions on Primary School Children's Subjective Wellbeing and PA Enjoyment

An overview of the measures and primary outcomes of each intervention is shown in Tables 1 and 2. These show that the studies' measurements were diverse, particularly for assessing children's SWB.

Common measures that addressed SWB outcomes were used in 8 studies. Three studies used the Attitudes toward Physical Activity Scale (APAS).³⁷⁻³⁹ Specifically, they used the "self-efficacy in learning with video exercises" and "self-confidence on physical fitness" scales. One study used the Child Health Questionnaire.⁴⁰⁻⁴² Two studies measured self-efficacy using a self-report questionnaire.^{35,36} Common measures that addressed enjoyment were used in 5 studies. Three studies used the "exercise motivation and enjoyment" factor from the APAS³⁷⁻³⁹ and 2 studies measured enjoyment through the Sport Enjoyment Scale.^{35,36} Half of the 15 studies included in this systematic review used different measures to assess the impact of their interventions. Therefore, it is challenging to make connections between these and synthesize all the study outcomes based on SWB and enjoyment

outcomes. For this reason, it was not possible to conduct a meta-analysis and instead, a narrative review of effectiveness is provided.

The concepts of SWB and enjoyment concepts of positive affect and emotions were used to inform the analysis. The concepts relating to SWB were: self-efficacy,^{26,34,37-39} QoL,^{37,40} mood,⁴³ and self-confidence.^{38,39} The concepts related to enjoyment were related to overall enjoyment of PA.

Effectiveness of Classroom-Based PA Breaks on Subjective Wellbeing

Table 1 provides an overview of the results as they relate to the outcome of SWB. A small to large positive significant effect on SWB was reported for 5 of the 13 studies.^{34,37,39,40,47} However, for one of these studies, the positive effect was found for the control group rather than the intervention group, with no significant effects reported for the intervention group.⁴⁷ Most interventions examined "self-efficacy in learning," rather than self-efficacy as a concept in itself when considering SWB. Self-efficacy in learning with video exercises demonstrated a significantly larger gain in the intervention group than control group in 1 study,³⁹ and another study³⁷ noted significantly higher scores from the intervention group on the "self-efficacy in learning with video exercises" scale at posttest than the control group. However, 1 study³⁴ detected only a borderline significant change in effect of the intervention on children's self-efficacy related to barriers for PA. In addition, 1 study reported a significant increase in "self-confidence on physical fitness" in the intervention group.³⁹ Moreover, 1 study reported a significant increase in psychosocial QoL with the first-grade participants only, from a study with first and fifth graders.⁴⁰ Data from teachers were not included in any of the studies, other than one,⁴⁵ which included data from teacher questionnaires. This study's⁴³ teacher data included statistically significant improvements in the children's mood, however, the children did not report this, and were unaware of any changes in their own behavior. Finally, for those studies that reported a significant effect, only 1 study used a multicomponent intervention that included classroom-based activities,³⁴ and the rest were solely classroom-based interventions.

However, a further 8 studies found no significant effect of classroom-based PA breaks on SWB.^{26,35,36,38,41,42,45} Further, 2 of these studies focused on QoL.^{41,42}

Effectiveness of Classroom-Based PA Breaks on Enjoyment of PA

Table 2 provides an overview of results as they relate to the outcome of enjoyment. Five of the 8 studies that reported on enjoyment found that PA had a

small to large effect.^{34,36,39,44,46} This effect was positive for these 5 studies, except 1 study,⁴⁶ which found that enjoyment scores significantly increased from baseline to follow-up for the whole sample; whereas grade 3 children only showed a decrease. One study reported increased enjoyment for standing in class for their “reducing sedentary behaviour” group who were provided with regular light movement breaks during class period.⁴⁴ Another study³⁶ also found that enjoyment of PA significantly increased across the 12-week intervention. One study’s³⁹ intervention group also made a significantly larger gain from pretest to posttest on the “exercise motivation and enjoyment” scale than the control group.

Another study that found an increase in enjoyment for the intervention group also found a decrease in enjoyment for the control group.³⁴ Finally, for those studies that reported a significant effect, only 1 study involved a multicomponent intervention.³⁴

However, 3 studies found no effect of classroom-based PA breaks on enjoyment of PA.^{35,37,38} One study used the Sport Enjoyment Scale to measure self-reported enjoyment.³⁵ The other 2 studies^{37,38} used the APAS questionnaire to measure both motivation and enjoyment; and although neither found an effect on motivation and enjoyment, 1 study did find a large positive effect on self-efficacy in learning as reported in the previous section.³⁷

DISCUSSION

The numerous benefits of PA highlight the importance of promoting positive affect, enjoyment, and motivation during childhood to establish prolonged physically active behavior. PA can also support children in the development of life skills, self-efficacy, goal setting, feeling a sense of self-esteem, and a strong work ethic that can be transferable to other contexts,^{48,49} contributing to their overall sense of SWB, and feelings of enjoyment. While short-PA breaks are promising because of their feasibility and acceptability in the primary school setting, we need to determine their effectiveness and the qualities associated with effective interventions. This systematic review provides preliminary evidence that classroom-based PA may impact primary school-aged children’s enjoyment of PA, self-efficacy in learning with video exercises, QoL, and self-confidence. Self-efficacy is the most significant factor that influences people’s cognition.⁵⁰ These beliefs are complex, as they influence the way that people behave, think, and feel when they engage in a range of experiences.⁵⁰ Enjoyment of PA, self-efficacy in learning with video exercises, QoL, and self-confidence concepts are important precursors in establishing strong and healthy habits for children wanting to continue PA habits beyond short classroom-based PA breaks.

Promisingly, PA was not reported to have a negative effect on children’s SWB or enjoyment, except in 1 study where there was a small negative effect of PA on enjoyment for grade 3 participants only.⁴⁶ Therefore, it is unlikely that classroom-based PA causes harm. However, significantly more research is required in order to understand the impact of PA breaks on children’s SWB, as only 4 of the 13 included studies found that PA had a positive effect for the intervention group.^{37,39,40,47} Further, more research is required to build a greater understanding of children’s enjoyment of PA; as, although, enjoyment is recognized as a major determinant of ongoing participation in PA⁴⁶ only 5 of the 8 studies that explored the impact of PA on enjoyment demonstrated significant increases in enjoyment. Regardless of whether the primary outcome is SWB or enjoyment, there does not appear to be a relationship between significant findings and any particular type of intervention or measurement across the reviewed studies. Therefore, future research should focus on identifying aspects of the interventions, moderators, and mediators that may constrain and explain, inconsistencies between study outcomes.

A significant gap in the articles identified for this review relates to the lack of understanding of teachers’ knowledge about PA, primary school teachers’ attitudes toward brief classroom-based PA interventions, and detailed information about training opportunities provided for teachers to prepare to deliver short PA breaks in their own classrooms. This is particularly important to consider when classroom teachers are the prime facilitators of and advocates for classroom-based PA breaks in primary schools.^{37,51,52} In the majority of the studies in this systematic review there was an absence of clear descriptions of the training or professional learning on implementing the PA interventions provided to teachers. Another systematic review⁵³ similarly found a lack of reporting on training provided. Thus, replication of these studies is problematic, providing a significant limitation to these studies. Only one of the articles in the current systematic review clearly outlined the process of training and professional learning that teachers were afforded in the intervention.⁴⁷ Some teachers were not provided with professional learning or training to prepare them for the classroom-based PA breaks, particularly if they used videos to implement PA, despite most classroom teachers facilitating and leading children in short PA breaks in the interventions included in this systematic review. One study³⁹ indicates that the use and implementation of online-streamed video exercises can encourage motivation toward PA in children. Understanding the perception of teachers toward PA is also important, as teachers can be enablers or significant barriers of classroom-based PA being enacted.³⁷

It is important to design interventions and classroom-based PA breaks that integrate and explore all these concepts, alongside the experiences and attitudes of teachers leading PA breaks, as they are currently underrepresented.

This systematic review has explored a wide-range of brief classroom-based PA breaks that facilitated SWB and primary school-aged children's enjoyment of PA. Findings from these studies suggest that the integration of brief PA breaks may support children's SWB and enjoyment in PA. However, facilitating sustainable classroom-based PA will not be possible without considering how classroom-based PA programs are introduced, supported, and maintained by schools. One study⁴¹ in this systematic review noted that broadening the types of PA to include a wider range of PA strategies and expanding the levels of the intervention may support PA interventions to include, engage and maintain the interest of more children; this may lead to increasing children's PA levels in an enjoyable way. The authors⁴¹ also queried the long-term sustainability of their PA intervention and advised commitment to following PA intervention programs over several years to determine ideal circumstances for interventions, such as intervention content, setting, duration, and, importantly, the cost-effectiveness of PA interventions. This is an important area for future research to continue to explore to support the provision of classroom-based PA to children.

Although there is preliminary evidence to suggest that classroom-based PA may impact primary school-aged children's self-efficacy in learning with video exercises, QoL, self-confidence, and enjoyment of PA, more research is required to consolidate these findings due to the inconsistency in direction of findings and of measures used across the studies. The issue of inconsistency of measurement across SWB and longer PA interventions was also observed in a previous systematic review.⁶ It is hoped that consistency can increase as the evidence-base for this field continues to grow. Indeed, there is limited literature that investigates the benefits of short classroom-based PA breaks on the SWB and PA enjoyment of primary school-aged children. Therefore, this topic remains poorly understood. As noted, the results of this systematic review suggest that classroom-based PA may have a positive effect on primary school-aged children's self-efficacy in learning with video exercises, QoL, self-confidence, and enjoyment of PA. These findings are promising, given previous studies have recognized self-efficacy and self-confidence in PA as being significantly correlated to lifelong engagement in PA.^{49,54,55} However, further research is required to confirm these preliminary findings, given the limited amount of research currently available.

Limitations

This systematic review is the first, to our knowledge, that explicitly considers classroom-based PA breaks and their impact on SWB and enjoyment. However, only primary school-based PA interventions were analyzed, therefore, the results from these studies are unable to be generalized to out-of-school contexts, such as home-based or community settings¹⁸ or to secondary school students or those in early learning contexts. In addition, the review did not include gray literature or studies in languages other than English that may have reported relevant primary data to inform this review's findings. The key concept of SWB was defined in such a way that it was not possible to include an exhaustive list of all constructs that have previously been considered under this term. This is largely due to inconsistencies in the way SWB has previously been defined in the existing literature. It is also important to qualify the synthesis of findings of a positive effect of PA on SWB and enjoyment of PA, by considering that 7 of 12 studies that focused on SWB as a primary outcome^{26,35,36,38,41,42,45} and 3 of 8 studies that focused on enjoyment of PA as a primary outcome^{35,37,38} found no significant effect.

IMPLICATIONS FOR SCHOOL HEALTH

Primary schools are an important setting for adopting and sustaining PA behaviors.⁴⁵ However, creating and sustaining ongoing classroom-based PA is not achievable without considerations of how classroom-based PA programs are introduced, supported, and maintained by schools. The use of online interventions has been identified as a way to improve the reach and scale of interventions for children.⁵⁶ Introducing short PA breaks in classrooms, whether these are via online-streamed videos or PA-trained teacher-led, requires planning, consideration of the context in which they will take place and ways in which to continue the flexible and engaging implementation of PA. It is vital that teachers are provided with regular professional learning in order for them to implement and maintain short classroom-based PA breaks to support student's SWB and enjoyment of PA. PE teachers or psychologists that support children's SWB in schools could lead professional learning in schools and support teachers' ongoing use of classroom-based PA to strengthen student's SWB holistic health.

Some studies have demonstrated the ability of short PA breaks to impact self-efficacy via learning with video exercises.^{34,37,39} Self-efficacy is recognized as a core building-block outcome for social and emotional development⁵⁰ and has flow-on effects for children, such as, important implications for future success in school, relationships, and career.⁵⁰

Therefore, short PA activity breaks may prove to be an important part of the school day in terms of facilitating development across these areas. Focusing on not only the impact of PA itself but also motivation toward PA and knowledge of and self-confidence in exercise is key.

A more holistic and connected approach of linking the significant relationship between physical and mental health has been identified in recent Australian Government-funded publications and initiatives. The Australian Government's National Children's Mental Health and Wellbeing Strategy⁵⁷ and Mitchell Institute's policy evidence brief which focuses on improving Australia's mental and physical health through a more connected approach⁵⁸ identifies that improvements and more holistic views of health are required for prevention and early intervention of mental health challenges.⁵⁷

Human Subjects' Approval Statement

As this is a systematic review of published studies, preparation of this paper did not involve primary research or data collection involving human subjects, and therefore, no institutional review board examination or approval was required.

Conflict of Interest

Philanthropic funding was received from the Ferrero Group as part of its Kinder Joy of Moving Corporate Social Responsibility initiative to promote active lifestyles among young people. Ferrero had no role in this research including the design of the study, collection, analysis, and interpretation of data; in writing of the manuscript; and /or in the decision to submit the article for publication.

[Correction added on 6 June 2022, after first online publication: the 'Conflict of Interest' section has been corrected in this version.]

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