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REVIEW

WILEY

Effects of out-of-school physical activity interventions based on self-determination theory in children and adolescents: A systematic review and meta-analysis

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Objective: This systematic review and meta-analysis aimed to examine the effects of out-of-school physical activity (PA) interventions, based on Self-Determination Theory (SDT), on basic psychological needs (BPN), motivation toward PA, and PA levels in youths.

Design: Systematic review and meta-analyses.

Method: We searched for intervention studies examining the effects of PA interventions based on SDT implemented outside the school published in English and Spanish in six electronic databases up to January 2022.

Results: Outcomes of interest were BPN, motivation, and PA levels. In total, nine studies were included in this review. Seven individual meta-analyses were conducted for each variable, revealing nonsignificant clustered effects for the outcomes autonomy satisfaction ($g = 0.12$, 95% CI [−0.31, 0.55]), competence satisfaction ($g = 0.02$, 95% CI [−0.28, 0.32]), relatedness satisfaction ($g = 0.13$, 95% CI [−0.43, 0.68]), autonomous motivation ($g = 0.15$, 95% CI [−0.38, 0.67]), controlled motivation ($g = 0.12$, 95% CI [−0.32, 0.55]), amotivation ($g = -0.36$, 95% CI [−0.88, 0.16]), and PA behavior ($g = 0.02$, 95% CI [−0.08, 0.12]).

Conclusion: Meta-analyses suggest that out-of-school PA interventions based on SDT are not effective in increasing levels of needs satisfaction, types of motivation, and PA levels.

KEYWORDS
basic psychological needs, motivation, physical activity, school-based interventions, students, youth

1 | INTRODUCTION

The World Health Organization (WHO)[1] defines physical activity (PA) as any bodily movement produced by skeletal muscles that involves energy expenditure. It is well documented that regular PA has been associated with many physical (e.g., reduced adiposity, increased physical fitness, improved bone health, etc.), psychological (e.g., improved well-being, quality of life, social relationships, etc., as well as reduced stress, anxiety, etc.) and cognitive (e.g., improved attention, learning, and academic performance)[2–5] benefits in young people. The WHO recommends that children and adolescents aged 5–17 years should accumulate at least 60 min per day of moderate- to vigorous-intensity PA (MVPA) on average and incorporate vigorous-intensity aerobic activities as well as muscle- and bone-strengthening activities at least 3 days per week.[6] However, international studies and reports continue to show that child and adolescent PA levels are low worldwide.[7–12] Specifically, the systematic review by Guthold et al.[9] conducted with a total sample of 1.6 million young people from 146 countries, noted that 81% did not meet PA recommendations.

School-based interventions have succeeded in increasing PA levels in regular school classes of Physical Education[13] and recess.[14] However, the school context presents a time constraint for developing interventions. Furthermore, interventions delivered in the school setting could present a lower challenge regarding commitment and adherence to the program than adolescents may have out of school. For these reasons, out-of-school interventions have also been carried out to increase PA levels.[15,16] Out-of-school PA interventions are programs developed in leisure time, referring to all PAs, such as sports, exercising, or recreational walking, which are not considered essential daily life activities and are performed at the person's discretion.[17] Demetriou et al.[18] examined systematic reviews related to out-of-school PA intervention programs (i.e., improving PA levels in young people's leisure time), identifying six systematic reviews with numerous studies showing moderate support for the effectiveness of after-school programs on children's PA levels. One of the limitations pointed out by Demetriou et al.[18] was that the systematic reviews included studies based on numerous theories applied to the design of out-of-school interventions, so conclusive results could not be drawn. Previously, some systematic reviews had examined the role of mediating variables between the intervention and the consequences for improving PA levels.[19] In this regard, evidence has supported the importance of motivational theories for PA interventions outside the school setting to improve PA levels.[20,21] Self-determination theory (SDT)[22] is a popular framework that allows an in-depth examination of the relationship between the correlational sequence of basic psychological needs (BPN), types of motivation, and PA as the outcome variable.[23–25] Furthermore, this theory is also considered an adequate framework for developing health intervention programs and understanding children and adolescents' motivation toward PA.[26,27] However, the effects of SDT-based PA interventions developed outside of school are less well-known.

Specifically, SDT establishes six motivation regulations arranged on a systematically varying continuum, depending on the degree of self-determination.[28] On the self-determined end of this continuum is intrinsic motivation, reflecting behavioral engagement resulting from enjoyment and personal interest in the behavior. In contrast, extrinsic motivation comprises various regulatory styles differing in their relative autonomy. Specifically, although it is extrinsic motivation, integrated regulation is a highly self-determined regulation, which is defined by feelings of self-valuation and beliefs on personal needs.* Then, identified regulatory style[29] involving a feeling of guilt for not performing some activity. Introjected regulation concerns being motivated by contingent self-esteem and a desire for self- or other approval, whereas external regulation is defined by behaviors motivated by external pressures or contingent rewards.[24,26,29] Finally, amotivation refers to the lack of motives and interest in doing an activity.[15] These motivational regulations have been broadly grouped as autonomous motivation (i.e., intrinsic and identified

*This type of regulation does not usually display by children[74], and since the systematic review is focused on this population group, it was decided not to include it in this work.

regulations), controlled motivation (i.e., introjected and external regulations), and amotivation.[25] This grouping has been adopted because people can be simultaneously intrinsically motivated and identified toward some actions or both externally regulated and introjected. In addition, similar outcomes can be expected from the three autonomous motivation regulations and the two controlled motivation regulations.[30]

In addition, to achieve self-determined motivations, three BPNs should be satisfied: autonomy, competence, and relatedness.[22] Autonomy refers to the feeling of being the agent of one's own behavior and being able to make decisions.[28] People who feel that autonomy is supported in a PA setting will tend to adhere to the activity. Competence concerns the feeling of efficacy in the activities carried out and is best satisfied within well-structured environments.[30] Experiences of competence vary depending on success or failure in challenging physical tasks or as a function of feedback from, for example, a PA professional.[31] Finally, relatedness refers to the feeling of integration with the people with whom an action is performed, also concerning a sense of closeness and genuine connection with others, which is facilitated by the conveyance of respect and caring.[30] If people feel connected (relatedness) to others (e.g., fellow members of a PA intervention program), they are more likely to adhere to a PA context. Thus, it has been shown that BPNs satisfaction has been associated with increased levels of PA.[31]

Grounded on SDT, previous reviews related to motivational teaching strategies (i.e., need supportive behaviors) have been developed to increase students' motivation toward PA.[26,27,32] Several studies have examined the effects of school-based PA interventions on selected motivational outcomes. The review and meta-analysis developed by Kelso et al.[27] assessed the effects of school-based PA interventions on students' BPNs and motivation toward PA. The studies examined showed significant effect sizes for autonomous satisfaction ($g = 0.15$), autonomous motivation (i.e., intrinsic motivation [$g = 0.42$], and identified regulation [$g = 0.38$]), but not for competence and relatedness satisfaction or controlled motivation and amotivation. They also reported increased levels of PA over time in children and adolescents. However, the findings on PA were inconclusive, as the authors did not perform a meta-analysis of PA outcomes. Furthermore, the scoping review by Stewart and Sharma[26] analyzed the effects of in- and out-of-school SDT-based interventions on PA levels in children and adolescents, finding weak evidence for increased PA. These authors did not differentiate between in-school and out-of-school interventions, nor did they follow a robust systematic procedure (e.g., PRISMA guidelines) that could reach conclusions.[26]

Another set of systematic reviews examined the effects of SDT-based programs on different motivational and health variables.[30,33,34] First, Gillison et al.[35] analyzed SDT-centered health intervention studies on motivational outcomes. The results showed significant effect sizes for autonomy support, needs satisfaction (i.e., autonomy, competence, and relatedness), and autonomous motivation. Second, Ntoumanis et al.[29] examined experimental studies which tested changes in at least one SDT variable and at least one health behavior outcome. Their results revealed small-to-medium changes in need support, needs satisfaction, autonomous motivation, and in health behaviors. Third, Manninen et al.[33] conducted a meta-analysis to examine the effect of SDT interventions only on participants' motivational regulations in organized PA. They found a positive effect on intrinsic motivation and identified regulation and a negative effect on external regulation and amotivation. However, they focused on all contexts (e.g., schools, fitness classes, or sports clubs) and ages (i.e., from children to older adults) and only Ntoumanis et al.[29] analyzed the effect on PA levels. Despite this, Gillison et al.[35] found differences between children and adults on competence satisfaction and Manninen et al.[33] on autonomous motivation, whereas age was not a determining variable in the outcomes in the meta-analyses developed by Ntoumanis et al.[29] However, studies identified in these systematic reviews were largely based on school context. As Maninnen et al.[34] pointed out, different age groups in PA settings should be further examined. Finally, the review of reviews conducted by Demetriou et al.[18] only identified four studies in children and adolescents that used SDT background. As we noted previously, even though they found mixed results suggesting some support for the effectiveness of this motivational theory in children and adolescents, they did not analyze the effect of each theory independently.

In summary, the literature suggests that SDT-based PA interventions that implement motivational strategies (i.e., need supportive behaviors) may positively affect the quality, and/or duration, intensity, and maintenance of PA as an outcome of motivational processes, as shown in the educational context.[27] For this reason, it is necessary to analyze the specific effect of SDT-based PA interventions outside the school context.[18] However, an evaluation of the effects of out-school PA interventions on needs satisfaction, types of motivation, and participants' PA levels has not yet been conducted. Therefore, this systematic review aimed to identify peer-reviewed studies of out-of-school SDT-based interventions to increase motivational processes and PA levels in children and adolescents, as

well as to perform a meta-analysis to test the effects found in such interventions.

2 | METHOD

This systematic review and meta-analysis was registered in PROSPERO (registration number: CRD42023420747) and conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement published in 2021.[34]

2.1 | Eligibility criteria

In this systematic review and meta-analysis, studies were required to meet the following PICOS (Participants, Intervention, Comparison, Outcomes, Study) criteria: (1) Participants: apparently healthy children and adolescents aged 5–18 years; (2) Intervention: intervention programs that developed SDT-based strategies to promote out-of-school PA; (3) Comparison: not applicable; (4) Outcomes: evaluating the out-of-school PA levels (i.e., objective and subjective measures), or one of the following SDT dimensions: needs satisfaction/frustration (autonomy, competence, and relatedness) or motivation (autonomous motivation, controlled motivation, amotivation, motivational regulations or subfactors); (5) Study: intervention studies. To determine intervention effects, the intervention group (IG) was compared to a control group (CG), which received the standard class treatment. The outcomes of interest were measured before (at baseline) and after the intervention (post-test). Searching was restricted to Spanish and English languages.

The exclusion criteria were the following: (1) non-intervention studies (e.g., descriptive studies, correlational studies, longitudinal studies...); (2) intervention studies not based on SDT; (3) studies with a school-based intervention; (4) gray literature (e.g., books or book chapters and abstracts or congress communications); (5) protocol studies; (6) systematic reviews and/or meta-analyses.

2.2 | Literature search

Studies were identified by comprehensively searching the most representative electronic databases in the scope of this systematic review (see Demetriou et al.[36]) up to January 1, 2022: Web of Science (WOS), Scopus, SPORTDiscus, PsycINFO, PubMed, and ERIC. Therefore, there were no restrictions on publication date or status. Potential studies were searched on a string combining terms (text words, several Boolean truncators, and subject headings) indicative of teaching behavior, psychological needs, and motivational regulations included in out-of-school intervention programs of PA with youths. Therefore, these different combinations did not contain restricting terms and included a high number of references to screen but minimized the risk of missing relevant studies. An example of the search strategy for WOS can be found in Table S1. We also performed a manual search in the reference lists of potential studies to identify additional research missed in the database searches to include in the study.

2.3 | Study selection

The flow of search results through the systematic review process is shown in Figure 1. First, two authors (FML and MALG) completed the search and compared their results to ensure that the same number of articles had been found. Second, duplicate articles identified in the initial and previous searches were excluded. For this step, one of the authors (FML) downloaded the main data from the articles (title, authors, year, date, and database) to an Excel spreadsheet (Microsoft Excel; Microsoft, Redmond, WA, USA). Third, title, abstracts, and method sections were independently screened for eligibility by two authors (FML and MALG), with two researchers screening each record. Subsequently, the full text of the remaining records was reviewed to verify inclusion/exclusion criteria. Regarding studies without full text, the researchers contacted the original studies' authors to complete the data-collection process. Any disagreements were resolved with a third reviewer until a 100% consensus was reached. Finally, nine studies were included for data extraction, quality, and risk of bias assessment, and GRADE (Grades of Recommendation, Assessment, Development, and Evaluation).[37]

2.4 | Data extraction

Two researchers (MATS and FMLM) independently reviewed the full text of the selected studies. One researcher extracted the information from the selected articles (MATS), and the other researcher (FML) checked the data for accuracy. Inconsistencies were resolved by discussion between them. The following information was extracted from the studies that met the selection criteria: author(s), country, design, theoretical background, sample, age, female (%), intervention description, covariates, and outcomes (i.e., motivational processes and PA assessment; see Table 1). If more information about the studies included was required, the authors of the primary studies were contacted via e-mail.

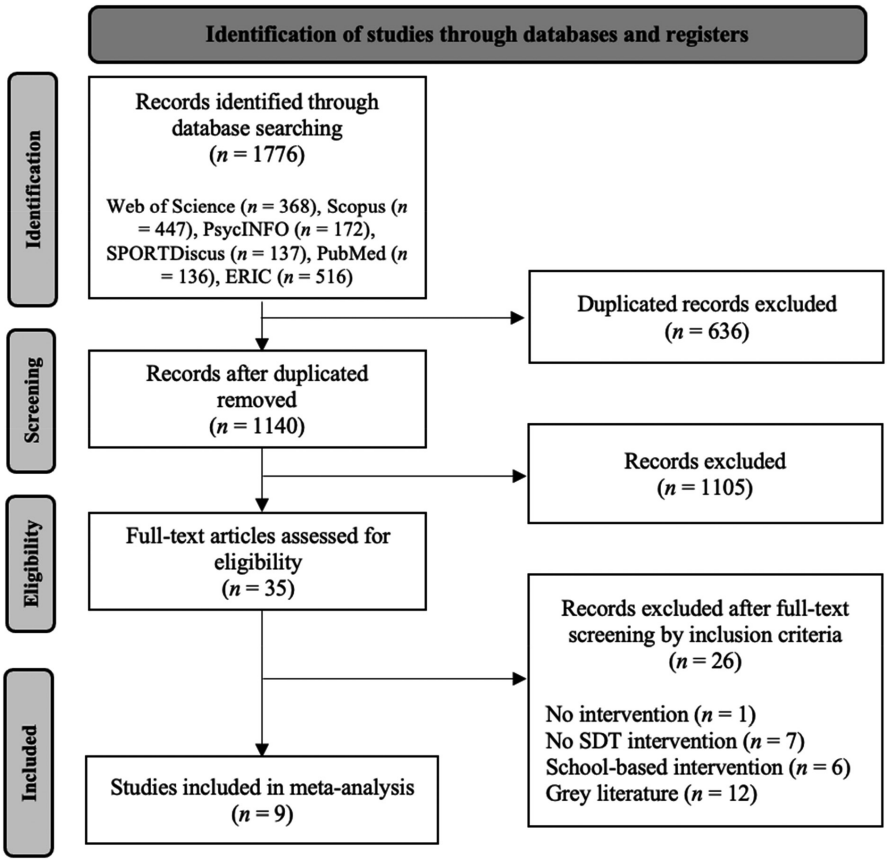

FIGURE 1 Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram.

2.5 | Methodological quality assessment and risk of bias

The "Risk of Bias" was assessed using the Cochrane Collaboration tool for assessing the risk of bias in randomized controlled trials (RCTs).[38] Two authors (MATS and IGP) performed the assessment of methodological quality independently. In case of disagreement, a third review author (PASM) was consulted, and doubts were discussed until a consensus was reached. This tool consists of eight items that measure the following aspects: (a) timing of measurement; (b) group similarity at baseline; (c) selective reporting; (d) incomplete outcome data; (e) blinding of outcome assessment; (f) blinding of participants/personnel; (g) allocation concealment; (h) random sequence generation. The complete checklist of risk of bias is included in Table S2. Each item was rated as low (+), high (−), or unclear risk of bias (?), the latter indicating a lack of information or uncertainty about possible bias.

Information on the authors, affiliations, date, and source of each study included in this review was hidden to avoid bias in the assessment of the methodological quality of the articles. The review authors MATS and IGP assessed the methodological quality independently (i.e., high quality, medium quality, and low quality). In case of disagreements, a third review author was consulted (PASM), and uncertainties were discussed until a consensus was reached. The methodological quality of studies was assessed using the Quality Assessment of Controlled Intervention Studies.[39] This checklist comprises 14 items that measure the following elements: (a) described as randomized; (b) treatment allocation-two interrelated pieces; (c) blinding; (d) similarity of groups at baseline; (e) dropout; (f) adherence; (g) avoid other interventions; (h) outcome measures assessment; (i) power calculation; (j) prespecified outcomes; (k) intention-to-treat analysis. The complete list of quality assessment questions has been included in Table S3. Each item was classified as yes (1 point), no (0 points), not reported, or not applicable, and was scored 1 point if the article provided a sufficient description of the item or 0 points if the publication did not provide an adequate description of the item. In addition, it was considered not reported if an insufficient or unclear description of the item was provided, while not applicable was assigned in cases where the criterion to be evaluated could not be applied. The maximum possible score that could be achieved was 14 points (all positive items). Based on the quality assessment of controlled intervention studies,[40] if the "yes" answers were >75% of the total, an article was considered of good quality; if they were ≤75% but ≥50%, an article was scored as fair quality; if they were <50%, the article was scored as poor quality. Therefore, a score >9 indicated good quality, 9–7 was fair quality, and studies scoring below seven were deemed poor quality.

TABLE 1 Description of the included studies reports.

Author; country/ design	Theoretical background	Sample/age/female (%)	Intervention description	Covariates	Outcomes	
					Motivational processes	PA assessment
Wilson et al.[52] United States Design: RCT	SDT and SCT	Children and adolescents 1563/10–13 years/55.0 IG: 729/10–13 years/55.83 CG: 693/10–13 years/52.38	IG: over 17 weeks, students participated in 3 sessions for a week, 120 min each. The ACT program had three main components: homework/snack (30 min), PA activities (60 min) that students selected each week, and a behavioral skills and motivational component (30 min) during which intervention staff worked with participants on developing strategies for increasing their PA outside the school. CG: over 17 weeks, students participated in three sessions for a week, 120 min each. The comparison program consisted of homework/snack (30 min) and three hands-on activities related to general health (30 min each).	Sex, ethnicity, and BMI.	Intrinsic Motivation Inventory[59]: Enjoyment* Perceived choice (Autonomy)*	Accelerometer: MVPA levels (min)
Jago et al.[48] United Kingdom Design: RCT	SDT	Children 310/9–10 years/59.3 IG: 153/9–10 years/55.83 CG: 157/9–10 years/52.38	IG: over 20 weeks, students participated in 2 sessions for a week, 60 min each. The Action 3:30 intervention is based on training teachers to provide PA sessions after school and all necessary resources and support. Detailed session plans were provided for all 40 sessions, which the teaching assistants were asked to deliver in the prescribed order. Every 2 weeks, the pupils were provided with an information sheet that included activity ideas based on the content of the last four sessions, which they could practice outside the club. CG: students did not receive intervention.	Sex, SES, school size.	X	Accelerometer (overall): MVPA weekday (min) MVPA weekday after school (min)* Accelerometer (girls): MVPA weekday (min) MVPA weekday after school (min) Accelerometer (boys): MVPA weekday (min) MVPA weekday after school (min)*
Jago et al.[20] United Kingdom Design: RCT	SDT	Children 571/11–12 years/100.0 IG: 287/11–12 years/100.0 CG: 284/11–12 years/100.0	IG: over 20 weeks, students participated in 2 sessions for a week, 75 min each. Session plans included guidance on how to reinforce the underlying SDT principles and advice on activities, group work, and dancing skill development. Sessions began 5–10 min after school. CG: students did not receive intervention.	SES	Behavioral Regulation in Exercise Questionnaire[60]: Autonomous motivation PA*** Controlled motivation PA*** Scale of Standage et al.[54]: Autonomy PA Intrinsic Motivation Inventory Scale[55]: Competence PA* Need for Relatedness Scale[56]: Relatedness PA***	Accelerometer: MVPA (min)

TABLE 1 (Continued)

Author; country/ design	Theoretical background	Sample/age/female (%)	Intervention description	Covariates	Outcomes	
					Motivational processes	PA assessment
Sebire et al.[21] United Kingdom Design: RCT	SDT	*Children* Overall: 490/11–12 years/54.69 IG: 231/11–12 years/52.81 CG: 259/11–12 years/ 56.37 Girls: IG: 122/11–12 years CG: 146/11–12 years Boys: IG: 109/11–12 years CG: 113/11–12 years	IG: over 20 weeks, students participated in 2 sessions for a week, 60 min each. CG: students did not receive intervention.	Sex, age, SES, and BMI	*Girls*: Behavioral Regulation in Exercise Questionnaire[60]: Autonomous motivation PA: Intrinsic motivation* Identified motivation* Controlled motivation PA: Introjected motivation External motivation Relatedness to Others in Physical Activity Scale[57]: Autonomy satisfaction* Competence satisfaction Relatedness satisfaction* *Boys*: Behavioral Regulation in Exercise Questionnaire[60]: Autonomous motivation PA: Intrinsic motivation Identified motivation Controlled motivation Introjected motivation External motivation* Relatedness to Others in Physical Activity Scale[57]: Autonomy satisfaction Competence satisfaction Relatedness motivation	X

(Continues)

TABLE 1 (Continued)

Author; country/ design	Theoretical background	Sample/age/female (%)	Intervention description	Covariates	Outcomes	
					Motivational processes	PA assessment
González-Cutre et al.[47] Spain Design: CT	SDT	Adolescents 88/14–17 years/59.09 IG: 29/14–17 years/73.68 CG: 59/14–17 years/64.41	IG: in the experimental group, three simultaneous actions were developed: (1) to teach a unit of 15 1-h sessions of the content block of fitness and health in PE lessons (the contents and activities of the teaching unit were reviewed by the research team to promote satisfaction of students' BPN); (2) to offer a program of free extracurricular PA after school for 6 months, with three 90-min weekly sessions (the contents were consistent with PE lessons); (3) three meetings were held with the parents, and a trekking excursion was organized in the natural environment, to involve parents in doing PA with their children. CG: to teach a teaching unit of 15 1-h sessions of the content block of fitness and health the same way as usually taught.	X	Spanish version of the Perceived Locus of Causality Scale[61]: Autonomous motivation PA: Intrinsic motivation** Integrated motivation Controlled motivation PA: Identified motivation* Introjected motivation External motivation Amotivation PA* Basic Psychological Needs in Exercise Scale[58]: Competence PA* Autonomy PA** Relatedness PA**	Spanish version of the Physical Activity Recall[73]: Physical strength Physical self-worth Daily light PA Daily moderate PA Daily hard PA* Daily very hard PA
Robbins et al.[51] United States Design: RCT	SDT and HPM	Children and adolescents 1519/10–15 years/100.0 IG: 753/10–15 years/100.0 CG: 766/10–15 years/100.0	IG: over 17 weeks, the intervention included three components: (1) 90-min after-school PA club offered 3 days/week; (2) two motivational, individually tailored counseling sessions; and (3) an interactive Internet-based session at the midpoint of the intervention. CG: students did not receive intervention.	Age, SES, BMI, ethnicity, race, pubertal stage, and study year.	X	Accelerometer: MVPA (min)
Riiser et al.[49] Norway Design: RCT	SDT	Children 456/5–6 years/47.8 IG: 212/5–6 years/45.8 CG: 214/5–6 years/49.1	IG: The Active Play in the after-school program intervention consisted of a 7-month course program targeting after-school program staff. The intention was to enhance their knowledge of and skills in creating a PA-supportive environment by accommodating and gently encouraging activities instead of directing them in a controlling manner. The intervention course program for the after-school program staff consisted of two introductory sessions led by two researchers, focusing on the children's PA play, the importance of friends, and the activity place. Furthermore, the sessions emphasized the after-school program staff's interaction styles, the children's motivation for PA, and how the staff could support the children's engagement in PA. CG: students did not receive intervention.	X	X	Accelerometer: MVPA (min)

TABLE 1 (Continued)

Author; country/ design	Theoretical background	Sample/age/female (%)	Intervention description	Covariates	Outcomes	
					Motivational processes	PA assessment
Robbins et al.[50] United States Design: RCT	SDT	Children and adolescents 81/10–13 years/50.6 IG: 38/10–13 years/31.6 CG: 43/10–13 years/67.4	The intervention included two parts: (1) parent-adolescents dyad meeting (1 week); (2) after-school Guys/Girls Opt for Activities for Life Club for PA, healthy eating, and cooking skills development for adolescents (weeks 2–12); and Facebook participation—Parents together with adolescents. IG: over 12 weeks, students participated for two 50-min PA sessions per week. CG: students did not receive intervention.	Sex, age, race, Hispanic ethnicity, weight status, annual family income, and parent marital status.	Behavioral Regulation in Exercise Questionnaire[60]: Autonomous motivation PA** Controlled motivation PA Amotivation	Accelerometer: MVPA (min)
Zarret et al.[53] United States Design: RCT	SDT and AGT	Adolescents 167/11–14 years/55.69 IG: 92/11–14 years/54.35 CG: 75/11–14 years/57.33	Prior to implementation, all intervention staff attended a 3-day training with PE consultants to learn how to implement all program activities and establish a positive social climate for PA. IG: over 10 weeks students participated in three 90-min PA sessions per week. CG: students did not receive intervention.	Sex, BMI, PA at baseline, and school.	X	Accelerometer: MVPA (min)*

Abbreviations: AGT, Achievement Goal Theory; BMI, Body Mass Index; BPN, Basic Psychological Needs; CG, Control Group; CT, Controlled Trial; HPM, Health Promotion Model; IG, Intervention Group; IMD, Index of Multiple Deprivation; MVPA, Moderate-to-Vigorous Physical Activity; PA, Physical Activity; RCT, Randomized Controlled Trial; SCT, Social Cognitive Theories; SCT, Social Cognitive Theory; SDT, Self-Determination Theory; SES, Socioeconomic Status.

*Indicates significant effects (pre to post) with a *p*-values <0.05.; **p-values <0.01.; ***p-values <0.01.

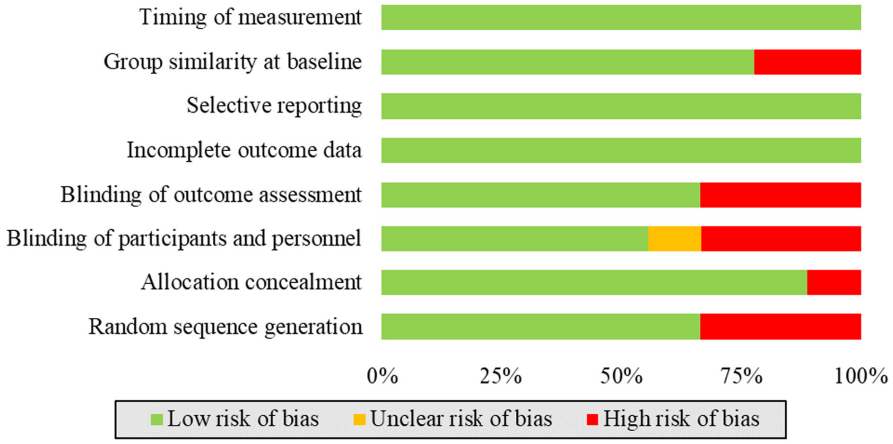

FIGURE 2 Risk of bias across all included studies.

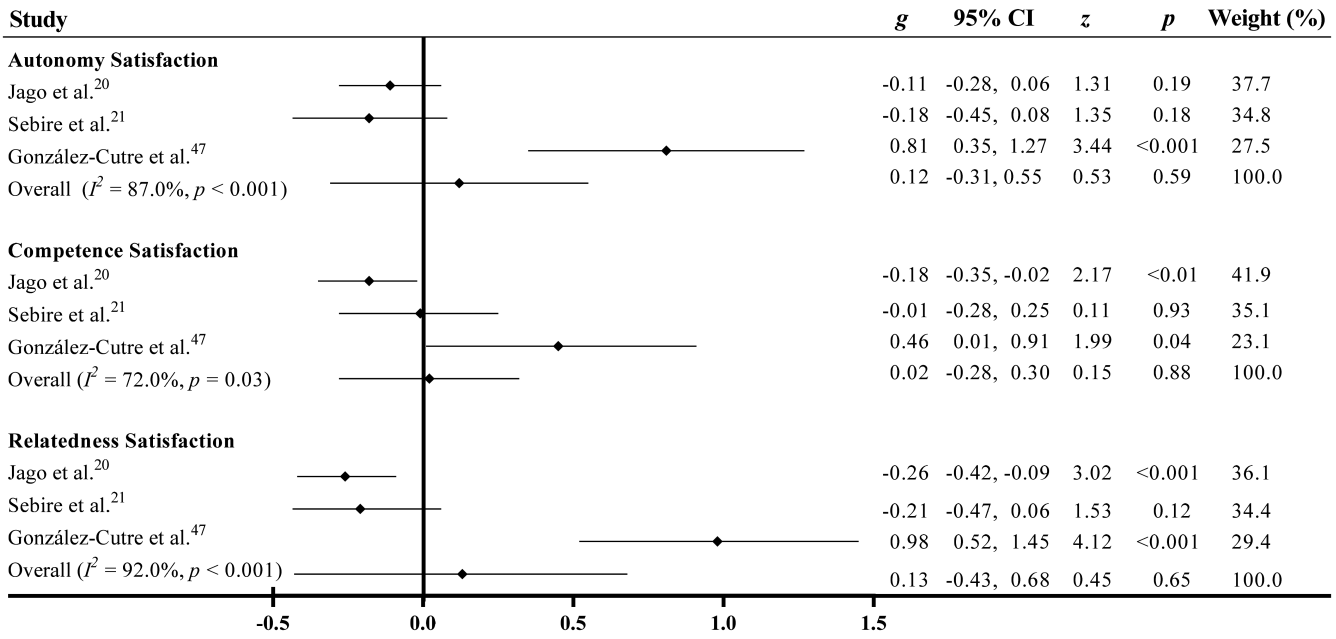

FIGURE 3 Forest plot BPN outcomes.

2.6 | Certainty of evidence

The certainty of evidence across studies was assessed at the outcome level using the GRADE approach.[37] Following this approach, randomized controlled trials begin as high-quality evidence, but they may be downgraded by the following domains: (a) study limitations (risk of bias), (b) imprecision, heterogeneity, (c) indirectness, and (d) suspicion of publication bias. The overall quality of evidence was rated by consensus between two authors (MATS and FMLM).

2.7 | Statistical analysis

Meta-analysis procedures of the results were performed using the Comprehensive Meta-analysis software (Version 2; Biostat Inc.)[41] and included a calculation of effect stations, a test for heterogeneity, and an analysis of publication bias.

As the outcomes of interest were continuous variables, Hedges' g of effect size was used to represent the standard mean difference between the means of the IG and the CG at post-test. Follow-up measurements were not considered. Hedges' g has the advantage of being more accurate for a small number of participants.[42] Like Cohen's d, effect sizes of 0.8 were assumed to be large, effect sizes of 0.5 were moderate, and effect sizes of 0.2 were small.[43] Positive effect estimates indicated that IGs had increased, higher scores than CGs; negative effects indicated that IGs had lower, more reduced scores than CGs. For demotivation scores, negative effect estimates indicate better scores for IGs compared to CGs. The main data input format used for effect size calculation was the mean, standard deviation, and sample size for each group. The main analyses included effect size

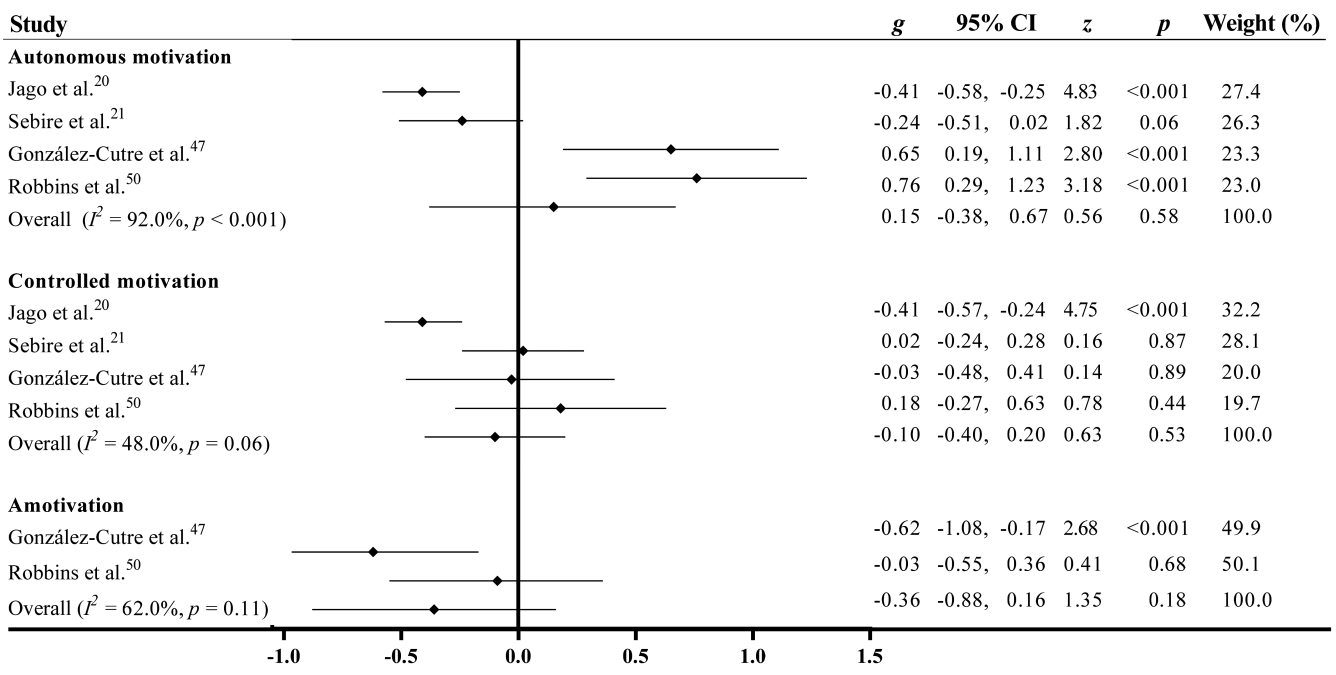

FIGURE 4 Forest plot motivations outcomes.

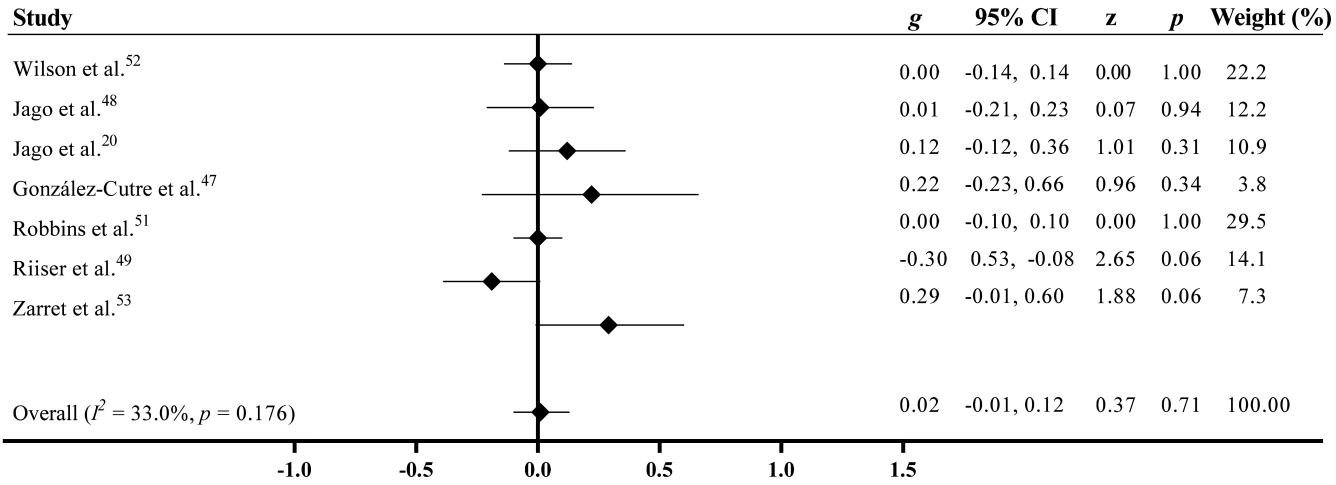

FIGURE 5 Forest plot physical activity outcomes.

calculations for needs satisfaction, motivations, and PA behavior. Effect sizes were calculated for studies overall (combining control trial [CT] and RCTs). The DerSimonian and Laird random effects model was used to account for anticipated heterogeneity between studies.[42,44] In addition, moderator analyses were conducted for the participants' age and the duration of the intervention.

Moreover, between-study heterogeneity was assessed quantitatively using Cochran's Q test (with alpha set at $p < 0.10$) and the I^2 statistic. The magnitude of heterogeneity was considered low if $I^2 < 50\%$, moderate if $I^2 = 50\%$–75%, and large if $I^2 > 75\%$.[45]

Publication bias was tested by visual inspection of the Funnel Plot in the outcome measures (an asymmetrical, rather than symmetrical, inverted funnel shape indicated publication bias). In addition, Funnel Plot asymmetry was statistically assessed using[46] the Egger linear regression test to quantify the bias captured by the funnel plot and test whether it was significant ($p < 0.05$).

3 | RESULTS

3.1 | General study characteristics

The studies included in this systematic review were carried out between 2011 and December 2021.[20,21,47–53] Most studies were performed in the United States ($n = 4$),

TABLE 2 Grade evidence profile.

N° of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Impact	Certainly
Autonomy satisfaction								
3	RCT	Not serious	Very serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = 0.12$, 95% CI = −0.31; 0.55)	⨁◯◯◯ Very low
Competence satisfaction								
3	RCT	Not serious	Serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = 0.02$, 95% CI = −0.28; 0.30)	⨁⨁⨁◯ Moderate
Relatedness satisfaction								
3	RCT	Not serious	Very serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = -0.13$, 95% CI = −0.43; 0.68)	⨁◯◯◯ Very low
Autonomous motivation								
4	RCT	Very serious	Very serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = 0.15$, 95% CI = −0.38; 0.67)	⨁◯◯◯ Very low
Controlled motivation								
4	RCT	Not serious	Serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = -0.10$, 95% CI = −0.40; 0.20)	⨁⨁◯◯ Low
Amotivation								
2	RCT	Serious	Serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = -0.36$, 95% CI = −0.40; 0.20)	⨁◯◯◯ Very low
Physical activity								
8	RCT	Not serious	Not serious	Not serious	Not serious	None	Meta-analysis revealed no significant effect (Hedges' $g = 0.10$, 95% CI = −0.01; 0.18)	⨁⨁⨁⨁ Very high

Abbreviation: RCT, Randomized controlled trial.

followed by the United Kingdom ($n=3$), Spain ($n=1$), and Norway ($n=1$). Concerning the study design, eight studies were RCTs, and one study was CT. Two studies included only female participants, and seven studies included both girls and boys (see Table 1). The youngest students were between 5 and 6 years old;[49] the oldest students were aged 17 years.[47] Studies were grouped according to students' age: participants between 5 and 11 years were categorized as children, and participants between 12 and 17 years were categorized as adolescents. In total, four studies directed their intervention at children,[20,21,48,49] two studies targeted adolescents,[47,53] and three studies targeted the intervention at both children and adolescents.[50–52]

Regarding the duration of the study, two studies had a short duration (<3 months),[50,53] five studies had a moderate duration (4–6 months),[20,21,48,51,52] and two studies were longer than 6 months (>6 months).[47,49] The sample sizes ranged from 81[50] to 1563 students.[52] In total, seven studies offered out-of-school PA lessons only,[21,48–53] one study combined out-of-school PA lessons and modified physical education lessons,[47] and one study included out-of-school PA classes in addition to involving parents.[53] The staff that delivered the interventions was diverse: research team staff, external health professionals, and peers. Regarding the theoretical frameworks, six studies were only based on SDT,[20,21,47–50] and three studies combined SDT with another theory.[51,52] Specifically, one study combined SDT and Social Cognitive Theory,[39] one study combined SDT and the Health Promotion Model,[38] and one study combined SDT and Achievement Goal Theory.[42]

In all studies, the IG was compared to the CG. Seven studies reported that CG received no intervention,[20,21,47–53] and two studies reported that CG participated in regular and traditional PA lessons.[47,52] The studies included in the review are described in detail in Table 1.

3.2 | Outcomes: needs satisfaction, motivations, and PA

Table 1 shows the outcomes of interest measured in the IG and CG at two time points (pre- to post-intervention). Meaningful results at post-test are indicated where applicable. Needs satisfaction was measured in three studies.[20,21,47] The instruments used to measure needs satisfaction were: Scale of Standage,[54] Intrinsic Motivation Inventory Scale,[55] Need for Relatedness Scale[56] Relatedness to Others in Physical Activity Scale,[57] and Basic Psychological Needs in Exercise Scale.[58]

Overall, five studies measured variables related to motivation.[21,47,48,51,52] The instruments used to measure motivations were: Intrinsic Motivation Inventory,[59] Behavioral Regulation in Exercise Questionnaire,[60] Spanish version of the Perceived Locus of Causality Scale.[61] Specifically, four studies assessed autonomous motivation and controlled motivation,[21,47,48,51] two studies assessed amotivation,[47,51] and one study evaluated enjoyment and perceived choice (i.e., subfactors of intrinsic motivation).[52] Lastly, four studies did not measure any motivational outcomes.

Out of the nine studies included in the systematic review, PA was measured in eight studies,[20,47–53] of which seven studies used accelerometers,[20,48–53] while only one study used self-reported questionnaires to measure PA.[47] There was only one study that did not assess PA.

3.3 | Methodological quality assessment and risk of bias

An overview of risk of bias for all included studies and each category is provided in Figure 2. Table S2 shows the risk of bias for each individual study. The most significant risk of bias across studies was found in the domains of random sequence generation and blinding of outcome assessment. The lowest risk of bias across studies was found in the domain's performance bias, incomplete outcome data, and timing of measurement. The latter is not included in the standard Cochrane Collaboration tool for assessing risk of bias in randomized trials.

Results of the methodological quality assessment are provided in Table S3. Thus, 55.6% of the studies ($n=5$) were considered "high quality," 33.3% ($n=3$) were considered "medium quality," and 11.1% ($n=1$) were considered "low quality." Most studies were RCTs, and performed a correct randomization process (88.9% Item 1, 77.8% Item 2, and 55.6% Item 3). Regarding blinding, 33.3% of the studies performed correct blinding of participants (Item 4), and 44.4% of the outcomes (Item 5). Concerning the IG and CG, 66.7% of the studies included samples with similar baseline characteristics (Item 6). In 33.3% of the studies, the dropout rate of participants was less than 20% (Item 7), while in 66.7% of the studies, the difference between the dropout rate of the CG and the IG was greater than 15% of the sample (Item 8). Overall, adherence to the programs of the included studies was high, with 77.8% of the studies indicating high adherence to the intervention program (Item 9). Only 11.1% of the studies reported avoidance of other interventions (Item 10), but 55.6% adopted sample size as the inclusion criteria (Item 12). Nevertheless, 100% of the studies included measurement of outcome measures (Item 11), outcomes measured at baseline (Item 13), and compared the outcomes of the IG and the CG (item 14).

3.4 | Effect of interventions on needs satisfaction, motivational variables, and PA

The effect of the motivational programs on each of the needs satisfaction is shown in Figure 3. More detailed information on the individual studies included in the meta-analysis of needs satisfaction can be found in Table S4. The results found no significant effect on autonomy satisfaction ($g = 0.12$, 95% CI [−0.31, 0.55], $p = 0.59$, $I^2 = 86.57\%$), competence satisfaction ($g = 0.02$, 95% CI [−0.28, 0.32], $p = 0.88$, $I^2 = 72.3\%$), or relatedness satisfaction ($g = 0.13$, 95% CI [−0.43, 0.68], $p = 0.65$, $I^2 = 91.79\%$).*

The effect of the motivational programs on the motivational variables can be seen in Figure 4. Detailed motivational results for each of the studies included in the meta-analysis of motivations can be found in Table S5. The results showed no significant changes in autonomous motivation ($g = 0.15$, 95% CI [−0.38, 0.67], $p = 0.56$, $I^2 = 91.64\%$), controlled motivation ($g = -0.10$, 95% CI [−0.40, 0.20], $p = 0.53$, $I^2 = 48.0\%$), or amotivation ($g = -0.36$, 95% CI [−0.88, 0.16], $p = 0.18$, $I^2 = 62.0\%$).*†

Figure 5 shows the effect of motivational programs on PA levels. Detailed information on the studies included in the meta-analysis of PA can be found in Table S6. Overall results for PA revealed high between-study heterogeneity ($g = 0.23$, 95% CI [−0.02, 0.47], $p = 0.07$, $I^2 = 89.97\%$). However, the exclusion of higher outliers resulted in a reduction of heterogeneity. Once the most discordant studies were removed, a sensitivity analysis was performed to compare the results of the fixed effects model vs. the results of the random effects model to check whether the mean effect sizes were similar between the two models (Figure S1). For PA, no significant effect sizes were found ($g = 0.02$, 95% CI [−0.08, 0.12], $p = 0.71$, $I^2 = 33.0\%$). Moderation analyses revealed no significant effect sizes in children ($g = 0.04$, 95% CI [−0.14, 0.22], $p = 0.220$) or adolescents ($g = 0.06$, 95% CI [−0.12, 0.23], $p = 0.530$). Moreover, no significant differences were found for the duration of the interventions ($g = -0.15$, 95% CI [−0.38, 0.07], $p < 0.188$). Neither were significant differences found based on the quality of the included studies ($g = 0.10$, 95% CI [−0.06, 0.18], $p < 0.202$).

3.5 | Publication bias

The results of the Funnel Plot and Egger's test can be found in Figures S2–S7. Neither funnel plot asymmetry nor Egger's test showed significant publication bias for autonomy satisfaction (see Figure S2, bias = 2.08, $p = 0.40$), competence satisfaction (see Figure S3, bias = 2.67, $p = 0.09$), relatedness satisfaction (see Figure S4, bias = 2.93, $p = 0.28$), controlled motivation (see Figure S5, bias = 1.94, $p = 0.05$), or PA (see Figure S6, bias = 1.64, $p = 0.10$), indicating no evidence of publication bias. However, Eggers' test was significant for autonomous motivation (see Figure S7, bias = 5.85, $p < 0.01$), showing an asymmetric funnel plot. Given that only two studies included amotivation, the analyses of Egger's test and the funnel plot could not be conducted for this variable.

3.6 | Certainty of evidence

The certainty of evidence was assessed according to the Grading of Recommendations Assessment, Development, and Evaluation (GRADE)[37] for the meta-analyzed outcomes of needs satisfaction, autonomous motivation, controlled motivation, amotivation, and PA (Table 2). The assessment of the certainty of evidence was classified as "very low," "low," "moderate," or "very high."

The certainty of evidence was initially set high for RCTs and CTs and decreased by one point for each item rated as "serious" and two points for each item rated as "very serious." The reasons for the decrease in the quality of evidence were publication bias, inconsistency of results, indirectness of evidence, and imprecision. Publication bias was present when Egger's test results were significant.[62] Results were considered inconsistent if heterogeneity between trials was large (serious: $I^2 > 50.0\%$; or very serious: $I^2 > 75.0\%$).[63] The indirectness criterion was not considered because we only included similar studies regarding population, intervention, comparator, and outcome.[63] Evidence was downgraded for imprecision if the total number of participants was less than 400 in all studies included in the meta-analysis.[63] Very high evidence was shown for PA. Moderate certainty of evidence was determined for competence satisfaction. Low certainty of evidence was determined for controlled motivation. Lastly, very low certainty of evidence was determined for autonomous motivation, amotivation, autonomy satisfaction, and relatedness satisfaction.

4 | DISCUSSION

This systematic review and meta-analysis sought to (1) identify peer-reviewed studies that applied an SDT-based out-of-school PA intervention to improve motivational processes toward PA and PA levels in children and adolescents; (2) perform a meta-analysis to test the effects found in such interventions. To our knowledge, this is the first meta-analysis that has examined the effects of

†Moderation analyses for BPNs and motivations were not performed because the number of studies was very low.

out-of-school SDT-based PA interventions on needs satisfaction, motivation toward PA, and PA behaviors. The main findings of this meta-analysis suggest that out-of-school SDT-based PA interventions do not improve levels of needs satisfaction or motivation toward PA. Similarly, no significant increase in participants' PA levels was found. These results contrast with SDT, so a thorough analysis of the characteristics of the identified studies is needed.

First, few studies have been published with out-of-school SDT-based PA interventions. Only nine publications were found that met the specified criteria. For instance, Demetriou et al.[18] found four studies, and Stewart and Sharma[26] identified five studies with out-of-school SDT-based interventions. In an educational context, Kelso et al.[27] found 57 studies that included different motivational theories during the regular school day. In summary, the literature shows that there are many more works on interventions within the school context than outside it, and few studies based on SDT.[26]

4.1 | Effect on needs satisfaction, motivational variables, and PA

First, a total of three studies assessed needs satisfaction after the intervention program.[20,21,47] The meta-analysis results indicated that the overall pooled effect size was small and statistically nonsignificant for autonomy satisfaction ($g = 0.12$, 95% CI [−0.31, 0.55], $p = 0.59$, $I^2 = 86.57\%$), competence satisfaction ($g = 0.02$, 95% CI [−0.28, 0.32], $p = 0.88$, $I^2 = 72.3\%$), or relatedness satisfaction ($g = 0.13$, 95% CI [−0.43, 0.68], $p = 0.65$, $I^2 = 91.79\%$). Only González-Cutre et al.[47] found positive changes in needs satisfaction due to the fact that: (a) the out-of-school PA program presented three 90-min weekly sessions over 30 weeks, and (b) the parents were involved in doing PA together with their children. In contrast, Jago et al.[20] and Sebire et al.[21] interventions were developed in 2 sessions over 20 weeks. Therefore, it seems that the duration of the program (3 months vs. 2 months), the intensity (3 sessions vs. 2 sessions), and the families' involvement may be key aspects for the interventions to have positive effects. In the educational setting, the meta-analyses on the satisfaction of the three BPNs developed by Kelso et al.[27] found that the overall combined effect size of PA interventions in school was small-to-moderate and statistically significant for autonomy satisfaction, but not for competence and relatedness satisfaction. Although the number of studies in the school setting was much higher (autonomy satisfaction [$n = 18$], competence satisfaction [$n = 30$], relatedness satisfaction [$n = 16$]), the results found were not very encouraging because the interventions did not improve competence and relatedness satisfaction. Perhaps assessing needs support is crucial in all contexts to know whether the strategies developed to improve needs satisfaction are optimal. However, need support was not evaluated in all the studies found in our systematic review. Furthermore, the fidelity of the intervention program was measured in five studies, and some of them did not report optimal values in the development of the strategies. For instance, González-Cutre et al.[47] evaluated need support, and improvements were found in the experimental group. However, Jago et al.[20] and Sebire et al.[21] studies showed small-to-moderate fidelity in the strategies to develop in the intervention program.

Second, five studies assessed autonomous motivation, controlled motivation, or amotivation in out-of-school PA interventions. The meta-analyses indicated that the overall pooled effect size of out-of-school SDT-based PA interventions was small and statistically nonsignificant for all types of motivations (i.e., autonomous motivation, controlled motivation, and amotivation). González-Cutre et al.[47] and Robbins et al.[51] found positive changes in autonomous motivation in contrast to Jago et al.[20] and Sebire et al.[21] The same reasons as previously explained for need satisfaction can be applied here. Overall, these results contrast with the findings shown in the meta-analysis developed by Manninen et al.[33] in organized activities (i.e., in and out of school) and by Kelso et al.[27] in the school setting. Manninen et al.[33] found a positive effect on autonomous motivation (i.e., intrinsic motivation and identified regulation) and a negative effect on external regulation and amotivation. Kelso et al.[27] found small-to-moderate and statistically significant effects for autonomous motivation (i.e., intrinsic motivation and identified regulation) and nonsignificant effects for controlled motivation (i.e., introjected and external regulations) and amotivation. Likewise, the meta-analysis of Burns et al.[32] revealed that school-based PA interventions (not based on SDT) had small-to-moderate effects on intrinsic motivation. Although this indicates that school-based intervention programs are more effective for increasing motivation, upon analyzing the studies included in our meta-analysis, significant effects for autonomous motivation can be observed in three studies[20,21,47] and for controlled motivation[20] and amotivation[47] in one study. Therefore, the studies developed so far do not seem to achieve the desired effects of improving motivation toward PA. In this regard, previous systematic reviews[36,64] have reported some benefits of interventions in school compared to interventions developed outside of school. Some of these benefits are: (1) the intervention brings together the entire population for an extended period of time; (2) children spend a large part of the day in

schools; (3) it employs PE teachers with prior training in promoting PA and motivation in class; (4) it links all the agents of the educational and social community. However, out-of-school interventions based on behavior change theory, such as SDT, take a long time, and prior training in motivational strategies is necessary to train the instructors.

Third, the effect of out-of-school PA interventions based on the participants' PA levels was nonsignificant. A review of reviews of out-of-school PA interventions[18] revealed significant differences among published reviews assessing the impact of out-of-school interventions on children's PA. For instance, Beets et al.[65] concluded that out-of-school programs were effective in improving PA and health in children and adolescents. In contrast, Atkin et al.[66] stated that to date, interventions to promote PA in the out-of-school setting were ineffective, but they attributed this in part to weaknesses of methodology or implementation. Finally, Pate and O'Neill,[15] Branscum and Sharma,[67] and Mears and Jago[68] reported that out-of-school PA interventions had mixed effectiveness in increasing PA levels and that, as yet no definitive conclusions could be derived regarding their efficacy. Overall, Demetriou et al.[18] synthesized that there was little support for the effectiveness of out-of-school programs on children's PA levels, but the overall evidence was inconclusive. Therefore, given that the results of our meta-analyses showed a positive effect close to 0.05 ($p = 0.07$), this suggests that the SDT-based interventions developed so far may not be sufficient to increase PA levels in children. Thus, the combined use of SDT with other practical strategies, such as the Supportive, Active, Autonomous, Fair, and Enjoyable (SAAFE)[69] principles could be a resource for increasing the effectiveness of interventions to promote out-of-school PA. The SAAFE principles enable practitioners to deliver engaging PA sessions to youth to maximize their participation and increase their motivation toward PA.

To summarize the meta-analysis results, it seems that SDT-based interventions to increase motivational processes and PA developed outside the school have a lower effect, with a lack of significance, compared to interventions developed in the school, which have demonstrated their usefulness in optimizing motivational variables, as well as levels of PA.[27] Furthermore, it seems that SDT-based interventions are not more effective than interventions only focused on PA.

This could be due to several reasons. As previously mentioned, the small number of studies makes it more difficult to establish clear and robust results concerning existing research in the educational context. Furthermore, interventions developed outside the educational context are also more complex than those carried out in a more controlled and stable environment such as a school. This fact may hinder greater experimental control for the activities carried out by the participants, the facilities and materials used to perform the activities, the diversity of the activities, or the sample's characteristics, among other issues.[68] For example, PA interventions carried out outside the school context usually target participants who have voluntarily agreed to do PA and who usually already participate in sports programs. Thus, these participants probably had high levels of PA practice and motivation toward these activities.[18]

Another possible explanation for the differences showed in our work and previous reviews may be the theoretical framework used in out-of-school PA interventions. Demetriou et al.[18] found numerous theories applied to the design of the out-of-school interventions (e.g., social cognitive theory [$n = 23$] or SDT [$n = 4$]). However, they did not analyze the effects of the interventions in terms of the theory used. For instance, Mears and Jago[68] reported that the interventions based on theories of behavior change were no more effective than those with no underlying theory. Therefore, it would be interesting to analyze the effects of the interventions of each theory, as the most appropriate theories may not be used, or the theories may not be implemented adequately.

Regarding heterogeneity, similar to previous meta-analyses,[27,32,70] the overall pooled effects were affected by considerable heterogeneity across studies, recommending their further exploration in subgroup analyses. Removing outliers and studies with higher or lower effect estimates reduced the heterogeneity in the results for PA. Previous studies have suggested that the age and duration of interventions might help explain heterogeneity.[27,70] However, the results of the present study found no significant differences between moderator groups for age and duration of interventions. Due to the mixed results found, it is suggested that future studies further explore subgroups for age and duration of interventions.

This review and meta-analysis have some limitations that open new perspectives of research. First, as the search only considered studies published in English and Spanish, some works may have been left out of this search due to the publication language. Second, the motivational strategies of the included studies were not analyzed because not all studies specifically presented the strategies developed in the programs, so it is impossible to know how the interventions were developed outside the school setting. Therefore, it would be interesting for future works to analyze SDT-based strategies used in these studies' intervention programs to evaluate their effectiveness. Third, we could not analyze the effects of the interventions on all motivational regulations but only on the types of motivation (i.e., autonomous motivation, controlled motivation,

and amotivation) because some studies did not report the values of these motivational regulations. Fourth, we did not perform the moderation analysis for BPNs and motivations because the number of studies was very low. Nor did we perform the moderation analysis for objective vs. subjective tests because the groups were very different, which could bias the results. Finally, another limitation of the review is that only SDT-based PA interventions were included, so the results could not be compared with other interventions based on other theories. Future reviews could examine the effect on PA of programs based on other theories.

4.2 | Perspectives

Despite these limitations, the present systematic review and meta-analysis have several strengths. This is the first study to analyze the effectiveness of SDT-based PA interventions outside the school. Furthermore, the present review and meta-analysis followed a process based on the PRISMA guidelines. Based on the results found future studies should employ strategies or techniques identified as effective for promoting PA motivation and increasing PA levels.[35,71,72] These strategies could be applied conjointly with others from other behavior change theories, perhaps achieving better results. Furthermore, the instructors' training should be more extended, even during the intervention, and knowledge of SDT strategies and their implementation in a real context should play a significant role. In addition, supervision of the development of these strategies during the intervention is essential; that is, exhaustively assessing the degree of fidelity to the strategies can help the children and adolescents to achieve more benefits. Finally, more robust designs with larger population sizes and better measurement tools may obtain better results in motivational processes and PA.

5 | CONCLUSIONS

The results of this systematic review and meta-analysis suggest that out-of-school SDT-based PA interventions do not increase autonomy, competence, or relatedness satisfaction. Results in the range of motivational outcomes also indicated that this type of out-of-school PA intervention seems ineffective for autonomous motivation, controlled motivation, and amotivation. Similarly, out-of-school SDT-based PA interventions do not seem to have a positive effect on participants' PA. Thus, this study shows that out-of-school SDT-based PA interventions have not achieved a sustainable change in motivational processes or PA behavior.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Additional supporting information can be found online in the Supporting Information section at the end of this article.

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