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Are school-based interventions promoting 24-hour movement guidelines among children? A scoping review

Javier Rodrigo-Sanjoaquín[a,b], Julien E Bois[a], Alberto Aibar Solana[b], Léna Lhuisset[a], Ana Corral-Abós[b] and Javier Zaragoza Casterad[b]

[a]Département Sciences et Techniques des Activités Physiques et Sportives (STAPS), Université de Pau et des Pays de l'Adour, Tarbes, France
[b]Departmento de Expresión Musical, Plástica y Corporal, Facultad de Ciencias Humanas y de la Educación, Universidad de Zaragoza, Huesca, España

Abstract

Objective: 24-hour movement behaviours can effect sustainable long-term benefits in children, but their implementation and effectiveness have not previously been reviewed in the school setting. Thus, the aim of this scoping review was to provide an overview of school-based interventions targeting physical activity (PA), sedentary behaviour (SB), and sleep in 5–12-year-old children.

Design: Scoping review.

Methods: A structured bibliographic search of five databases was conducted to retrieve peer-reviewed intervention studies published in English language, between January 2010 and December 2020.

Results: Among the 37 studies included with a total sample size of 27,145 primary school-aged children, only one study assessed sleep, PA and SB. The average duration of the intervention studies was between 7 and 10 months.

Conclusion: The main gap identified was that current school-based interventions do not include complete 24-hour movement behaviours among children as there is a lack of intervention studies addressing sleep behaviour. In addition, this first international review of 24-hour movement behaviours in a school setting found that the number of intervention studies that incuded follow-up measures is limited, so it is difficult to interpret their sustainability.

Keywords

Children, health promotion, physical activity, sedentary behaviour, sleep

Corresponding author:
Javier Rodrigo-Sanjoaquín, Département Sciences et Techniques des Activités Physiques et Sportives (STAPS), Université de Pau et des Pays de l'Adour, 65000 Tarbes, France.
Email: jrsanjoaquin@univ-pau.fr

Background

The prevalence of non-communicable diseases has increased over the last few decades, to become a major public health problem and the first cause of death worldwide (Roth et al., 2018). Insufficient physical activity (PA), as well as high levels of sedentary behaviour (SB) are two of the most noteworthy health-related behavioural risks for non-communicable diseases (Ding et al., 2016; Roth et al., 2018). In addition, 80% of the world's children and adolescents do not meet current PA recommendations (Guthold et al., 2020). Moreover, sedentary screen-time behaviours (i.e. playing videogames, TV viewing, smartphone use or computer use) and sedentary time (ST; i.e. leisure and occupational sitting time) take up over 50% of the waking day for 7-year-old children, and 75% of the waking day for 15-year-old adolescents (Janssen et al., 2016). Some studies have also shown that unhealthy sleep habits (i.e. irregular sleep patterns, poor sleep quality and short sleep duration) are associated with poor health outcomes (e.g. poor physical and psychological well-being, unhealthy dietary patterns and a lack of cognitive performance) among young people (Chaput and Dutil, 2016; Golley et al., 2013). In addition, children sleep less today than several decades ago, with only 60% of them meeting sleep recommendations (Chaput et al., 2015; Matricciani et al., 2012). Overall, low PA, high SB levels and short sleep duration have been linked to various adverse health outcomes including lack of perceived well-being, poor cardio-metabolic health, overweight and obesity in children (Chaput et al., 2017; Rollo et al., 2020).

The three behaviours (PA, SB and Sleep), also called movement behaviours, can influence sustainable long-term benefits in children (Chaput et al., 2014; Rollo et al., 2020; Tapia et al., 2022). Due to the lack of a common research approach to the three behaviours, an integrated theoretical framework was developed in Canada in 2016, called the 24-Hour Movement Guidelines, which incorporates the recommendations for PA, SB and sleep (Tremblay et al., 2016). The model recognises the importance of movement behaviours to improve health outcomes in children and adolescents from an integrated perspective (Rollo et al., 2020; Tapia et al., 2022). The combination of these movement behaviours appears to impact health in different ways that cannot be explained simply by adding together the effects of the individual behaviours studied separately (Chaput et al., 2017; Rollo et al., 2020). Despite this, much school health research has largely focused exclusively on PA or SB (Chaput et al., 2014), with sleep usually dealt with separately from the other two behaviours (Blunden and Rigney, 2015; Busch et al., 2017). However, in view of the recent publication of 24-hour movement guidelines, sleep should clearly be taken into consideration in school health interventions.

School plays a vital role for promoting healthy behaviours in both children and adolescents, as the majority of the population have spent time there for a certain period in the course of their lifetime, and children spend half their daily waking time at school (Hegarty et al., 2016). In addition, schools offer a context in which to reach the majority of children, and provide an obvious intervention setting, irrespective of children's background characteristics, gender, socio-economic status (SES) or ethnicity (Åvitsland et al., 2020). Moreover, schools are an ideal health promotion setting as they can reach several other target groups in addition to children and adolescents, such as school staff, teachers, families and even members of the local community (Gugglberger, 2021).

While some studies have adopted multiple movement behaviour interventions, no review of this global approach exists in the school setting. We found only some reviews that targeted a combination of two movement behaviours in children (e.g. PA and SB) or a single movement behaviour (e.g. sleep), which addressed issues and outcomes such as obesity prevention (Agaronov et al., 2018; Ash et al., 2017), weight gain prevention (Goldthorpe et al., 2020; Nooijen et al., 2017) and energy balance (Anselma et al., 2020). Finally, only three meta-analyses focused on examining PA and SB in school children (Jones et al., 2020; Love et al., 2019; Rodrigo-Sanjoaquín et al., 2022).

Aim

In terms of all 24-hour movement behaviours, to date, only two systematic reviews of cross-sectional studies have addressed the prevalence of meeting the guidelines (Rollo et al., 2020; Tapia et al., 2022). However, there is a lack of information on the implementation of 24-hour movement behaviours in the school setting through school-based interventions. Thus, to fill this gap in the literature, we aimed to review and summarise the implementation and effectiveness of school-based interventions targeting movement behaviours among 5–12-year-old children.

Materials and methods

This scoping review (ScR) was written up in a manner informed by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018). The PRISMA-ScR checklist is available as online Supplemental Material to this paper. The study was also registered in PROSPERO (CRD42020199154).

Information sources and search strategy

A structured electronic bibliographic search of five databases (Pubmed, Scopus, SPORTDiscuss, The Cochrane Library and Web of Science) was conducted to retrieve peer-reviewed intervention articles published in the English language between January 2010 and to December 2020, coinciding with the last decade of research and consolidation of the 24-hour movement guidelines. We selected these databases according to published recommendations on conducting academic searches for ScR, systematic reviews and meta-analyses in terms of database availability (Gusenbauer and Haddaway, 2020). The search strategy combined multiple previously agreed keywords, which were developed by breaking down the study aim. We also selected the keywords based on the search strategies of similar review studies (Agaronov et al., 2018; Goldthorpe et al., 2020; Love et al., 2019; Rodrigo-Sanjoaquín et al., 2020). To conduct the literature search, we followed the Population, Interventions, Comparisons and Outcomes (PICO) framework (Schardt et al., 2007). An example of the keywords selected for the database searches is available in Table 1. More detailed information on the search strategy is available as online Supplemental Material.

Eligibility criteria

Two review authors (JR-S and AC-A) assessed studies that met the following eligibility criteria in the initial search processes. Studies were included if they targeted healthy primary school children without mental disabilities. Study participants were required to have a mean age of between 5 and 11.99 years old, with at least two exposure measurement points (i.e. baseline and post-test), although follow-up measures of movement behaviours were acceptable beyond this age limit.

Only interventional designs with a control group measure (i.e. randomised controlled trials [RCTs], cluster RCTs, grouped RCTs, pilot RCTs and non-randomised studies [e.g. quasi-experimental controlled studies and pilot quasi-experimental controlled studies]) were included. Studies that exclusively used a qualitative approach, and therefore did not include any quantitative data, were excluded from the review. Finally, studies were required to incorporate at least two movement behaviours from the three behaviours of the 24-hour movement guidelines. The behaviours could have been assessed by self-report (e.g. questionnaires) or by device-based measures (e.g. accelerometer data and/or pedometers).

Table 1. PICO strategy.

Category	Definition	Search terms
Population	Children (from 5 to 12 years old)	Child* OR student OR pupil OR infant OR childhood OR school* OR schoolchildren OR school children OR schoolage* OR school-age* OR school age* OR primary school OR elementary school OR basic school NOT adolescent*
Intervention	Health promotion intervention studies that implement different strategies in/from school	Strategy* OR technique* OR intervention* OR program* OR health prevention OR health prevention program* OR health program* OR health promotion program* OR health promotion intervention OR health education OR health intervention OR school setting OR school based intervention OR school-based intervention OR school based program* OR school-based program* OR school program* OR school health program OR school intervention OR school health intervention
Comparisons	Between intervention and control group	Not applicable
Outcomes	Movement behaviours: increase PA, reduce SB, improve sleep	(PA OR Total PA OR MVPA OR VPA OR LPA OR total physical activity OR moderate to vigorous physical activity OR vigorous physical activity OR light physical activity OR physical activity OR physical inactivity OR active OR activit* OR sport* OR sports participation OR active transport OR active commuting OR leisure activity OR walking OR aerobic exercise OR outdoor play OR exercis* OR motor behavio* OR movement) AND (sedentar* OR sedentary behavio* OR sedentary time OR sedentary lifestyle OR total sedentary time OR sitting behavio* OR sitting time OR prolonged sitting OR domestic activities OR computer use OR computer time OR media use OR video games OR tablet use OR smartphone use OR mobile phone use OR computer time OR television time OR TV time OR gaming OR screen time OR screen-time OR reading OR TV viewing OR TV child room OR television viewing OR video viewing) AND (sleep* OR sleep behavio* OR sleep duration OR sleep quality OR sleep pattern* OR bedtime OR sleep disturbance OR insomnia)

MVPA: moderate-to-vigorous physical activity; PA: physical activity; PICO: Population, Interventions, Comparisons and Outcomes; SB: sedentary behaviour; VPA: vigorous physical activity; LPA: light physical activity.

Study selection

Two review authors (JR-S and AC-A) identified the studies included via a three-step process in line with the literature (Gunnell et al., 2020). First, titles and abstracts of the articles returned from the initial search were screened and selected based on prior broken-down eligibility criteria. Second, full-text articles were analysed in detail and selected for eligibility. Third and finally, bibliographic references of all the articles selected were manually analysed to identify relevant articles missed in the initial search strategy.

Data extraction

Two review authors (JR-S and AC-A) independently extracted the data from the final list of studies selected. The following categories were identified and considered from the manuscripts: publication details (i.e. authors, year); study characteristics (i.e. design, country, sample size, SES, age and gender); movement behaviours targeted (i.e. PA, SB and sleep); other health-related behaviours (e.g. nutrition); intervention duration (e.g. 3 months); measurement tools (i.e. questionnaires, accelerometer data); main findings (related to movement behaviours measured), and follow-up measurements if available. Discrepancies between the authors were resolved by a consensus-based decision. All the extracted data were synthesised and pooled together using tables created with Microsoft Excel.

Results

Using the search strategy described above, 11,432 records were identified. After removing 3,542 duplicates, 7,890 articles remained for screening. These manuscripts were screened by reading the abstract and 7,761 were excluded based on the eligibility criteria. A total 129 full-text articles were then screened, of which 37 publications fulfilled the criteria and were deemed eligible for inclusion (see Figure 1).

Description of the included studies

Table 2 shows the general characteristics of the studies included in this scoping review. Of the 37 studies included, 28 were RCT studies (i.e. RCT, Cluster RCT, Pilot RCT and Group RCT) and nine were non-randomised studies (i.e. quasi-experimental studies). The studies were conducted in six European countries ($n=12$, 32%), the UK ($n=10$, 28%), four Asian countries ($n=5$, 13%) and two countries in Oceania ($n=4$, 11%). The remaining six studies were conducted in the USA ($n=4$, 11%) and Mexico ($n=2$, 5%). SES was not detailed in 14 studies. The total sample size of the acoping reviewe was 27,145 primary school children. The sample size of school-based interventions was less than 250 students in 6 studies, between 250 and 999 students in 24 studies, and over 1,000 students in 7 studies. Children's mean age varied between 5 and 9 years old in 40% ($n=15$) of the studies, and between 9 and 12 years old in the remaining studies. All studies included both male and female participants ($n=37$), with the percentage of male children ranging between a minimum of 40% and a maximum of 58%. All but one study detailed male/female participation percentages (Fairclough et al., 2013). Regarding the other health-related behaviours measured, 23 studies measured nutrition outcomes (i.e. dietary patterns, daily food and beverage intake), 1 study measured nutrition and health-related quality of life, while 13 studies did not measure any other health behaviour (see Table 2).

Outcome measures and effectiveness of school-based interventions

Table 3 presents the measurement tools, the outcome results and the follow-up measures in the studies included. Regarding the measurement tools, 12 studies exclusively used accelerometry devices (Brittin et al., 2017; Carson et al., 2013; Chesham et al., 2018; Fairclough et al., 2013; Hamer et al., 2017; Huberty et al., 2014; Lloyd et al., 2017; Madsen et al., 2015; Morris et al., 2018; Taylor et al., 2018; Van Kann et al., 2016; Verloigne et al., 2012); nine studies only used children's self-report questionnaires (Amini et al., 2016; Bacardí-Gascon et al., 2012; Colín-Ramírez et al., 2010; Efstathiou et al., 2016; Habib-Mourad et al., 2014; Lloyd et al., 2012; Salmon

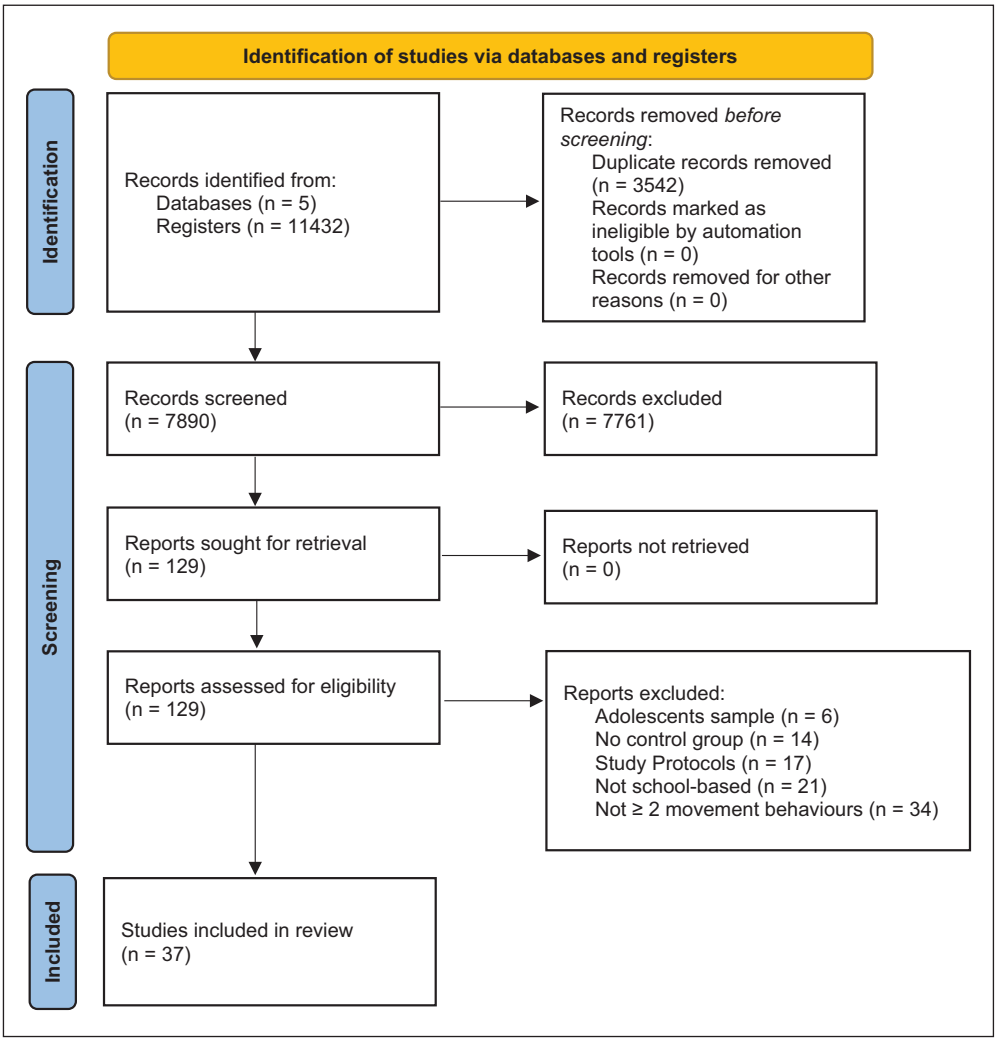

Figure 1. PRISMA flow diagram.

et al., 2011; Van Stralen et al., 2012; Xu et al., 2015); six studies used a combination of self-report questionnaires for children and device-based measures such as pedometers or accelerometers (Anderson et al., 2016; Breslin et al., 2012; Kipping et al., 2014; Li et al., 2019; Lynch et al., 2016; Verjans-Janssen et al., 2020); four studies used parental-report questionnaires (Brandstetter et al., 2012; Kobel et al., 2014, 2016; Norman et al., 2019); three studies used a combination of parental-report questionnaires and device-based measures in children (Duncan et al., 2019; Hands et al., 2011; Nyberg et al., 2016); two studies used parental-report and self-report questionnaires for children (Bhave et al., 2015; Gallotta et al., 2016); and just one study used a combination of parental-report, children's self-report questionnaires and device-based measures in children (Li et al., 2019). The three movement behaviours were measured together in just one study (Lynch et al., 2016), but without a sleep post-test measure. This study reported no significant intervention effects in any of the three behaviours.

Table 2. Summary of the studies included.

Study	Characteristics (design; country)	Sample (Sample; mean age; % men)	SES	Target behaviours	Other health behaviours	Duration
Colín-Ramírez et al. (2010)	RCT; Mexico	10 schools/498 children; 9.4; *SD*: 0.71; 8–10 Y.O.; 56%	Low	PA and SB (screen-time)	Not applicable	12 Months
Hands et al. (2011)	RCT; Australia	27 schools/305 children 7.2; *SD*: 0.1; 7–8 Y.O.; 54%	Low–Medium–High	PA and SB (screen-time)	Not applicable	6 Months
Salmon et al. (2011)	RCT; Australia	15 schools/ 957 children 10.3; *SD*: 0.62; 9–12 Y.O.; 42%	Low	PA and SB (screen-time)	Not applicable	3 Months
Bacardí-Gascon et al. (2012)	RCT; Mexico	4 schools/532 children 8.5; *SD*: 0.73; 8–9 Y.O.; 52%	Not detailed	PA and SB (screen-time)	Nutrition	6 Months
Brandstetter et al. (2012)	RCT; Germany	32 schools/945 children 7.57; *SD*: 0.42; 7–8 Y.O.; 53%	Not detailed	PA and SB (screen-time)	Nutrition	9 Months
Breslin et al. (2012)	Non RCT; Northern Ireland	24 schools/416 children 9.1; *SD*: 0.36; 8–9 Y.O.; 48%	Low	PA and SB (screen-time)	Nutrition	3 Months
Lloyd et al. (2012)	Cluster RCT; England	4 schools/202 children 9.69; *SD*: 0.3; 9–10 Y.O.; 50%	High	PA and SB (screen-time)	Nutrition	6 Months
Van Stralen et al. (2012)	Non RCT; Netherlands	19 schools/600 children 9.8; *SD*: 0.7; 8–12 Y.O.; 49%	Low	PA and SB (screen-time)	Not applicable	8 Months (2 years)
Verloigne et al. (2012)	Pilot RCT; Belgium	10 schools/372 children 10.9; *SD*: 0.7; 10–12 Y.O.; 40%	Not detailed	PA and SB (ST)	Not applicable	2 Months
Carson et al. (2013)	Cluster RCT; Australia	20 schools/293 children 8.0; *SD*: 1.3; 7–10 Y.O.; 44%	Low–Medium–High	PA and SB (ST)	Not applicable	7 Months (2 years)
Fairclough et al. (2013)	RCT; England	12 schools/318 children 10.6; *SD*: 0.3; 10–11 Y.O.; % Not detailed	High and Low	PA and SB (ST)	Nutrition	5 Months
Habib-Mourad et al. (2014)	RCT; Lebanon	8 schools/387 children 10.2; *SD*: 0.9; 9–11 Y.O.; 55%	Not detailed	PA and SB (screen-time)	Nutrition	3 Months
Huberty et al. (2014)	Group RCT; USA	12 schools/667 children 9.7; *SD*: 1.2; 7–11 Y.O.; 46%	Not detailed	PA and SB (ST)	Not applicable	9 Months

(Continued)

Table 2. (Continued)

Study	Characteristics (design; country)	Sample (Sample; mean age; % men)	SES	Target behaviours	Other health behaviours	Duration
Kipping et al. (2014)	RCT; England	60 schools/2,221 children 9.5; *SD*: 0.3; 9–10 Y.O.; 49%	Low-Medium-High	PA and SB (screen-time)	Nutrition	5 Months
Kobel et al. (2014)	RCT; Germany	1,943 children 7.1; *SD*: 0.6; 7–8 Y.O.; 51%	Not detailed	PA and SB (screen-time)	Nutrition	12 Months
Bhave et al. (2015)	Quasi-experimental; India	3 schools/865 children 9.5; *SD*: 1.1; 9–10 Y.O.; 52%	High	PA and SB (ST and screen-time)	Nutrition	12 Months (For 5 years)
Madsen et al. (2015)	RCT; USA	6 schools/879 children 9–11 Y.O.; 48%	Not detailed	PA and SB (ST)	Nutrition	10 Months (For 2 years)
Xu et al. (2015)	RCT; China	8 schools/1,108 children 10.2; *SD*: 0.5; 9–10 Y.O.; 56%	Not detailed	PA and SB (screen-time)	Nutrition	8 Months
Amini et al. (2016)	RCT; Iran	12 schools/ 334 children 10.8; *SD*: 0.9; 10–12 Y.O.; 51%	Medium–Low	PA and SB (screen-time)	Nutrition	5 Months
Anderson et al. (2016)	RCT; England	60 schools/2,221 children 9.5; *SD*: 0.3; 9–10 Y.O.; 49%	Low–Medium–High	PA and SB (screen-time)	Nutrition	7 Months
Efstathiou et al. (2016)	RCT; Greece	30 schools/729 children 8–10 Y.O.; 46%	Low–Medium–High	PA and SB (screen-time)	Nutrition	5 Months
Gallotta et al. (2016)	RCT; Italy	3 schools/230 children 9.3; *SD*: 0.8; 8–11 Y.O.; 45%	Not detailed	PA and SB (screen-time)	Nutrition	5 Months
Kobel et al. (2016)	RCT; Germany	525 children 7.1; *SD*: 0.7; 7–8 Y.O.; 49%	Low	PA and SB (screen-time)	Nutrition	10 Months
Lynch et al. (2016)	Pilot RCT; USA	1 school/51 children 7.8; *SD*: 0.2; 7–8 Y.O.; 45%	Not detailed	PA, SB (screen-time) and SLP	Nutrition	2 Months
Nyberg et al. (2016)	RCT; Sweden	13 schools/378 children 6.3; *SD*: 0.3; 6 Y.O.; 51%	Medium–Low	PA and SB (screen-time)	Nutrition	6 Months

(Continued)

Table 2. (Continued)

Study	Characteristics (design; country)	Sample (Sample; mean age; % men)	SES	Target behaviours	Other health behaviours	Duration
Van Kann et al. (2016)	Quasi-experimental; Netherlands	18 schools/520 children 10.1; *SD*: 0.7; 8–11 Y.O.; 44%	Low	PA and SB (ST)	Not applicable	12 Months
Brittin et al. (2017)	Quasi-experimental; USA	2 schools/41 children 9.3; *SD*: 1.2; 8–11 Y.O.; 58%	Not detailed	PA and SB (ST)	Not applicable	12 Months
Hamer et al. (2017)	Quasi-experimental; England	7 schools/347 children 8.8; *SD*: 0.7; 8–10 Y.O.; 55%	Low	PA and SB (ST)	Not applicable	12 Months
Lloyd et al. (2017)	RCT; England	32 schools/1,244 children 9.8; *SD*: 0.3; 9–10 Y.O.; 48%	Not detailed	PA and SB (ST)	Nutrition	12 Months
Chesham et al. (2018)	Quasi-experimental; Scotland	2 schools/379 children 8.4; *SD*: 2.0; 6–10 Y.O.; 51%	Not detailed	PA and SB (ST)	Not applicable	10 Months
Morris et al. (2018)	Pilot RCT; England	6 schools/154 children 9.9; *SD*: 0.3; 9–10 Y.O.; 40%	Not detailed	PA and SB (ST)	Not applicable	2 Months
Taylor et al. (2018)	RCT; England	7 schools/114 children 9–10 Y.O.; 48%	Low	PA and SB (ST)	Not applicable	2 Months
Li et al. (2019)	Quasi-experimental; Netherlands	8 schools/ 1,676 children 7.5; *SD*: 1.3; 5–12 Y.O.; 47%	Low	PA and SB (screen-time)	Nutrition	10 Months (4 years)
Duncan et al. (2019)	RCT; New Zealand	16 schools/675 children 8.72; *SD*: 1.0; 7–10 Y.O.; 48%	Low, Medium–High	PA and SB (screen-time)	Nutrition	2 Months
Li et al. (2019)	RCT; China	40 schools/ 1,641 children 6.15; *SD*: 0.35; 6–7 Y.O.; 54%	Medium–High	PA and SB (screen-time)	Nutrition and health-related quality of life	12 Months
Norman et al. (2019)	RCT; Sweden	13 schools/378 children 6.3; *SD*: 0.3; 6 Y.O.; 51%	Medium–Low	PA and SB (screen-time)	Nutrition	12 Months
Verjans-Janssen et al. (2020)	Quasi-experimental; Netherlands	11 schools/ 523 children 8.5; *SD*: 1.06; 7–10 Y.O.; 46%	Low	PA and SB (ST)	Nutrition	10 Months (2 years)

PA: physical activity; RCT: randomised controlled trial; SB: sedentary behaviour; SLP: sleep; ST: sedentary time; Y.O.: year old.

Table 3. Measurement tools and outcome results.

Intervention studies	Numbers of studies	Studies with significative effects in PA	Studies with significative effects in SB	Percentage of effectiveness (%)
Outcomes				
Sleep + PA + SB	1	0	0	0
PA + SB	36	17	15	44
Measurement tools				
Self-reported	14	7	6	46
Device-based	12	5	5	41
Self-reported + device-based	11	5	4	38
Studies with follow-up				
PA + SB	8	4	4	50

PA: physical activity; SB: sedentary behaviour.

The remaining 36 studies only measured PA and SB. Out of these 36 intervention studies, there was no overall evidence of significant effects on PA and SB outcomes following the intervention in 36% ($n=13$) of the studies (Anderson et al., 2016; Brandstetter et al., 2012; Efstathiou et al., 2016; Fairclough et al., 2013; Habib-Mourad et al., 2014; Hamer et al., 2017; Huberty et al., 2014; Kobel et al., 2016; Li et al., 2019; Lloyd et al., 2017; Madsen et al., 2015; Norman et al., 2019; Nyberg et al., 2016). A total of, 25% ($n=9$) reported significant effects on both PA and SB outcomes (Bacardí-Gascon et al., 2012; Bhave et al., 2015; Breslin et al., 2012; Brittin et al., 2017; Chesham et al., 2018; Gallotta et al., 2016; Li et al., 2019; Verloigne et al., 2012; Xu et al., 2015); 22% ($n=8$) reported significant effects on PA outcomes alone (Amini et al., 2016; Colín-Ramírez et al., 2010; Duncan et al., 2019; Hands et al., 2011; Morris et al., 2018; Van Kann et al., 2016; Verjans-Janssen et al., 2020; Van Stralen et al., 2012); and 17% ($n=6$) reported significant effects on SB alone, of which 11% ($n=4$) in sedentary screen-time (Kipping et al., 2014; Kobel et al., 2014; Lloyd et al., 2012; Salmon et al., 2011) and 6% ($n=2$) on ST (Carson et al., 2013; Taylor et al., 2018).

Significant changes between baseline time and post-test in at least one of the targeted behaviours were found in 17 studies for PA and 15 for SB in the intervention group compared to the control group. The duration of effective studies varied from 6 weeks (Morris et al., 2018; Verloigne et al., 2012) to 5 years, with three studies reporting intervention durations of 2 years or longer (Bhave et al., 2015; Carson et al., 2013; Verjans-Janssen et al., 2020). The average duration of the interventions was between 7 and 10 months, the most repeated duration was 12 months, and 75% ($n=17$) of the effective studies had an intervention duration of at least 5 to 12 months (Amini et al., 2016; Bacardí-Gascon et al., 2012; Bhave et al., 2015; Brittin et al., 2017; Carson et al., 2013; Chesham et al., 2018; Colín-Ramírez et al., 2010; Gallotta et al., 2016; Hands et al., 2011; Kipping et al., 2014; Kobel et al., 2014; Li et al., 2019; Lloyd et al., 2012; Van Kann et al., 2016; Van Stralen et al., 2012; Verjans-Janssen et al., 2020; Xu et al., 2015).

In terms of follow-up measures, 29 studies did not report or indicate any measure of the 24-hour movement guidelines. Among the remaining studies, two reported non-significant effects on any movement behaviour variable (Madsen et al., 2015; Norman et al., 2019), two studies reported a significant effect on both PA and SB outcomes (Bartelink et al., 2019; Verjans-Janssen et al., 2020), two studies reported a significant reduction only in sedentary screen-time or ST (Colín-Ramírez et al., 2010; Nyberg et al., 2016) and two other studies reported a significant improvement only in PA outcomes (Duncan et al., 2019; Fairclough et al., 2013). There were no studies with positive effects in either post-test or follow-up for PA and SB outcomes. Three studies presented

non-significant effects in the post-test, but reported positive effects in the follow-up measure (Bartelink et al., 2019; Fairclough et al., 2013; Nyberg et al., 2016). Further details on the results and follow-up of the 37 studies are available in Supplemental Material.

Discussion

Overall, the purpose of this scoping review was to identify existing intervention studies about 24-hour movement behaviours that were delivered in the school setting. The review allowed us to identify a distinct lack of school-based interventions targeting the three 24-hour movement behaviours in 5–12-year-old children.

Among the 37 included studies, 23 intervention studies of which 18 were RCTs effectively improved PA and/or SB outcomes. Of the three movement behaviours, PA reported positive effects in 17 of the 23 effective studies. Regarding SB, 15 of the 23 effective studies reported positive effects (i.e. screen-time and/or ST reduction). Thus, it appears that PA has been the most improved outcome after conducting a school-based intervention.

A recent study on the contribution of different settings to young people's daily PA accumulation suggested that the school setting was the preferred environment to promote PA and reduce ST (Tassitano et al., 2020). Nevertheless, it noted that school-based interventions might produce better results if they were focused on reducing ST rather than promoting PA (Tassitano et al., 2020). This conclusion is supported by a recent meta-analysis, which found that school-based interventions seem to be effective in reducing ST but not in improving moderate-to-vigorous physical activity (MVPA) (Rodrigo-Sanjoaquín et al., 2022).

School-based interventions such as those targeting PA, SB and/or diet are very common in our field as shown in Table 2. However, one key finding from our review points out that there is a lack of primary school-based intervention studies that include sleep behaviour. We expected to find several intervention studies targeting the three movement behaviours in literature, but we only identified one study (Lynch et al., 2016), with just a baseline measure (i.e. without a post-test) of sleep. This lack of studies did not allow us to conduct a systematic review or meta-analysis, but it enabled us to detect an important gap in the research field. The absence of school-based interventions on this outcome in our review does not mean that no sleep research studies have been conducted independently in the literature (Ávila-García et al., 2021; Gruber et al., 2016). However, we identified the scarcity of school-based interventions that include sleep with at least one of the other two movement behaviours simultaneously (i.e. PA and SB).

Most interventions that aim to improve sleep among children have focused on specific or clinical subgroups, and are not applicable to school-aged children (Busch et al., 2017). One recent study (Ávila-García et al., 2021) found that only four sleep education programmes have been conducted in primary schools to improve children's sleep over the last 5 years (Ashton, 2017; Ávila-García et al., 2021; Gruber et al., 2016; Rigney et al., 2015). Including sleep interventions in primary schools has the potential to promote knowledge on the importance of sleep, and can involve families for consolidating good sleep habits prior to adolescence and adulthood (Agaronov et al., 2018; Gruber et al., 2014). Since adequate sleep is a core aspect of good health and is reportedly decreasing in children (Chaput et al., 2015; Matricciani et al., 2012), sleep education should be an important consideration for school-aged children. Moreover, since movement behaviours need to be combined to maximise their benefits throughout the whole day (Rollo et al., 2020), we believe that sleep should be included in future school-based interventions. Furthermore, our findings indicate that school health research continues to focus mainly on PA and SB (Chaput et al., 2015; Rigney et al., 2015), and that the study of the three movement behaviours has not been fully integrated into primary school interventions.

We noted that the percentage of the age range in the eligible studies was almost the same for 5- to 9-year-olds and for 9- to 12-year-olds, as well as in terms of participant gender. Thus, we can assume that our results are broadly representative of the entire stage of childhood (i.e. 5–12 years) in both male and female children. Regarding this age range and gender differences, the most recent global studies on 24-hour movement behaviours prevalence found that only a small proportion of children aged 5–12 years (i.e. 10.31%) met the overall guidelines (Rollo et al., 2020; Tapia et al., 2022), with movement behaviours being significantly lower in girls (6.94%) than in boys (11.05%). On the contrary, the mean value of the SES in our scoping review was medium–low, while most of the countries where eligible studies have been conducted are in high income regions (i.e. countries from Europe, Oceania and North America). The same concerns about SES were found in a previous systematic review (Dobbins et al., 2013), although it is not clear if these findings are applicable to low and medium SES countries, since cultural differences and school systems may differ and findings should therefore be considered with caution. Due to this discrepancy and the general lack of detail, we cannot draw sound conclusions about the relevance of SES in this review. Nevertheless, primary school-based interventions in high-income countries appear to show an acceptable degree of effectiveness, especially in PA outcomes.

Strengths and limitations

The originality of this study is that it focused on the three movement behaviours in primary school-based interventions, which has not previously been reviewed. However, the study also has some limitations that should be noted. First, it is possible that we overestimated the effects when interpreting the results across studies, since we could not conduct a meta-analysis due to the lack of intervention studies concerning three 24-hour movement behaviours. Second, we found a lack of transparency about the intervention details in some studies that made it difficult to extract specific data. Finally, we restricted our search strategy to five databases, English language studies and peer-reviewed articles only, avoiding the grey literature. This search procedure may have introduced a certain degree of publication bias.

Implications for school health policy and practice

This article makes some recommendations for future research. First, the school is an ideal setting in which to increase PA and reduce SB. Furthermore, incorporating sleep behaviour into school-based interventions to improve children's health should be considered from the 24-hour movement guidelines perspective due to the important effect of sleeping behaviour on overall health. Second, 29 studies did not report or indicate any follow-up measure of the 24-hour movement behaviours, so we encourage researchers, if possible, to include follow-up measures in their school-based interventions to assess their sustainability. Moreover, when examining whether school-based interventions work and are sustainable, the literature usually focuses on the teacher, staff training, funding and supportive policies. Third, we detected misleading information regarding the intervention details in several studies. To promote future transparency, researchers should try to correctly describe their intervention details and components in future studies or in their study protocols.

Conclusion

This is the first scoping review of school-based intervention studies targeting 24-hour movement behaviours among children aged 5–12 years. Our main finding was the lack of implementation of school-based interventions targeting 24-hour movement behaviours. Beyond this, we highlight a

lack of primary school-based interventions that include sleep in their intervention programmes. Further research and more studies are needed to explore this gap in the literature and the effectiveness of 24-hour movement behaviours in the school setting. Only a few studies to date have included follow-up measures on the movement behaviours targeted, making it difficult to assess the sustainability of interventions. Finally, we encourage researchers to consider the recommendations provided in this paper when designing future school-based interventions, especially if they wish to target 24-hour movement behaviours among 5–12-year-old children.

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ORCID iD

Javier Rodrigo-Sanjoaquín https://orcid.org/0000-0002-9369-5520

Supplemental material

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