

Physical activity among school-aged children and intervention programs using self-determination theory (SDT): A scoping review

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Abstract

Introduction: Moderate to vigorous physical activity (MVPA) among children is imperative for proper development. However, the problem of physical inactivity is a concern among many countries worldwide. Self-Determination Theory (SDT) has been widely used to develop interventions aimed at promoting autonomy for physical activity (PA) among children and adolescents. The aim of this scoping review was to evaluate the efficacy of intervention studies based on SDT in promoting MVPA among school-aged children.

Methods: PRISMA-ScR guidelines were used in conducting this scoping review. An electronic literature search in MEDLINE (PubMed), Google Scholar, ERIC, and Academic Search Premier was performed to identify intervention studies based on SDT aimed at promoting PA among school-aged children. Studies had to meet the following inclusion criteria: (i) participants were children or adolescents (between 5 and 18 years of age); (ii) a focus on promoting PA interventions; (iii) quantitative or mixed-method based, and (iv) intervention had to be based on SDT.

Results: A total of 10 interventions met the eligibility criteria. Nine of the 10 studies were experimental studies and 1 observational, cross sectional study. A total of 2,577 children and adolescents participated in the 10 studies. Six studies utilized the randomized controlled trial design (RCT); only three studies demonstrated a significant, consistent, increase of MVPA among the intervention groups; one of which was a RCT study. There was little to no increase in MVPA among girls within the research. Additionally, two studies revealed that children were more physically active as long as parents or teachers were involved.

Discussion: The results of this scoping review showed insufficient evidence for the efficacy of intervention studies based on SDT in promoting MVPA among children and adolescents. Therefore, newer fourth-generation theories such as the multi-theory-model (MTM) for health behavior change is suggested and can be tested by future interventions.

KEY WORDS: sedentary behavior, physical activity, moderate to vigorous physical activity, motivation, intrinsic motivation, autonomy.

Riassunto

Introduzione: L'attività fisica moderata o intensa nei bambini è fondamentale per uno sviluppo appropriato. Tuttavia, il problema dell'inattività fisica è motivo di preoccupazione per molti Paesi nel mondo. La teoria dell'autodeterminazione è stata ampiamente usata per sviluppare interventi finalizzati alla promozione di autonomia per l'attività fisica nei bambini ed adolescenti. L'obiettivo di questa scoping review è stato quello di valutare l'efficacia di studi di interventi basati su questa teoria per promuovere l'attività fisica moderata ed intensa tra i bambini in età scolastica.

Metodi: Le linee guida PRISMA-ScR sono state utilizzate per condurre questa scoping review. Una ricerca di letteratura nei database MEDLINE (PubMed), Google Scholar, ERIC, ed Academic Search Premier è stata realizzata per identificare studi di interventi basati sulla teoria dell'autodeterminazione per promuovere l'attività fisica nei bambini in età scolastica. Gli studi dovevano rispettare i seguenti criteri di inclusione: 1) i partecipanti erano bambini o adolescenti (tra i 5 ed i 18 anni); 2) focalizzare su interventi di promozione dell'attività fisica; 3) studi quantitativi o basati su metodi misti ed 4) interventi basati sulla teoria dell'autodeterminazione.

Risultati: Un totale di 10 studi ha soddisfatto i criteri di eleggibilità. Nove dei 10 studi erano studi sperimentali ed 1 era osservazionale con disegno di studio trasversale. Un totale di 2.577 bambini ed adolescenti ha partecipato nei 10 studi. Sei studi erano trial clinici randomizzati controllati (RCT); solo tre studi hanno dimostrato un significativo, consistente, incremento dell'attività fisica moderata/intensa all'interno dei gruppi di intervento ed uno di questi era un RCT. C'è stato un incremento piccolo o nessun incremento di attività fisica tra le ragazze. Inoltre, due studi hanno rivelato che i bambini erano fisicamente attivi tanto quanto i genitori o gli insegnanti coinvolti.

Discussione: I risultati di questa scoping review hanno evidenziato insufficiente evidenza di efficacia degli studi di intervento basati sulla teoria dell'autodeterminazione nel promuovere l'attività fisica tra i bambini e gli adolescenti. Le teorie più recenti della quarta generazione come la Multi-theory-model (MTM) per i cambiamenti degli stili di vita è suggerita e può essere testata da futuri interventi.

TAKE-HOME MESSAGE

In this scoping review, we found that Self-Determination Theory has limited applicability in changing physical inactivity behavior in children and adolescents. For a holistic and sustainable approach to physical activity among children, newer fourth-generation models that utilize multiple theories must be tested.

Competing interests - none declared.

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INTRODUCTION

Moderate to vigorous physical activity (MVPA) among school-age children provides a variety of health benefits [1]. Regular MVPA can help children and adolescents improve cardiorespiratory fitness, build strong bones and muscles, increase energy balance, control weight, reduce symptoms of anxiety and depression, and reduce the risk of developing health conditions like heart disease, cancer, type 2 diabetes, high blood pressure, osteoporosis, and obesity in adulthood [1, 2]. Conversely, uninterrupted sedentary behavior can lead to the onset of a host of health problems [3]. Clinical and public health guidelines found that youth need a minimum of 60 minutes of MVPA a day [4]. The Active Healthy Kids Global Alliance's goal [3] is to increase children's MVPA on a global level. A Global Matrix report is produced every two years with PA trends and findings among the participating countries. In 2016, Matrix 2.0, included reports for 38 countries on MVPA among children [3]. Only two of the 38 countries received an A on the report card using a scale ranging from A-F. Both the United States of America and the United Arab Emirates received an F grade for the children's MVPA report cards. On the other hand, Zimbabwe and the Netherlands are the only two countries that received an A [3]. Physical inactivity and sedentary behavior are associated with a variety of health problems. According to research, habitual physical inactivity is associated with energy imbalance, increase risk of becoming overweight and obese, increase factors for cardiovascular disease, increase risk of developing type 2 diabetes, increase risk of developing some types of cancers, low bone density, and depression [1,2,6]. Children who are intrinsically motivated and supported for continual MVPA are more likely to become physically active and continue such behavior throughout adulthood [5]. School and home interventions are needed to address the problem of childhood physical inactivity adequately. The Social Cognitive Theory (SCT) has been widely used by many behavioral health professionals aiming to reduce physical

inactivity, and as a guide to predict MVPA and healthy food choices among children [2, 6, 7]. Self Determination Theory (SDT) is another theory that has been used in promoting physical activity among children and adolescents. SDT is a motivation theory based on three foundational psychological needs, autonomy – having choice and control; competence - having the knowledge and skills to perform a behavior successfully; and relatedness – connectedness to essential others and self. Motivational promotion with SDT is commonly used to foster MVPA through intervention, as intrinsic motivation through autonomy is the foundation of this theory [8–10]. High autonomy for MVPA is thought to be a powerful predictor of the sustenance of MVPA. According to SDT, the degree of autonomy children have in MVPA depends on the satisfaction of SDT constructs [9]. MVPA interventions using SDT depend on internal motivation and desire. The purpose of this scoping review was to examine existing evidence on the efficacy of behavioral health childhood MVPA interventions based on SDT and identify recommendations for interventions to promote MVPA in school-aged children between the ages of 5-18 years.

METHODS

PRISMA-ScR was used as a guideline for completing this scoping review. The PRISMA-ScR checklist consists of 22 items that researchers can use to guide the development and synthesis of a scoping review. In conducting this research, the authors ensured that each section that applied, met the PRISMA-ScR guidelines' standards. Using these guidelines, this scoping review aims to identify gaps in the literature on PA within school-aged children and to induce further research [11].

Search strategy

A comprehensive search of five electronic databases (MEDLINE, PubMed, Google Scholar, ERIC, and Academic Search Premier) was conducted. Databases were searched from January 26, 2020, through March

31, 2020. Articles published 2015 and after were first searched with the following search terms: children AND physical activity AND behavioral intervention, adolescents AND physical activity AND intervention, children AND physical activity AND theory-based intervention, adolescents AND physical activity AND theory-based intervention. Most articles found were atheoretical interventions, except for a few based on various theories. Nonetheless, a theme arose. Articles that populated the results were based on SDT. For consistency, the first author narrowed the search to one theory-SDT. The timeline was broadened to articles published 2010 and after, and the search terms were changed to: children AND moderate to vigorous physical activity AND SDT intervention, and adolescents AND moderate to vigorous physical activity AND SDT intervention.

Studies had to meet the following criteria for inclusion into the scoping review: (i) study participants had to be with children or adolescents (between 5 and 18 years of age); (ii) the study had to focus on promoting physical activity interventions, on enhancing motivation to be physically active, or interventions that enhance/promote moderate to vigorous physical activity; (iii) studies had to be quantitative or mixed-methods based evaluations, and (iv) interventional approach of the studies had to be based on the SDT. The first author independently reviewed identified studies based on title, abstract, findings, and, if needed, the full text of the articles. The exclusion criteria were: (i) articles from other databases and gray literature; (ii) articles utilizing other theories or atheoretical; (iii) descriptive or review articles; and (iv) qualitative evaluations (Figure 1).

Data extraction

The first author completed the data extraction from articles and independently checked it. The data which were available in the selected studies were extracted including the following items: (i) author, year and country; (ii) population and sample; (iii) theory used; (iv) design; (v) intervention description; (vi) sa-

lient findings, (vii) statistical methods, (viii) outcome measures, (ix) number of measurements (x) whether the sample size was estimated, (xi) whether the measurement scales were validated, and (xii) whether the process evaluation was done; if yes salient findings. Because initiation to participate in MVPA depends upon motivation, an analysis of the role of motivation and sustenance was conducted.

Quality of evidence

The quality assessment instrument was critical in the finding of quality primary studies used in this scoping review. The instrument consists of six quality components that aid in the score of RCTs and nonrandomized studies [12]. The components include: (i) sample selection/selection bias, (ii) study design, (iii) confounders, (iv) blinding, (v) reliability and validity of data collection tools and (vi) withdrawals and drop-outs. The rating of the overall study is determined by the rating of these six components, which are appraised as strong, moderate, and weak. Studies with at least four strong ratings out of the six are considered strong. Studies with less than four strong ratings and one weak rating are termed moderate. Finally, studies with two or more weak ratings were considered weak [2, 12]. All studies used in this scoping review were rated as moderate or strong according to the quality assessment instrument.

RESULTS

The literature search yielded 37 published references. After review of the title, abstract, and full-text (in some studies), a total of 10 studies met the full inclusion criteria and were included. Articles that were excluded included: two systematic reviews, two articles that were repeated, seven articles that were nonintervention, six that were not based on SDT, one that was a qualitative study, and the last nine were atheoretical intervention based. Tables 1 and 2 summarize the main results of the included studies. Studies were conducted in countries across the world, including the United States (one study), Australia

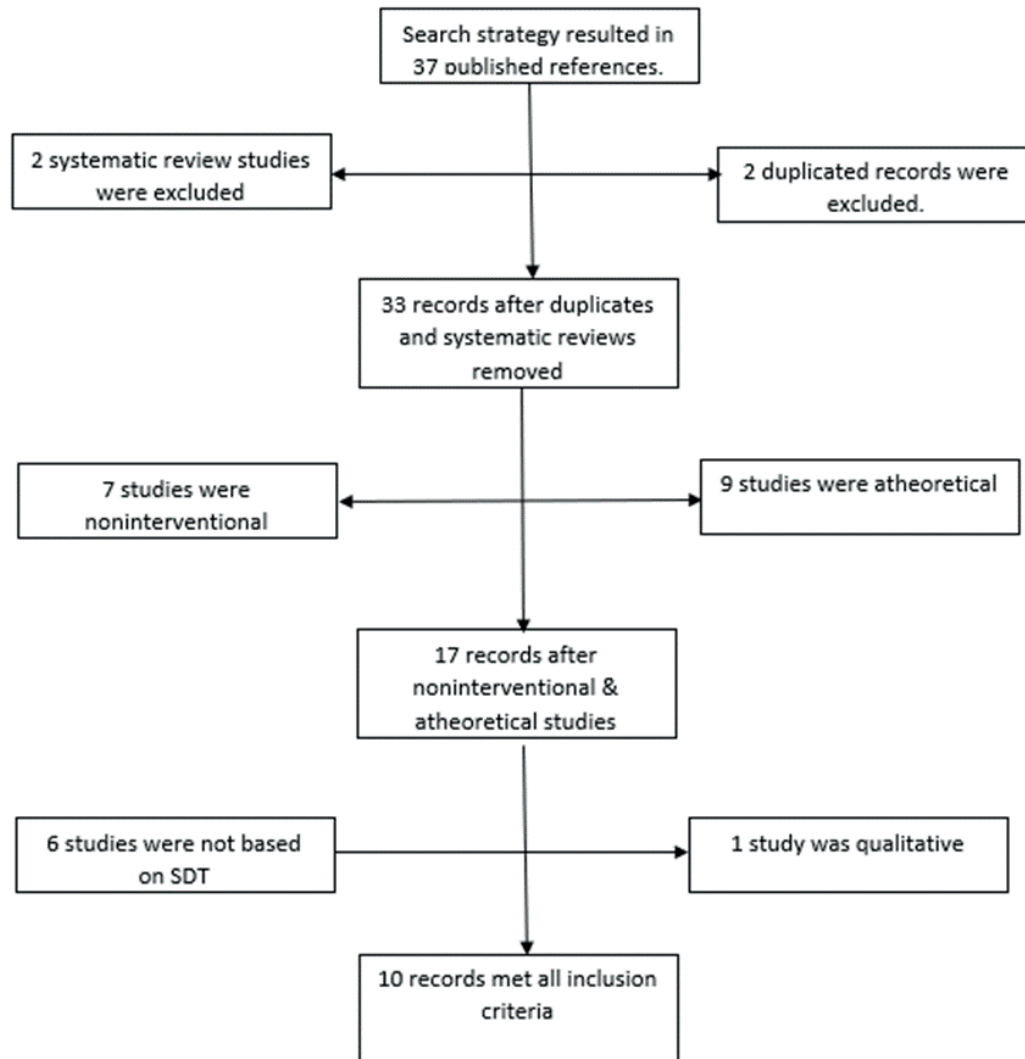


Figure 1. Flowchart for identification of trials for inclusion in the scoping review.

(one study), England (two studies), Bristol United Kingdom (three studies), Spain (two studies), and Ireland (one study). The mean ages of the study participants were between 8 and 11 years. A total of 2,577 children and adolescents participated in all the 10 studies combined. One study was performed only on girls [15], and study participants of the other nine studies were both girls and boys. All ten studies focused on building or measuring children’s and adolescent’s autonomy for physical activity. Three studies did not have a control group [9, 10, 19], two of which used a baseline and follow-up assessment [10, 19]. The duration of the intervention in most studies was between 1 week and 15 weeks. One intervention was 20 weeks with a one-year

follow-up [15]. One study only shared the time length of the intervention activity, four blocks of four 20-minute lessons; however, the duration of the intervention was not stated [13]. One intervention was longitudinal over a period of three years [10]. There were six RCT studies, all of which conducted a follow-up or post-test after the intervention [8, 13–17]. Parents and caregivers were included in one study [17]. In two studies, some of the results were shown in earlier papers, which were included [14, 16]. All of the studies used SDT to increase autonomy for MVPA. The main target of all the studies was to promote MVPA sustainability through autonomy. Overall, among the RCT studies ($n = 6$) that reported MVPA, only one study showed a

significant increase in MVPA among all intervention groups in comparison to the control groups [13], and three studies did not show consistent, significant differences with all intervention participants at the end of the study [14–16]. Within the three randomized controlled studies that showed no significant difference, one had a significant increase in MVPA among boys and no increase in MVPA among the girls, and one was an all-girl group without any significant increase in MVPA [14, 15]. The other study showed an increase in MVPA only during intervention days, proving unsustainability of PA [16]. One RCT showed a moderate increase in MVPA among participants [8]. One RCT study showed a significant increase in MVPA during the weekdays compared to the control group, while the control group reported more MVPA time during the weekends compared to the intervention group [17]. For three randomized controlled trial studies, which showed follow-up data, no significant differences were found between groups at 4-month follow-up [14], 3-month follow-up [17], and a 1 year follow up [15] after the intervention. Two RCT studies were based on variations of the same intervention. One intervention was based on Action 3:30 [14], and the other intervention was based on Action 3:30R, a revised Action 3:30 intervention [16]. In one study which did not have a control group, the following results were found: significant improvement in MVPA among boys and private school students, while no significant compliance was found among obese students and girls [9]. In studies conducted with parents' or teachers' participation, children were more physically active as long as the parents or teachers were physically active. Once parents and teachers discontinued MVPA, children MVPA eventually followed suit [17, 19]. Three studies proved to have a significant, consistent increase of MVPA among participants [10, 13, 18], one of which was a RCT study [13]. SDT is a motivation theory based on three foundational psychological needs, autonomy – having choice and control; competence - having the knowledge

and skill to perform a behavior successfully; and relatedness – connectedness to essential others and self. Motivational promotion with SDT is commonly used to foster MVPA through intervention, as intrinsic motivation through autonomy is the foundation of this theory [8–10]. Autonomy and competence were used as SDT constructs in most, if not all, of the studies to change MVPA behaviors in children. However, only in a few studies the effects of intervention on SDT constructs were specifically measured and reported [8–10, 13–19].

DISCUSSION

The purpose of this study was to conduct a scoping review of all published interventions based on SDT and suggest recommendations for designing interventions that can promote MVPA in children and adolescents. The results of the current review showed weak evidence for the efficacy of interventional studies based on SDT in promoting MVPA among children and adolescents. There was found an uptake in MVPA in only three of ten studies [10, 13, 18], one of which was RCT [13], and one of which was a longitudinal study of over a year to verify sustainability [10]. One study showed modest improvement in MVPA among all participants [8]. Additionally, MVPA uptake and sustenance among girls proved to be especially ineffective. Seven studies documented no consistent, significant increase in MVPA among girls [8, 9, 14–17, 19]. This is contrary to what was found in a systematic review conducted in 2012 on MVPA and SDT. The results in this review found a significant increase in uptake and predicted sustenance of MVPA among all participants of the articles reviewed. However, the participants in this systematic review were all adults, and the duration of the interventions or follow-up were not provided [20]. In all of the referred review studies (except for two studies: one which was performed among children and parents [17], and one which was performed among girls only [15], both children and adolescents were considered as the studied population. Among the ten articles,

Table 1. Summary of studies included in the review with a focus on interventions ($n = 10$).

Title and Year	Country of study	Study population	Theory used	Study design	Type of intervention and duration	Main findings
A cluster randomized controlled trial of strategies to increase adolescents' physical activity and motivation in physical education: Results of the Motivating Active Learning in Physical Education (MÁLP) trial 2013 [13]	Sydney Australia	288 students Adolescents year 8 (11-13) in public and private secondary schools located in Sydney Australia -16 total	SDT	Quasi-experimental cluster-randomized controlled trial design	Intervention group- PA guided by choice and autonomy using SDT. Control group- PA guided by teacher choice. 4 blocks of 4-20min PE lessons	When given an opportunity to choose PA during PE, adolescents were more likely to participate in MVPA. -The 'free choice' intervention increased PA ($p < .05$). -Providing choice' and 'free choice' interventions decreased sedentary behavior ($p < .05$).
Feasibility trial evaluation of a physical activity and screen-viewing course for parents of 6 to 8-year-old children: Teamplay 2013 [17]	Bristol	48- 6-8 years old and their parents	SDT	Randomized control	Parent/children program to promote family PA. 2 months with a 2 month follow up	Within the 2-month intervention families were more PA and watched less TV, except for weekends. -The controlled group continued to watch more TV and less PA. -After intervention parents and families were not consistent with routines. -Children in the intervention group engaged in 2.6 fewer minutes of weekday MVPA at Time 1 but engaged in 11 more minutes of weekend MVPA.
Self-determined motivation, physical exercise and diet in obese children: A three-year follow-up study 2014 [10]	Spain	27 adolescents ages 8-11	SDT	Quasi-experimental	The program consisted of three weekly 90-minute sessions of physical activity. 3 years	-For uptake and intrinsic motivation in long term PA, more time is needed for obese children to perceive exercise and a balanced diet as habits of a healthy lifestyle. - Both groups showed improvements in motivation in the 3rd year and in the detraining period (in the G1 and G2, respectively) and study in intrinsic regulation of exercise behavior (in the G1 and G2, respectively) -Intrinsic motivation was maintained during 6 months of detraining. -SDT helped to build motivation for pleasurable PA
Factors associated with compliance with physical activity recommendations among adolescents in 2015 [9]	Huesca Spain	200 students 12-13	SDT & SEF	Cross-sectional	Sigue la Huella is a school-wide PA Promotion intervention for adolescents aged 12-15 years. Based on a SEF and SDT, the intervention incorporates strategies to create favorable environments, address barriers, and empower adolescents to live a more physically active life 1 week	- About 56.4% of boys and 9.9% performed >60 min. MVPA a day. - Compliance with MVPA intervention was higher among boys and students attending private schools, and lower for obese student - Compliance was also associated with higher perceptions of physical competence, higher perceptions of autonomy in physical education, greater importance attached to physical education and less sedentary time -SDT can be used to address motivational factors in PA - Complying with the recommendations were approximately 30% lower in obese students.

Title and Year	Country of study	Study population	Theory used	Study design	Type of intervention and duration	Main findings
Effect and cost of an after-school dance program on the physical activity of 11-12 year old girls: The Bristol Girls Dance Project, a school-based cluster randomized controlled trial 2015 [15]	Bristol, UK	40 - 7 th grade girls age 11-12	SDT	Mixed method evaluation -cluster-randomized controlled intervention	9 classes of controlled and 9 intervention groups. The intervention consisted of 40, 75-min after-school lessons that took place, twice per week for 20 weeks at school and were led by 10 professional dance instructors between January and July -Girls kept dance diaries to record feelings and thoughts -BDGP instructors were taught on SDT how to provide autonomy, competence and relatedness support Twice a week for 20 weeks-1 year follow-up	The BGDGP intervention was not effective in increasing girls' MVPA at the end of the intervention period when dance lessons were still running or at 12 months after baseline - Following the intervention, autonomous and controlled motivation and perceptions of competence and relatedness were lower among intervention versus control group participants -Instructors showed low autonomy support according to data. -The dance MVPA program was chosen based on SDT, as girls stated they would prefer dance MVPA in a previous study conducted by the author.
Texting to Increase Adolescent Physical Activity: Feasibility Assessment 2016 [8]	Southwest United States	160- Adolescents 14-17	SDT	Randomized control	82 texts were delivered - 12 goal prompts (e.g., "My daily step goal this week is...!") and 72 texts promoting the basic psychological needs 12 weeks	- Those who were a part of the intervention group partook more steps a day. - Participants in the pedometer + goal prompt and pedometer + goal prompt + SDT informed text groups received one goal prompt each week; those in the pedometer + goal prompt + SDT informed text group also received 6 weekly texts promoting the basic psychological needs. - Modest increases in average daily step counts and moderate-to vigorous physical activity were observed in all groups except the control group. - Adolescents in the group receiving all intervention components had the greatest increases in steps (+317.8 steps/day) and MVPA (+1.73 minutes/day) when compared to other groups
Delivery and Receipt of a Self-Determination-Theory Based Extracurricular Physical Activity Intervention: Exploring Theoretical Fidelity in Action 3:30 2016 [14]	Bristol, UK	539 Children 8-10- primary school with 18 TA	SDT	Experimental mixed method Randomized control	- 6 Intervention schools received Action 3:30 - based on motivation 15 weeks - twice a week 60min-4 month follow up	- Among intervention boys there were small increases in identified, introjected, and external motivation and no differences in need satisfaction. - Among girls, intrinsic and identified motivation and autonomy and relatedness were lower in the intervention group

Title and Year	Country of study	Study population	Theory used	Study design	Type of intervention and duration	Main findings
Evaluation of a Walking-Track Intervention to Increase Children's Physical Activity during Primary School Break Times 2018 [19]	England	81 children ages 5-7 and 7-9	Ecological model BCT and SDT	Experimental approach Mixed method	A walking trail was installed into the students play area. Students' autonomy (SDT) was thought to guide the use of the walking trail. The number of walking steps each play period during the intervention was measured. 6-9 weeks	-Students used the walking trail at the onset of intervention. -More boys used the walking trail than girls. -When teachers stopped walking consistently, it affected children's uptake of the trail. -Sustained use of the walking trail was not found during mid and end follow-up measurements. -Older children 7-9 used the walking trail more - Short term positive increases in girls' and boys' MVPA and longer-term increases in boys' vigorous PA (VPA) were found.
The Effect of a School-Based Intervention on Physical Activity and Well-Being: a Non-Randomized Controlled Trial with Children of Low Socio-Economic Status 2018 [18]	Ireland	155 - 8-9 years	SDT	Non-randomized experimental control	Weekly sessions consisted of a series of active discussions and physical tasks that contained messages around the health benefits of physical activity. The student volunteers received a teaching resource detailing language and techniques consistent with needs supportive tenets in SDT 10 weeks	- In comparison to the control group, the intervention was related to increases in MVPA ($r = .45$) and autonomy-support ($r = .17$) -Autonomy support from teachers increases PA motivation. - In comparison to the control group, the intervention group increased their total and MVPA during school days from baseline to post-intervention (i.e. 4.49 min improvement).
Action 3:30R: process evaluation of a cluster randomized feasibility study of a revised teaching assistant-led extracurricular physical activity intervention for 8 to 10 year old 2019 [16]	Southwest England	335 Children 8-10- primary school with 18 TA	SDT	Cluster randomize control experimental	6 Intervention schools received Action 3:30 - based in motivation 15 weeks - twice a week 60min	-Confidence intervals spanning zero suggest no meaningful difference between groups for primary or secondary PA outcomes. -The proportion of pupils meeting the 60 min MVPA per weekday guidelines appeared to be no different in the intervention group compared to the control group overall and among the boys and girls separately. (mean 18.99 min of MVPA vs 10.38 min of MVPA respectively). -84 out of 120 students participated in $\geq 50\%$ of sessions study arms at the end of the intervention

Table 2. Summary of studies included in the review with a focus on methodology ($n = 10$).

Authors and year	Type of Outcome measures	Type of follow-up	Estimate of the sample size	Validation of measurement tools
Chris Lonsdale, Richard R. Rosenkranz, Taren Sanders, Louisa R. Peralta, Andrew Bennie, Ben Jackson, Ian M. Taylor, David R. Lubans 2013 [13]	-ActiGraph GT3X accelerometers (ActiGraph; Pensacola, FL) were used to assess PA levels (percentage of time spent in MVPA and percentage of time spent sedentary) -Freedson's MET prediction equation was used to determine PA intensity, and 100 counts per minute was used as a criterion to determine the sedentary time. -Research assistants conducted all data collection	4 baseline & post-intervention	Yes- using moderate levels at (medium $f = 0.25$) (Cohen's $d = 1.07$). A sample of 76 students in order to achieve 95% power, with alpha set at .05. Increase of the sample by 20% and recruit 308 students from 16 PE classes	Yes
Russell Jago, Simon J Sebire, Katrina M Turner, Georgina F Bentley, Joanna K Goodred, Kenneth R Fox, Sarah Stewart-Brown and Patricia J Lucas 2013 [17]	- Accelerometer data Standard deviations of 12, 17 and 20 minutes were used as these three different values have been reported in the literature when describing the PA patterns of 6-8 year old children [44-46]	-3 - baseline (time 0), end of the intervention (week8) 3 month follow up (week 16)	Yes	Yes
Jose M. Saavedra Antonio García-Hermoso, Yolanda Escalante, Ana M. Dominguez 2014 [10]	-A repeated-measure ANOVA was used to compare the interaction between the different groups (G1 and G2 group) and the different evaluations (baseline, 3rd-year, and detraining) -The Tukey post hoc test was used to compare means. Cohen's categories were used for the magnitudes of the effect size (ES): small if $0 < d < .2$; medium if $.2 < d < .5$; and large if $ d > .5$ (Cohen, 1988). Obese prevalence was compared using Pearson's χ^2 - The level of significance for all statistical tests was set at $p < .05$. All calculations were performed using SPSS	3 - baseline, mid/end and follow up/detraining	No	Yes
Berta Murillo Pardo, Enrique García Bengochea, Alberto Aibar Solana, José Antonio Julián Clemente, Luis García González, José Martín-Alboy Sergio Estrada Tenorio 2015 [9]	- descriptive statistics for all predictor variables and the outcome variable - chi-square tests and analyses of variance (ANOVA) to examine potential associations between the predictor variables and compliance with recommendations. Statistical significance in both cases was set at $p < .05$	1	Yes- sample of this study was 200 adolescents (108 boys and 92 girls) with an average age of 12.16 (± 0.51) years. Of these, 142 attended public schools, and 58 private school	Yes
Russell Jago, Mark J. Edwards, Simon J. Sebire, Keeley Tomkinson, Emma L. Bird, Kathryn Banfield, Thomas May, Joanna M. Kesten, Ashley R. Cooper, Jane E. Powell, and Peter S. Blair 2015 [15]	Baseline (T0) assessments (before randomization) - . The first follow-up (T1) was weeks 17-20 to assess MVPA during the intervention. The second follow-up (T2) was 52-weeks after T0 assessments	3 - baseline, mid/end and follow up	Yes- ICC of 0.087 and final cluster size for analysis of 24 we estimated that with 90 % power and 5 % (two-sided) alpha an initial sample of 540 girls from 18 schools (30 per school) was required.	Yes
Debbe Thompson, Dora Cantu, Betsy Ramirez, Karen W. Cullen, Tom Baranowski, Jason Mendoza, Barbara Anderson, Russell Jago, Wendy Rodgers, Yan Liu 2016 [8]	- Accelerometer data were screened to identify periods of wear and non-wear time using the publicly available SAS - Data were collected in 10-second epochs -Adolescents in the group receiving all intervention components had the greatest increases in steps (+317.8 steps/day) and MVPA (+1.73 minutes/day) when compared to other groups	2 baseline and immediate post-study	Yes - a sample size of 160 (40/group)	Not mentioned

Authors and year	Type of Outcome measures	Type of follow-up	Estimate of the sample size	Validation of measurement tools
Simon J. Sebire, Mark J. Edwards, Kenneth R. Fox, Ben Davies, Kathryn Banfield, Lesley Wood, and Russell Jago 2016 [14]	- outcomes are reported for 222 boys (intervention n = 109, control n = 113) and 268 girls (intervention n = 146, control n = 122) who provided complete data at all three measurement time points (i.e., N = 490; 90.9% of randomized participants). Independent samples t tests indicated that included participants were not different from excluded participants on motivation, need satisfaction, deprivation, or BMI. BMI z scores (boys' M = 0.69, SD = 1.17; girls' M = 0.50, SD = 1.19)	3 – baseline, end and follow up	No	Yes- internal and external validity
Emma Powell, Lorayne A, Woodfield, Alexander J. Powell, Alan M. Nevill, and Tony D. Myers 2018 [19]	-Significant increase in children walking from baseline to post-intervention (MD = 236.52, p < 0.001, 95%CI) -However, there was a significantly different decrease from post-intervention to follow-up. (MD=-230.04, p <0.001, 95%CI) - Sex proved to be a significant factor, as boys accumulated more steps than girls at all three data collection points, with 9% variation mean	3 – pre-intervention, post-intervention, follow up	Yes-a purposeful sample, with the criterion of a mixture of boys and girls, and who represented diversity in activity behaviors	Yes
Stephen Shannon, Deirdre Brennan, Donncha Hanna, Zoe Younger, Jessica Hassan, and Gavin Breslin 2018 [18]	- MVPA ($\beta = .45$, $p = .005$) and autonomy-support (M1; $\beta = .17$, $p = .003$). The intervention group's mean minutes of MVPA increased from 21.06 (SD 6.24) at baseline to 24.91 (SD 7.48) at post-intervention, while the control group's - post-intervention mean minutes (M 23.48, SD 7.14) decreased in comparison to their baseline (M 19.50, SD 8.20)	baseline and post	Yes-the total sample size was 155 children, comprising 72 boys and 82 girls with a mean age of 8.7 years (SD = .50)	Yes
Byron Tibbitts, Alice Porter, Simon J. Sebire, Emma L. Bird, Emily Sanderson, Chris Metcalfe, Jane E. Powell, and Russell Jago 2019 [16]	335 (n = 170 intervention, n = 165 control) pupils aged 8–10 years (mean age 8.4 ± 0.66, 49% female) were recruited from 12 primary schools - (- 0.5, 95% CI = - 4.57, 3.57) - Quantitative measures were collected before and throughout the 15-week intervention to assess the dose, fidelity, and effectiveness of the intervention.	5 including pre and post-test	No	Yes- internal and external validity

one study showed a significant increase in MVPA only during intervention activity [16], three studies showed a significant increase in boys only [9, 14, 19], two studies documented a decline in MVPA uptake by the end of the intervention or follow-up [17, 19], one study reported a modest increase in MVPA without a follow-up [8], and one study reported no increase in MVPA at all [15].

It is important to note that the mean of the study participants were 8-10 years of age, as children transition into adolescents. Four studies consisted of participants aged 11 years and over [8, 13, 15, 19], five studies included participants between the ages of 8 and about 10/11 [10, 15, 16, 18, 19], and only one study consisted of participants under the age of eight, at 6-8 years of age [17]. Current data from this research explicitly reveals the lack of uptake of MVPA among girls and other children through the use of SDT interventions. The results of the present study indicate that physical inactivity among children is a global phenomenon, as only one of the studies were based in America. In fact, according to the Global Matrix 2.0: Report card grades on the PA of children and youth among the 38 countries, only two countries received an A on the report card on a scale from A-F and INC, and America was one of two that received a failing grade of F on the childhood PA report card [3].

Use of SDT to change physical inactivity

The use of behavioral theories helps in identifying measurable program outcomes, stipulates methods for behavioral change, and improves program efficiency and effectiveness compared to atheoretical interventions [2]. Psychological theories of motivation and behavior like SDT have also been vigorously used to explain physical inactivity patterns [20]. However, the problem persists nationally, and worldwide, as many youths, especially girls, MVPA levels remain low [1]. Interventions grounded in theories like SDT have made little impact in resolving the problem of physical inactivity among school-aged children.

SDT depends on the autonomy of participants in adhering to the newly adopted behavior. Therefore, intrinsic motivation to want to become physically active and continue with MVPA is crucial for this theory to work within an intervention. SDT does not emphasize the use of extrinsic motivation [21, 22]. Nevertheless, for children to adopt new behavior and develop autonomy about this behavior, mimicry, motivation, and sustenance support is crucial. Family support of being physically active motivate children to do the same. Social factors in and outside of the home, like mothers, fathers, friends, and teachers support, positively influence children to become physically active [5, 23]. Additionally, the sustenance of learned behavior is not taken into consideration with the SDT. With SDT being a psychologically-based theory and not behavior-based theory, the long-term implications of continual behavior are not taken into account. One may assume that the SDT perceives that autonomy for behavior is developed and sustained inwardly. However, with children, it must be enacted and continually nourished to become sustainable long-term.

A relatively new theory that may prove to be more successful in addressing the physical inactivity epidemic among children is the Multi-Theory-Model (MTM) for Health Behavior Change. The constructs of the MTM have been validated, and are based on previously proven theories [24, 25]. There are two overarching components of MTM, the initiation of health behavior change, and the sustenance of health behavior change. Under these components are specified constructs. Initiation, the stage a new behavior begins, consists of the following three constructs: participatory dialogue, behavioral confidence, and changes in the physical environment. Sustenance, that is the continuing of the behavior, is made up of three additional constructs: emotional transformation, practice for change, and change in the social environment [24, 25]. MTM addresses all aspects of behavioral change, from conception to continuance, as it explains and predicts health behavior changes

that are one-time and long-term [24, 25]. The composition of this theory provides a perfect nest to foster autonomy and motivation in children in order to initiate MVPA and sustain MVPA into adulthood.

Limitations of the review

The review is not a comprehensive systematic review and as such all PRISMA guidelines were not met. The review did not include articles from other than the selected databases as well as articles from gray literature were excluded. The review also did not include qualitative evaluations. Since only published peer-reviewed articles were included there is potential of publication bias having played a role in the interpretation of the results. However, the chances are low because many of the studies did not have significant results. Future studies can undertake systematic review and meta-analysis on this topic.

CONCLUSIONS

The current scoping review found weak evidence for the efficacy of SDT interventions that were designed to promote MVPA among school-aged children. Three of the ten studies [10, 13, 18], resulted in significant uptake of MVPA among all participants. Only one of these studies were RCT [12], one was CT non-randomized [18], and the last was non-RCT and non-CT [10]. It is recommended that a theory based on intrinsic motivation, uptake, and sustenance is used for MVPA intervention among school-age children to ensure long-term MVPA patterns. Results from this study prove that SDT based intervention has not enforced a sustainable change in the behavior of MVPA. Further studies systematically using effective behavior change strategies or techniques, larger population sizes, better measurement tools, and more robust designs are warranted for a conclusive judgment.

References

1. Physical Activity Facts [Internet]. The Center for Disease Control and Prevention. 2020 [cited 2020 Feb 12] Available from: <https://www.cdc.gov/healthyschools/physicalactivity/facts.htm>.
2. Bagherniya M, Taghipour A, Sharma M, Sahebkar A, Contento IR, Keshavarz SA, et al. Obesity intervention programs among adolescents using social cognitive theory: a systematic literature review. *Health Educ Res.* 2018;33(1):26–39.
3. Tremblay MS, Barnes JD, González SA, Katzmarzyk PT, Onywera VO, Reilly JJ, et al. Global matrix 2.0: report card grades on the physical activity of children and youth comparing 38 countries. *J Phys Act Health.* 2016;13(s2):S343–366.
4. Kohl III HW, Cook HD, editors. *Educating the student body: Taking physical activity and physical education to school.* National Academies Press; 2013.
5. Chicote-López J, Abarca-Sos A, Gallardo LO, García-González L. Social antecedents in physical activity: Tracking the self-determination theory sequence in adolescents. *J Community Psychol.* 2018;46(3):356–373.
6. Motl RW. Theoretical models for understanding physical activity behavior among children and adolescents—social cognitive theory and self-determination theory. *J Teach Phys Educ.* 2007;26(4):350–357.
7. Ramirez E, Kulinna PH, Cothran D. Constructs of physical activity behaviour in children: The usefulness of Social Cognitive Theory. *Psychol Sport Exerc.* 2012;13(3):30310.
8. Thompson D, Cantu D, Ramirez B, Cullen KW, Baranowski T, Mendoza J, et al. Texting to increase adolescent physical activity: Feasibility assessment. *Am J Health Behav.* 2016;40(4):472–483.
9. Pardo BM, García-Bengochea E, Solana AA, Clemente JA, González LG, Martín-Albo J, et al. Factors associated with compliance with physical activity recommendations among adolescents in Huesca. *Rev Psicol Deporte.* 2015;24(1):147–154.

10. Saavedra JM, García-Hermoso A, Escalante Y, Domínguez AM. Self-determined motivation, physical exercise and diet in obese children: A three-year follow-up study. *Int J Clin Health Psychol.* 2014;14(3):195–201.
11. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med.* 2018 Oct 2;169(7):467–473.
12. Thomas BH, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews Evid Based Nurs.* 2004;1(3):176–184.
13. Lonsdale C, Rosenkranz RR, Sanders T, Peralta LR, Bennie A, Jackson B, et al. A cluster randomized controlled trial of strategies to increase adolescents' physical activity and motivation in physical education: results of the Motivating Active Learning in Physical Education (MALP) trial. *Prev Med.* 2013;57(5):696–702.
14. Sebire SJ, Edwards MJ, Fox KR, Davies B, Banfield K, Wood L, et al. Delivery and receipt of a self-determination-theory-based extracurricular physical activity intervention: exploring theoretical Fidelity in action 3: 30 *J Sport Exerc Psychol.* 2016;38(4):381–395.
15. Jago R, Edwards MJ, Sebire SJ, Tomkinson K, Bird EL, Banfield K, et al. Effect and cost of an after-school dance programme on the physical activity of 11–12 year old girls: The Bristol Girls Dance Project, a school-based cluster randomised controlled trial. *Int J Behav Nutr Phys Act.* 2015;12(1):128.
16. Tibbitts B, Porter A, Sebire SJ, Bird EL, Sanderson E, Metcalfe C, et al. Action 3: 30R: process evaluation of a cluster randomised feasibility study of a revised teaching assistant-led extracurricular physical activity intervention for 8 to 10 year olds. *BMC Public Health.* 2019;19(1):1111.
17. Jago R, Sebire SJ, Turner KM, Bentley GF, Goodred JK, Fox KR, et al. Feasibility trial evaluation of a physical activity and screen-viewing course for parents of 6 to 8 year-old children: Teamplay. *Int J Behav Nutr Phys Act.* 2013;10(1):31.
18. Shannon S, Brennan D, Hanna D, Younger Z, Hassan J, Breslin G. The effect of a school-based intervention on physical activity and well-being: a non-randomised controlled trial with children of low socio-economic status. *Sports Medicine Open.* 2018;4(1):16.
19. Powell E, Woodfield LA, Powell AJ, Nevill AM, Myers TD. Evaluation of a walking-track intervention to increase children's physical activity during primary school break times. *Children.* 2018;5(10):135.
20. Teixeira PJ, Carraça EV, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: a systematic review. *Int J Behav Nutr Phys Act.* 2012;9(1):78.
21. Deci EL, Ryan RM. Self-Determination Theory In Van Lange P, Kruglanski AW, & Higgins ET (Eds.), *Handbook of Theories of Social Psychology.* 2011. p. 416–437.
22. Deci EL, Ryan RM. Self-Determination Theory. P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of Theories of Social Psychology.* Sage Publications Ltd; 2012. <https://doi.org/10.4135/9781446249215.n21>.
23. Chatham RE, Mixer SJ. Cultural influences on childhood obesity in ethnic minorities: A qualitative systematic review. *J Transcult Nurs.* 2020;31(1):87–99.
24. Sharma M. Multi-theory model (MTM) for health behavior change. *Webmed Central BEHAVIOUR.* 2015;6(9):WMC004982.
25. Sharma M. Developing multipronged intervention protocols for childhood obesity prevention based on Multi-Theory Model (MTM) of Health Behavior Change: A mini review. *Adv Obes Weight Manag Control.* 2017;6(4):141–142.
26. Jago R, Sebire SJ, Davies B, Wood L, Edwards MJ, Banfield K, et al. Randomised feasibility trial of a teaching assistant led extracurricular physical activity intervention for 9 to 11 year olds: Action 3: 30. *Int J Behav Nutr Phys Act.* 2014;11(1):114.