REVIEW ARTICLE

Panoramic view of the effects of active breaks in an educational context: A systematic review of the literature

Silvia Arribas Galarraga. *Faculty of Education, Philosophy and Anthropology. University of the Basque Country (UPV/EHU). Donostia-San Sebastián, Spain.*
Julen Maiztegi Kortabarria . *Faculty of Education and Sport (Education). University of the Basque Country (UPV/EHU). Vitoria-Gasteiz, Spain.*
Izaskun Luis de Cos. *Faculty of Education, Philosophy and Anthropology. University of the Basque Country (UPV/EHU). Donostia-San Sebastián, Spain.*
Saioa Urrutia. *Faculty of Education and Sport (Education). University of the Basque Country (UPV/EHU). Vitoria-Gasteiz, Spain.*

ABSTRACT

In education, optimising academic achievement (AA) and promoting attention and concentration are essential elements. The main goal of this systematic review (SR) is to analyse and synthetise the scientific evidence to examine the impact that the different interventions with active breaks (AB) have on the AA, attention, and concentration of the students in educational contexts. To do this, the PRISMA protocol is followed (REG INPLASY: INPLASY202390082). The documents that comply with the inclusion criteria for this research are 29 scientific articles extracted from the databases Web of Science (WOS), SCOPUS and ERIC. The specific goals of this study are detailed through 13 research questions related to the characteristics of the works and their results, e.g. thematic and geographic diversity, variability in the research designs, inclusion of several educational levels and academic contents, as well as the presence of common intervention modalities and heterogeneous durations. The panoramic view suggested by the results presents AB as an interdisciplinary topic of international interest mainly focused on basic education, with measure instruments that are diverse and have variable duration, which might influence the comparability between studies. Even though some studies back up the positive effects of AB, the heterogeneity of approaches and results highlights the need of future research in order to unify criteria and allow a better understanding of the effects of AB and their applicability in several educational contexts.

Keywords: Classroom-Based Physical Activity (CB-PA), Curriculum-Focused Active Breaks (CF-AB), Physically Active Lessons (PAL), Attention, Concentration, Academic achievement.

Cite this article as:
Arribas Galarraga, S., Maiztegi Kortabarria, J., Luis De Cos, I., & Urrutia, S. (2025). Panoramic view of the effects of active breaks in an educational context: A systematic review of the literature. *Journal of Human Sport and Exercise, 20*(1), 248-265. https://doi.org/10.55860/pq9apx72

Corresponding author. *Facultad de Educación y Deporte (Educación), Universidad del País Vasco (UPV/EHU), 01006 Vitoria-Gasteiz, España (Spain).*
E-mail: Julen.maiztegi@ehu.eus
Submitted for publication April 30, 2024.
Accepted for publication June 13, 2024.
Published December 08, 2024.
Journal of Human Sport and Exercise. ISSN 1988-5202.

doi: https://doi.org/10.55860/pq9apx72

INTRODUCTION

In education, optimising academic achievement (AA) and promoting attention and concentration are essential goals that, according to some studies, can be improved through physical activity (PA). According to Ruiz-Ariza et al. (2021), the modalities of PA that can be done in a school context are grouped in four categories: physical education lessons, active commuting to the school building, active breaks and pauses during the school day and physically active academic sessions. Watson et al. (2017) define active breaks in the classroom, or Classroom-Based Physical Activity (CB-PA), as short periods of PA that are done during regular lessons and the breaks between classes, that can or can't be related to the content in the syllabus. They can adopt three forms: Active Breaks (AB), which means short periods of PA as a break from the academic instruction; Curriculum-Focused Active Breaks (CF-AB), which are short periods of PA that include content from the curriculum; and Physically Active Lessons (PAL), which integrate PA in the classroom as a tool in the teaching-learning process.

Active breaks (AB) have arisen as an incipient strategy to improve these aspects. This investigation goes into scientific literature, synthetising an interesting variety of approaches and perspectives with the purpose of exhaustively analysing the relation between active breaks and their effect on attention, concentration and academic achievement, in order to shed light on the efficacy and the practical implications of this intervention in an educational context.

Among several investigations that have as subject of study the introduction of different PA modalities in the classroom, we can find Rasberry et al. (2011), who analysed the relation between PA at school and AA, finding mixed results. They concluded that the effect of practicing PA during school hours has no set pattern, since this practice may or may not influence AA, but it is not counterproductive. Norris et al. (2015) researched the effect of AB in educational variables in 11 articles, observing an improvement in maths, language, art, and social sciences in 1 study; and in social sciences in another. These authors emphasize having to consider the duration of the interventions, not being recommended to carry interventions that last less than 12 weeks in order to observe improvement thanks to practising physical activity in an educational context. Watson et al. (2017) evaluated the effects of PAL in AA, finding different results depending on the duration and the methodology of the interventions. Bedard et al. (2019) measured the impact of PAL on AA, cognitive functions, attention and enjoyment of 25 investigations done on students of between 3 and 18 years of age. The results of 20 studies reported improvement in attention, a small but positive effect on AA, but a negative effect on cognitive functions. Méndez-Giménez (2019) analysed the effect of PAL and AB in AA, cognitive performance, and health, including 11 studies in his analysis. He found improvement in the amount of moderate and intense PA in 5 studies, and improvement in concentration, cognition, and task time in 2; improvement in executive function was shown in 1, and 4 articles evidenced improvement in AA. However, he emphasized the diversity of interventions and results in this field. Sneck et al. (2019) analysed several interventions in maths, observing notable differences in 13 of the 29 studies carried out; however, in 14 other studies no notable differences were found, which suggests great variety of investigations in this field. Ruhland and Lange (2021) examined the impact of CB-PA (PAL) on attention and behaviour when carrying out tasks, finding significant differences in selective attention in 2 of 6 studies, and in concentration just 1 study showed a positive effect after the intervention. Peiris et al. (2022) evaluated the impact of PAL and CMB interventions on the variables AA, cognitive indicators, health habits, and health. The results showed considerable improvement in attention and concentration in 2 studies, and a positive and significant effect on maths in 6 investigations, 2 on reading, 1 on orthography, and 1 on learning a new language. Daly-Smith et al. (2018) researched the impact of interventions based on AB (n = 8) and PAL (n = 9) on cognitive variables, AA and behaviour in students of between 4 and 14 years of age. About attention, only 1 study showed considerable

differences. When it comes to AA, the AB interventions didn't show immediate improvement, but they did after 10 and 20 minutes. Masini et al. (2020) related AB to the levels of PA and behaviour in the classroom, finding significant effects in the moderate to vigorous PA; however, considerable improvement in cognitive functions or AA (maths, social sciences, reading) wasn't observed. Infantes-Paniagua et al. (2021) studied the relation of PA inside the classroom, during lessons (with or without academic content), or between classes with the variables of attention and concentration. The effect on the selective attention variable was moderate amongst the intervention and control groups; the effect on the concentration variable was insignificant amongst both groups. Loturco et al. (2022) analysed the effect of different interventions based on PA done with primary and secondary students, on the AA in maths, language, reading and composite scores. Even though the authors remind us that AA can vary due to a multitude of external factors, they point out that the impact of the interventions on AA and their effect on cognition is higher with higher intensity and longer interventions.

In face of the diversity and heterogeneity of studies, the main purpose of this systematic review (SR) is to analyse and synthetise the scientific evidence to examine the impact that different interventions with active breaks (AB) have on the academic achievement (AA), attention and concentration of the students in educational contexts.

MATERIAL AND METHODS

The standards that were stablished by PRISMA 2020 (Page et al., 2021) were the driving axles for the methodological development of the systematic review. It consists of 5 stages (Zawacki-Richter et al., 2020) that are presented below. The protocol is registered in INPLASY (Reg. INPLASY202390082).

Stage 1: Research questions

On Table 1 are presented the research questions analysed in the SR.

Table 1. Classification of the research questions and their initial coding.

	Research questions
PI.1	What year was the article published?
PI.2	What is the position of the journal in databases?
PI.3	What are the topics of the articles according to the category of the journal in databases?
PI.4	What is the geographic distribution of the publications?
PI.5	What research methodologies are used in the selected studies?
PI.6	Comparator?
PI.7	What education levels are included in the research? Or age of the participants?
PI.8	Number of participants?
PI.9	What areas of knowledge are involved in the studies?
PI.10	What kind of interventions have been used in the research?
PI.11	Duration of the intervention?
PI.12	What measure instruments have been used to measure the variables?
PI.13	What is the relation of active breaks with the attention, concentration, and academic achievement variables?

Stage 2: Eligibility criteria and information sources

Inclusion-exclusion criteria

The criteria were: type of document (open access scientific articles published in scientific journals), language (English, Spanish), time period (from the beginning until 30/11/2022), education level (preschool education,

primary education, lower secondary education, upper secondary education, vocational training, university education); research methodology (empirical studies with quantitative methods that aren't theoretical review articles), type of intervention (1. Active Breaks (AB) (short periods of PA as a break from academic instruction), 2. Curriculum-Focused Active Breaks (CF-AB) (short periods of PA that include content from the curriculum), 3. Physically Active Lessons (PAL) (PA in the classroom as a tool in the teaching-learning process), 4. Active Recesses (AR); comparator (passive control group, or group without physical activity; intervention group or groups based on PA during the school day and in the classroom; no control group); variables (attention, concentration, academic achievement).

Information sources
The databases used in the SR were Web of Science (WOS), SCOPUS and ERIC.

Stage 3: Search strategies
The classification parameters of keywords and filters sequence of the libraries used in the SR were stablished: "*Activity Break**" OR "*Active Class**" OR "*Classroom Movement Break**" OR "*CMB*" OR "*Physically Active Learning*" OR "*PAL*" OR "*School Based physical active*" OR "*Active Break**" OR "*Active Lesson**" OR "*Physically Active Classroom**" OR "*Active School Break**" OR "*School Physical Activity Break**" OR "*Classroom based physical activity*" OR "*Movement Break**" AND "*Academic Achievement*" OR "Academic performance" OR "Academic Progress" OR "*Academic Success*" OR "*Educational Achievement*" OR "*Academic Achievement*" OR "*Scholastic Achievement*" AND "*Attention*" AND "*Concentration*".

The search was delimited using the following filters sequence in the WOS search: 1) Main collection of Web of Science. 2) Collections: Social Science Citation Index (SSCI) -- 1956 –. 3) Inclusion criteria: Type of document: Article. 4) Inclusion criteria: Open access. The filters sequence used in the search in SCOPUS and ERIC: Type of document: Article.

Stage 4: Process for the selection of studies

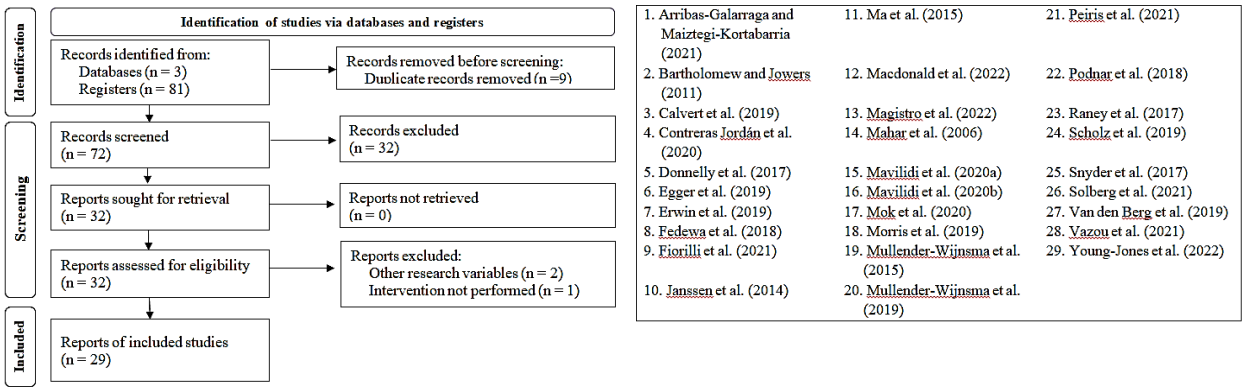

Figure 1. Flow diagram.

Stage 5: Coding and data synthesis
The bibliometric manager Zotero was used to compile and organise sources efficiently. After that, to synthetise and analyse the compiled information, a coding sheet with 13 specific fields was used. This sheet structured and categorised the data in a systematic way, facilitating the identification of patterns and relations in the information.

ANALYSIS AND RESULTS

PI.1. Publication year of the article

The years fluctuate between 2006 and 2022. In 2006, 1 publication (14). 2011, 1 publication (2). 2014, 1 publication (10). 2015, 2 publications (11,19). 2017, 3 publications (5, 23, 25). 2018, 2 publications (8, 22). 2019, 7 publications (3, 6, 7, 18, 20, 24, 27). 2020, 2 publications (1, 2). 2021, 5 publications (1, 9, 21, 26, 28). 2022, 5 publications (12, 13, 29, 15, 16).

PI.2. Impact index in JCR and/or SJR of the journal

The results of the impact of the journal in which the article was published indicate the following distribution: a total of 9 articles have been published in journals with a Q1 score in JCR (3, 10, 14, 15, 16, 17, 18, 21, 27). In a JCR Q2, a total of 5 investigations (5, 6, 9, 11, 19). In Q3 of JCR, 2 articles (26, 28). In Q4, a total of 2 articles published (12, 22). In journals with a Q1 score of SJR, 2 investigations (2, 13). Q3 of SJR, 1 article (8). Q4 of SJR, 2 investigations (24, 25). In journals with a Q2 score of JCI, 3 publications (1, 7, 20). In journals with a Q4 score of JCI, 1 publication (4).

PI.3. Thematic category of the journals according to the databases (WOS, SCOPUS, ERIC)

1 article (25) was published in the journal *Education*. 7 investigations (1, 4, 7, 12, 19, 20, 23) were published in the journal *Education and educational research*. 2 investigations (6, 9) were published in the journal *Health Care Sciences and Services*. 1 publication in the journal *Pediatrics* (15). 1 publication (24) in *Physical Therapy, Sports Therapy and Rehabilitation*. 1 article published in the journal *Psychology, Developmental* (28). 7 articles (2, 5, 16, 17, 21, 26, 27) were published in the journal *Public, Environmental and Occupational Health*. 6 publications in *Sport Science* (8, 11, 13, 14, 18, 22, 29). 1 article (29) published in *Teaching, Learning, Pedagogy, Education, Higher Education*.

PI.4. Geographic distribution of the publications

Most publications are from the United States, with a total of 8 articles (2, 5, 6, 14, 15, 19, 28, 29). In second place comes the Netherlands, with 7 investigations (3, 10, 12, 13, 18, 20, 26) published. In third place, United Kingdom with 4 publications (7, 8, 9, 23). In fourth place, Switzerland with 3 articles (16, 21, 27). In fifth place, with 2 articles (1, 4), Spain. And with only 1 publication, Canada (11), Croatia (22), Germany (24), Hong Kong (17), Turkey (25).

PI.5. Research methodologies

The review shows two studies that don't specify the used methodology. Amongst the rest of studies there are 2 studies of longitudinal character registered, the others (27) are transversal studies. 12 of the 29 analysed investigations use a quasi-experimental design, and 6 claim to be experimental. The rest of investigations don't explain the applied design.

Out of the 29 studies that compose our research, 10 use a quantitative methodology, 2 a mixed method and there is no research detected that complies with the inclusion parameters in this study that has used an exclusively qualitative methodology. The other investigations don't clarify it. When it comes to the type of study depending on the analysis they do, 2 are descriptive, 5 correlational, 2 make a regression analysis, 3 do multilevel analysis and 3 apply Cluster analysis.

PI.6. Comparator

Out of the 29 articles analysed, in 18 studies (1, 2, 5, 13, 14, 15, 16, 17, 18, 19, 21, 23, 24, 25, 27, 28), the participants were grouped in 1 passive control group or group without physical activity and in 1 intervention

group. In 4 of the studies (3, 4, 7, 22) there was no control group. In 4 studies (9, 12, 20, 26), 1 passive control group or group without physical activity and 2 intervention groups. The participants of 1 study (8) were divided into 2 intervention groups and no control group. And in 1 investigation (11) there was one group used both as control and intervention.

PI.7. Education levels of the participants

In section 7 of the analysis of results, out of the 29 reviewed articles, 23 articles had students of different levels of primary as participants of the investigation. In 3 articles (7, 14, 28), the participants were students at the age of preschool education. 2 of the articles (1, 26), were focused on secondary students. And 1 of the reviewed articles (21), on university students.

PI.8. Total N

The total number of participants varies from 29 until 3036.

PI.9. Areas of knowledge (subjects)

When analysing the types of intervention, out of the 29 studies, 10 investigations (1, 2, 9, 13, 15, 16, 18, 25, 27, 29) measured the AA of just one subject. 4 studies (7, 8, 19, 26), of 2 subjects. 4 studies (5, 6, 12, 20), of 3 subjects. 2 studies (17, 23) used more than one subject to measure the impact of active breaks on AA. Out of the 20 studies that analysed the impact of the interventions on AA, 16 investigations analysed the impact of active breaks on maths (5, 6, 7, 8, 9, 12, 13, 15, 16, 18, 19, 20, 25, 26, 27, 29) and 8 investigations (5, 6, 7, 8, 12, 19, 20, 26) used reading as an indicator of AA. 4 studies analysed the impact on orthography (1, 5, 6, 20). 1 study (29), on arts and language and 1 study (2) on word spelling.

PI.10. Type of intervention

Out of the 29 reviewed studies, in 13 of them (1, 2, 3, 5, 12, 13, 14, 17, 19, 22, 23, 27, 28) the interventions were composed by different CF-AB programmes. 7 other articles (4, 11, 16, 18, 21, 24, 29) have AB as a basis of the intervention. 2 studies (20, 25) have PAL as a basis. On the other hand, 7 studies (6, 7, 8, 9, 10, 15, 26) have used more than one type of intervention, allowing to analyse the effect of the different interventions.

PI.11. Duration of the intervention

The duration of the interventions fluctuates from only 1 intervention until a duration of 3 years. Only 1 session (9, 17, 29). Short-term interventions (1-4 weeks): 1 week (18), 10 sessions (4), 16 days (3), 3 weeks (11, 21), 4 weeks (2, 15). Medium term interventions (5-9 weeks): 5 weeks (25, 27); 7 weeks (1, 10, 28), 9 weeks (23). Long-term interventions (over 4 months and up to 3 years): 9 months (17, 8, 26), 20 weeks (6), 21 weeks (19), 1 year (12, 14, 22, 24), 2 years (7, 13, 20). 3 years (5).

PI.12. Measure instruments

This section compiles the instruments used to measure the different variables in each of the areas in which AB were implemented.

Academic achievement: maths

Wechsler Individual Achievement Test-Third Edition (WIAT-III) (5); arithmetic operations, visuospatial functions, Heidelberger Rechentest (HRT 1–4) (6); Mathematics Inventory (MI) (7); FastBridge Learning math and reading standardized assessment, Rasch Unit RIT Scale (8); MATH (9); WISC-IV (13); Individual Basic Facts Assessment Tool (IBFA), scales of the Programme for International Student Assessment (PISA) (15); Maths Addition and Subtraction, Speed and Accuracy Test' (MASSAT) (18); Tempo-Test Rekenen, reading

ability, Eén-Minuut-Test (19); The Speed-Test arithmetic (20); Common Summative Assessment (CSA) (25); national tests of the Norwegian Directorate for Education and Training (26); reading comprehension, orthography, maths/arithmetic with CITO; Learning quiz score (29).

Academic achievement: reading
Wechsler Individual Achievement Test-Third Edition (WIAT-III) (5); Salzburger Lesescreening (6); Reading Inventory (RI) (7); Fast Bridge Learning math and reading standardized assessment (8); Wechsler Individual Achievement Test—2nd Edition—Australian Standardised Edition (WIAT-II) (12); Eén-Minuut-Test (1-Minute Test) (19); One-Minute test (20); Norwegian Directorate for Education and Training (26).

Academic achievement: orthography
"*Dictated text*" ad hoc (1) active participation of two independent teachers specialised on physical education and primary to evaluate the lessons (2); Wechsler Individual Achievement Test-Third Edition (WIAT-III) (5); Hamburger Schreib-Probe (HSP 1–10) (6); The Speed-Test arithmetic (20).

Academic achievement: language and art
Learning quiz score (29).

Academic achievement: others
Mok et al. (17) used The Attitudes toward Physical Activity Scale (APAS) to measure the dimension of learning of content related to health and nutrition, social learning, environmental management, basic curricular learning, character development and exposition to arts and culture. Raney et al. (23) measured the knowledge on health, physical education, competences on nutrition, sciences, maths, and music through a 40 questions multiple choice quiz created ad hoc.

Attention
D2 attention test (1, 4, 11); Stroop Color and Word (SCWT) (9); subtest 'Sky Search' of the Daily attention test for children (TEA-Ch) (10); The Selective Visual Attention test (13); self-assessment through an analogic visual scale (21); Strengths and Weaknesses of ADHD-symptoms and Normal behaviour (SWAN) rating scale (28).

Concentration
D2 attention test (1, 4); Analogic visual scale, self-administered, of 10 cm (21); KT1 test (24).

PI.13. Relation of active breaks and academic achievement, attention and concentration variables
PI.13.1. Impact of active breaks on AA

Impact of active breaks on maths AA

In Table 2 are presented the results of the 16 investigations that analysed the impact of active breaks on maths. The results of 9 reviewed studies (6, 7, 9, 12, 13, 15, 19, 20, 26) indicate significant results in AA. However, 7 investigations (5, 8, 16, 18, 25, 27, 29) didn't identify significant differences.

Impact of active breaks on reading AA

In Table 3 are shown the results of the 8 investigations (5, 6, 7, 8, 12, 19, 20, 26) that analysed the impact of the interventions on reading AA.

Impact of active breaks on orthography AA

In Table 4 are presented the results of the 5 studies that analysed the impact on orthography (1, 2, 5, 6, 20).

Table 2. Impact of active breaks on maths AA.

	Author	Impact of active breaks on maths AA
5	Donnelly et al.	No significant difference between groups after 1 year, 2 years, 3 years and pre-post ($p < .05$).
9	Fiorilli et al.	Significant effect groups ($F_{2.123} = 3.68$; $p = .027$; $\beta = 0.66$; $\eta_p^2 = 0.06$). FIT (moderate-vigorous PA) better than CON (sedentary pauses) ($p = .023$; $d = .597$), no significant difference between CREAT (combination of cognitive-creative and conditional tasks) and FIT and between CREAT and CON ($p > .05$). Significant effect ($F_{1.123} = 10.82$; $p = .001$; $\beta = 0.90$; $\eta_p^2 = 0.08$). Post, higher scores for the intervention (pre: 26.6; post: 27.3; $p < .001$; $d = 0.155$). Significant interaction group-time ($F_{2.123} = 5.40$; $p = .005$; $\beta = 0.83$; $\eta_p^2 = 0.08$). Significant difference FIT (pre: 27.1; FIT post: 28.8; $p < .001$; $d = 0.344$), CON (FIT post: 28.8; CON post: 25.3; $p = .011$; $d = 0.621$).
6	Egger et al.	Significant difference post-test between groups ($F_{2.138} = 7.34$, $p = .001$, $\eta_p^2 = .096$). With significant difference G1 (high cognitive commitment, high physical effort) ($p = .001$) and G3 (high cognitive commitment, low physical effort) ($p = .002$) pre-post compared to G2 (low cognitive commitment, high physical effort).
7	Erwin et al.	Decreased significantly ($b = -10.90$, $t(1540) = -2.08$, $p = .04$) between winter 2016 and spring 2017. Significant difference ($b = 11.89$, $t(1540) = 2.28$, $p = .02$) in white students between winter 2017 and spring 2018. Between winter 2016 and spring 2017 white students significantly lower compared to students of two or more ethnicities ($b \wedge = 16.97$, $t(1540) = 2.26$, $p = .02$). No significant difference in gender, ethnicity, or grade as a result of the additional recess break given in 2017-2018.
8	Fedewa et al.	No significant difference ($b = -0.07$, $SE = 0.05$, $p = .19$, $ES = 0.07$) between groups. The difference in the intra-classroom correlation coefficients (CCI) between the reference model and the final model was .090 ([.011 - .010] / .011), 9% of the variance in maths measured in autumn.
12	Macdonald et al.	Significant general effect groups $F_{2.46} = 8.48$, $p = .001$, $\eta^2 = .269$ Small effect pre-post-test in group N (Cohen's $d = .10$, $p < .699$). Big effect pre-post-test in group R (Cohen's $d = 1.71$, $p < .001$) and group M (Cohen's $d = 1.31$, $p < .001$). Significant difference ($p < .001$) post-test between groups R and M compared to group N. Better progress group R ($p = .001$) and M ($p = .019$) than N.
13	Magistro et al.	Intervention group better result compared to control group (principal effect, $F_{1.80} = 24.32$, $p < .001$) and the scores of the participants improved over time (principal effect, $F_{3.240} = 180.66$, $p < .001$). Bigger effect in intervention group over time compared to control group (interaction group * time, $F_{3.240} = 14.43$, $p < .001$, $d = 0.9$ (big)). T4 better results in intervention group compared to control group (principal effect, $F_{1.80} = 28.90$, $p < .001$).
15	Mavilidi et al. (2020a)	Significant effect between AB and control group (DM = 2.92 , 95 %, CI =0.07 a 5.77; $p = .045$). No significant effect between AB and combined maths and control group. No significant effect between AB and AB and combined maths.
16	Mavilidi et al. (2020b)	Negative relation between AA and anxiety ($r = -0.27$, $p = .018$), the higher anxiety, the lower AA. Negative relation between anxiety and results during ($r = -0.24$, $p = 0.042$) and at the end of the test ($r = -0.43$, $p = .049$), and in the difficulty of the task ($r = -0,31$, $p = .014$). In both conditions, the very anxious ($M = 4.06$, $DT = 1,41$) obtained worse results than the not very anxious ($M = 5.11$, $DT = 1.72$).
18	Morris et al.	No effect on the TDM intervention group (model 1) pre-post ($b=1.03$, $SE=0.69$, 95% CI=-0.32, 2.39, $p=0.136$, $d=0.25$), nor in the TDM intervention group (model 2) ($b=1.23$, $SE=0.77$, 95% CI=-0.29, 2.74, $p=0.113$, $d=0.27$), neither on the control group ($b=-1.10$, $SE=0.70$, 95% CI=-2.48, 0.28, $p=.117$, $d=0.25$). No effect of the TDM intervention group total number of errors ($b=-0.63$, $SE=0.36$, 95% CI=-1.34, 0.08, $p=0.08$) nor in the control group ($b=0.61$, $SE=0.44$, 95% CI=-0.26, 1.47, $p=.168$)
19	Mullender-Wijnsma et al. (2015)	Significant interaction between the condition and the grade regarding post-test ($F_{1.209} = 26.48$, $p < .05$), but no significant effects. Intervention group 3 grade higher scores than control group 3 grade. Intervention group 2 grade lower scores than control group 2 grade.
20	Mullender-Wijnsma et al. (2019)	Significant improvement of the intervention group in the results of the mathematical velocity test ($t = 3.99$; $p < .005$; $ES = 0.35$) and in the results of the maths test ($t = 5.83$; $p < .005$; $ES = 0.54$) compared to the control group (period T0-T3)

25	Snyder et al.	No significant difference between both groups (t(30) = -1.732, p=.094).
26	Solberg et al.	Intervention of aerobic PA (path C) obtained an effect of 28% of the total effect of 1.73 points (95% CI: 1.13 a 2.33) and a direct effect (path C´) of 1.24 points (95%, CI: 0.58 s 1.91).
27	Van den Berg et al.	No significant effect between groups after the intervention, effect between groups of 0.40 points (95% CI: -0.4 a -1.2).
29	Young-Jones et al.	No significant difference after any intervention. No significant difference between groups (H(3) = 1.1, p = .781) after the intervention of low PA, moderate intensity PA, yoga and control.

Table 3. Impact of active breaks on reading AA.

	Author	Impact of active breaks on reading AA
5	Donnelly et al.	No significant difference between groups after 1 year, 2 years, 3 years and pre-post (p =.056).
6	Egger et al.	No significant difference between groups G1 (high cognitive commitment, high physical effort), G2 (low cognitive commitment, high physical effort) and G3 (high cognitive commitment, low physical effort) ($F_{2.138}$ = 1.46, p =.236, η_p^2 =.021).
7	Erwin et al.	Winter 2016 was significantly lower for black students than for white students (b ^ = -9.90, t(1308) = -2.04, p = .04). No significant difference in gender, ethnicity, and grade in the reading AA as a result of the additional recess between 2017-2018.
8	Fedewa et al.	Active Breaks (AB) significantly higher scores (pre-post) (b = -0.12, SE = 0.05, p = .009) than Curriculum-Focused Active Breaks (CF-AB). 0.13 effect, small difference between both groups. Score varies depending on the grade, since third and fourth grade students had higher scores than the fifth graders, with a small size effect (SE = 0.15 for third grade compared to fifth grade; SE = 0.14 for fourth grade compared to fifth grade).
12	Macdonald et al.	Big effect pre-post-test in N group (Cohen´s d = 1.27, p < .001), in group R (Cohen´s d = 1.30, p < .001) and group M (Cohen´s d = 1.54, p < .001). Significant difference (p < .001) post-test between group M compared to group N. Group M significantly bigger improvement (p = .017) than N class.
19	Mullender-Wijnsma et al. (2015)	Significant interaction between condition and grade regarding post-test of ($F_{1.208}$ = 5.41, p < .05), but no significant effects Intervention group 3 grade higher scores than control group 3 grade. No differences found between intervention group 2 grade and control group 2 grade.
20	Mullender-Wijnsma et al. (2019)	No significant differences (t = 1.40; p = .16; ES = 0.08) compared to control group.
26	Solberg et al.	Aerobic PA intervention (path C) obtained a direct effect of 0.89 points (95%, CI: 0.15 a 1.62) that lowered (path C´) to 0.40 points (95% CI: 0.48 a 1.28).

Table 4. Impact of active breaks on orthography AA.

	Author	Impact of active breaks on orthography AA
1	Arribas-Galarraga et al.	Significant difference between experimental and control group (p < .01) (pre-post). No significant difference in averages (Z = -0.279, p = .78) after the intervention of the intervention group compared to the control group.
2	Bartholomew et al.	The results indicate improvement of control group with a small but unsignificant benefit in relation to the intervention group (Cohen's d = -.22; p =.11).
5	Donnelly et al.	No significant difference between intervention and control groups after 1 year, 2 years, 3 years and pre-post (p = .366).
6	Egger et al.	No significant difference between groups G1 (high cognitive commitment, high physical effort), G2 (low cognitive commitment, high physical effort) and G3 (high cognitive commitment, low physical effort) ($F_{2.138}$ =1.26, p =.287, η_p^2 =0.018).
20	Mullender-Wijnsma et al. (2019)	No significant difference (t = 1.31; p = .19; ES = 0.14) compared to control group.

Impact of active breaks on language and art AA

The results of Young-Jones et al. (29) indicate no significant differences after any intervention.

Impact of active breaks on AA: others

Two of the reviewed studies used more than one subject to measure the results. Raney et al. (23) measured the knowledge on health, physical education, nutrition competences, sciences, maths, and music through a quiz. The results indicate significant differences in the intervention group after 6 weeks (+80.5 ± 12.4%; d = 1.42, with considerable effect, $p < .001$). But there were no significant differences between sexes (F1.89 = 0.01, $p > .05$) or between the control and experimental groups (F1. 89 = 0.05, $p > .05$).

Mok et al. (17) point out that learning, in reference to the subjects about health and nutrition, social education, environmental management, basic curricular learning, character development, art and culture, has a notable effect between both groups after the intervention. With an effect during the time of F443.503, $p <.01$, ηp2 =.177 and a significant effect between time and group, in favour of the intervention group (F236.484, $p <.01$, ηp2 =. 103).

PI.13.2. Impact of active breaks on attention

In this section are shown the results obtained after the review of the 29 articles included. Out of all the analysed articles, 8 investigations have analysed the existent relation between the different types of active breaks and the attention of the students. The total number of studies (1, 4, 9, 10, 11, 13, 21, 28) indicate significant differences on attention after the intervention. In Table 5 are shown the main results of the reviewed studies that have analysed the impact of active breaks on attention:

Table 5. Impact of active breaks on attention.

	Author	Impact of active breaks on attention
1	Arribas-Galarraga et al.	Significant difference (Z = -3.361, p = .001) in experimental group pre-post, no significant difference between groups.
4	Contreras Jordán et al.	Significant difference pre-post (Z = -6.916, p = .000).
9	Fiorilli et al.	Significant effect in groups ($F_{2.123}$ = 3.12; p = .047; β = 0.59; η_p^2 = .048), group FIT (moderate-vigorous PA) is faster than CON (sedentary pauses) (9,83 compared to 12,23; p = .034; d = 0.428). No significant difference between FIT groups and CREAT group (combination of cognitive-creative and conditional tasks) (9.83 compared to 11.00; p =.48) and between CREAT and control group (p =.45). Significant effect in time ($F_{1.123}$ = 18.83; p < .001; β = 0.99; η_p^2 = 0.13), post-test results faster after the breaks (pre: 11.8 - post: 10.2; p < .001). Significant effect between group and time ($F_{2.123}$ = 10.47; p < .001; β = 0.98; η_p^2 = 0.14). Higher performance FIT group with significant differences p < .001 (pre: 11.6; post: 8,1; p < 01; d = 0.764).
10	Janssen et al.	Significantly lower scores (pre-post) intervention group passive breaks (B = -0.27; IC of 95%: -0.35 to -0.18) than control. Significant improvement in selective attention. Scores (pre-post) vigorous PA group (B = -0.29; IC of 95%: -0.39 to -0.19) significantly lower than control group, significant improvement in selective attention, but not in the passive rest ones. Moderate PA intervention, the scores (-0.59; IC of 95%: -0.70 to -0.49) (pre-post) were lower (significant improvement in selective attention and bigger effect) and significantly lower than control, passive rest, and intense PA intervention.
11	Ma et al.	Significant difference pre-post-test intervention group (p < .05) in D2 test. All measures in D2 test improved from week 1 to week 2 (p < .05). Significant difference (p < .05) between day 1 and day 2 in every result. Significant difference (p < .05) between day 3 and 4 for TE, EOmis and E%.
13	Magistro et al.	Significant differences (p < .05) between intervention group and control group in phases T2, T3 and T4. With effect on the intervention group of $F_{3.240}$ = 48.65, p < .001 and on the control group of $F_{1.80}$ = 21.23, p < .001. Group time effect, $F_{3.240}$ = 7,71, p < .001, d = 0.3 (small). Bigger in the intervention group in T4 (main group effect, $F_{1.80}$ =4.20, p = .044).

21	Peiris et al.	Significant difference (pre-post) between the classes with active breaks and the classes without active breaks in group A (DM=1.5, 95% CI=1.1 to 1.9, p<.001) and in group B (DM=1.4, 95% CI=1.0 to 1.8, p<.001). No differences between the effects between class type (p= .796) nor class time (p=.194).
28	Vazou et al.	Significant effect of the walkabouts programme between the time and the group for attention ($F_{1.194}$ = 64.95, p < .001, η^2= .25) and for behavioural control ($F_{1.194}$ = 59.22, p < .001, η^2= .24), between the time and the group and the level for attention ($F_{2.194}$ = 17. 23, p < .001, η^2= 0,15) and for behavioural control ($F_{2.194}$ = 11,92, p < .001, η^2= 0.11), and between group and grade for attention ($F_{2.194}$ = 5,33, p = .006, η^2= 0.05) and for behavioural control ($F_{2.194}$ = 9.09, p < .001, η^2= 0,09). Preschool groups: No significant difference between groups after the intervention nor in behavioural control. Primary school groups (nursery): Principal significant effect and an interaction time x group (intervention, control) both for attention ($F_{1.48}$ = 17.28, p < .001, η^2= .26; $F_{1.48}$ = 116.18, p < .001, η^2= .71) and for behavioural control ($F_{1.48}$ = 21.84, p < .001, η^2= .31; $F_{1.48}$ = 61.23, p < .001, η^2= .56). Intervention group significant difference pre-post (t = 105.69, p = .000, d = 1.75; t = 50.19, p = .000, d = 1.33). Control group significant decrease pre-post (t = 43.16, p = .000, d = -.72; t = 25.83, p = .000, d = -.75). Primary school group (2nd grade): Significant principal effect and interaction time x group (intervention, control) both for attention ($F_{1.71}$ = 10.21, p = .002, η^2= .13) and for behavioural control ($F_{1.48}$ = 21.84, p < .001, η^2= .31; $F_{1.71}$ = 12.84, p < .001, η^2= .15). Intervention group significant difference pre-post both in attention (t = 12.18, p = .001, d = 0.45) and behavioural control (t = 10,78, p = 0,002, d = 0,49). Control group significant decrease pre-post in behavioural control (t = 43.16, p = .000, d = -.72; t = 25.83, p = .000, d = -.75).

PI.13.3. Impact of active breaks on concentration

The existent relation between active breaks and the concentration variable was analysed in 4 articles (1, 4, 21, 24) out of the 29 that were reviewed (Table 6).

Table 6. Impact of active breaks on concentration.

	Author	**Impact of active breaks on concentration**
1	Arribas-Galarraga et al.	Significant difference (pre-post). Experimental group (Z = 2.947, p = .003) and control group (Z = -2.983, p = .003). No significant difference between groups (p < .05).
4	Contreras Jordán et al.	Significant difference pre-post (Z = -7.273, p = .000).
21	Peiris et al.	Significant difference (pre-post) between the classes with active breaks and the classes without active breaks in group A (DM=1.4, 95% CI=1.0 a 1.9, p<.001) and in group B (DM=1.6, 95% CI=1.2 a 2.1, p<.001).
24	Scholz et al.	T1 no significant difference between control and intervention group (p = .96). T2 and T3 higher score intervention group with significant difference (p ≤ .001) between control and intervention group. Significant difference (p ≤ .001) in the times T1 and T2, T2 and T3 both in control and intervention group. Significant difference between T1 and T3 in both groups (p ≤ .02). No significant differences between sexes (p ≥ .74).

DISCUSSION

This SR analyses exhaustively the relation between AB and their impact on attention, concentration, and AA in a school environment. The results of the investigations included in this review, as it happened in other studies (Méndez-Giménez, 2019; Sneck et al., 2019) are not easy to interpret due to the variety of

methodologies used, the types of intervention, the variety of the composition of the intervention and control groups, the educational levels of the participants, the number of participants of each study, the areas of knowledge measured to analyse the impact on AA, the duration of the investigations and the instruments used to measure the variables of each study.

When interpreting the results of AA it must be taken into consideration its multifactoriality, so we agree with Loturco et al. (2022) in that AA can vary for a variety of external factors. Moreover, through the carried analysis, just like Watson et al. (2017), it is concluded that the effects of AB on the different variables vary depending on the duration of the intervention and the instrument of measure used. However, in line with the review done by Sneck et al. (2019), the improvement in the results in AA after the AB were significant in a greater number than the non-significant. This way, in maths –even though it brings to light the heterogeneity and disparity in the impact of the AB on AA when looking at the results, like it happened in the work of Sneck et al. (2019)–, it is concluded that there exists a general positive effect in favour of the different interventions with AB in the AA in maths. About the impact on AA in orthography, the results suggest that, despite certain variations in the results, in general the assessed interventions don't show statistically significant impacts. Along the same lines, the results related to language put into question the impact of AB on AA. However, Loturco et al. (2022) point out that the different interventions based on PA have a limited impact on AA in favour of AB, which has been substantiated in this review. Additionally, it should be pointed out that the results of the interventions done with PA of higher intensity and with longer interventions have a bigger effect on AA.

When considering the results of the investigations where they used more than one subject to measure the performance and impact of AB, the results, as it happened in the work of Méndez-Giménez (2019), make clear the complexity of AA and the great variety of investigations and results. However, when observing the effect of the interventions, in agreement with other reviews (Norris et al., 2015; Bedard et al., 2019; Loturco et al., 2022) the final results indicate improvement, but it is not always significant.

When it comes to the impact of the different interventions on attention, the reviewed documents (Watson et al., 2017; Ruhland and Lange, 2021; Daly-Smith et al, 2018) agree in pointing out that AB have a positive influence on the students' attention, which backs up the idea that incorporating AB in the school environment can be beneficial for the attention of the students. The results related to concentration (Contreras Jordán et al., 2020; Peiris et al., 2021), suggest that AB can have a positive impact on the students' concentration. Moreover, the Scholz et al. (2021) study backs up the results of the review by Watson et al. (2017), in which longer interventions, with a duration of between 1 and 3 years, obtained better results compared to shorter studies. However, the heterogeneity of the results brings up some interesting questions about the moderators that could influence the effects of the AB on concentration. It is important to add that these significant differences weren't observed in all studies equally, which suggests that the relation between AB and concentration is complex and can vary depending on the circumstances.

This review offers a vision of the relation between active breaks and AA, attention, and concentration in an educational environment. While some studies back up the positive effects of AB, the variability in the investigation designs, methods in the application of AB (number of participants, subjects and varied contents, duration, intensity, intervention programmes, measure instruments) and the variability in the results highlight the need for future investigations to better understand the effects of these interventions and their applicability in different educational contexts.

CONCLUSIONS

The most outstanding conclusions related to the specific goals are the following:

- Thematic and geographic diversity: the research comes from various disciplines and countries, which reflects a global interest in active breaks in education.
- Variability in the investigation designs: different methodological approaches, from intervention and control groups to more complex designs, which highlights the importance of considering the particularities of each study.
- Different educational levels: several educational levels are approached, with a predominant focus on primary school students.
- Varied subjects and content: various subjects and academic content for the interventions, which suggests great interest from the teachers and the necessity of exploring how these differences affect the results.
- Common modalities of intervention: the intervention of the type "*Curriculum-Focused Active Breaks*" and "*Active Breaks*" were the most frequent, which raises questions about their efficacy compared to other modalities.
- Heterogeneous duration of the interventions: they varied greatly in duration. It is concluded that temporality affects, and longer interventions are shown to be more effective.
- Diverse measure instruments: the diversity stands out, which emphasizes the importance of standardising the tools for future investigations.
- Impact on academic achievement: the heterogeneous results are made evident. The complexity and diversity of the interventions is highlighted, as well as the importance of considering external factors when evaluating their impact on academic achievement.
- Impact on attention: it consistently presents significative improvement after implementing AB, backing up the idea that these can have a positive impact on attention and behaviour during tasks.
- Impact on concentration: the results are more varied, indicating the complexity of these processes and the influence of contextual factors. Even though some studies suggest significant improvement, others show mixed results, highlighting the necessity of interpreting with precaution the conclusions about the impact of active breaks on these areas.

As a final conclusion, a panoramic view of the effects of AB in an educational context is offered. One of the important aspects that these results suggest is the distribution of publications in journals with various approaches, which cover areas like education, health, sport, psychology, and pedagogy. The diversity of countries of origin of the publications suggests a global interest in exploring the impact of AB in the school context, and it could reflect cultural differences and pedagogic approaches in relation to this strategy. A key element that comes up in the results is the diversity in the investigation designs, which might influence the interpretation of results and highlights de importance of considering the particularities of each study when analysing the effects of AB. Even though evidence of intervention with AB has been found in all educational levels, the fact that a great number of articles involved primary school students brings up a predominant approach on basic education. This fact influences the applicability of the results on other educational levels and raises the necessity of further investigating the effects on superior levels.

The subjects and academic content used in the interventions also showed a significant variability, with emphasis on maths (16 interventions), reading (8 interventions), and orthography (5 studies). These results suggest the necessity of exploring if certain subjects are more susceptible to the positive effects of AB, and if the intervention modalities differ depending on the academic content.

About modalities of intervention, it was observed that CF-AB (13 investigations) and AB (7 investigations) were the most common. This brings up the question if it exists a modality that stands out in terms of impact on AA, attention, and concentration, as well as the necessity of examining how different approaches can complement each other in an educational environment. It is fundamental to emphasize that the duration of the interventions varied greatly, from one-time interventions to investigations that expanded over the course of three years. This diversity in duration may have significant implications for the persistence of the observed effects and suggests the need to understand how temporality influences the efficacy of active breaks.

It is important to point out that the measure instruments used to compile data also presented variability, which might influence the comparability of the results among studies, and makes clear the importance of standardising the measure tools in future investigations to allow a more precise comparison and deeper understanding of the effects of AB.

Finally, we want to highlight that these studies reveal heterogeneous results on the effects of AB interventions and highlight the importance of considering several external factors when evaluating their impact on attention, concentration and AA.

AUTHOR CONTRIBUTIONS

This work has been done with a team, but the responsibilities have been distributed as follows:

- -Conception and design of the study: Silvia Arribas Galarraga, Julen Maiztegi Kortabarria.
- -Data compilation: Julen Maiztegi Kortabarria.
- -Data analysis and interpretation: Silvia Arribas Galarraga, Julen Maiztegi Kortabarria, Izaskun Luis de Cos and Saioa Urrutia.
- -Report redaction: Julen Maiztegi Kortabarria, Silvia Arribas Galarraga.
- -Report review: Silvia Arribas Galarraga, Julen Maiztegi Kortabarria, Izaskun Luis de Cos.

SUPPORTING AGENCIES

The spreading of this work is possible thanks to the support of the University of the Basque Country through the Research Groups Aid (Cod.21/047) and thanks to the ERRONKA research group (GIU21/047).

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

REFERENCES

Arribas-Galarraga, S., & Maiztegi-Kortabarria, J. (2021). Evolution of attention, concentration and academic performance after an intervention based on Activity Breaks. Revista Electronica Interuniversitaria de Formacion del Profesorado, 24(3), 87-100. https://doi.org/10.6018/reifop.467731

Bartholomew, J., & Jowers, E. (2011). Physically active academic lessons in elementary children. Preventive Medicine, 52, S51-S54. https://doi.org/10.1016/j.ypmed.2011.01.017

Bedard, C., St John, L., Bremer, E., Graham, J. D., & Cairney, J. (2019). A systematic review and meta-analysis on the effects of physically active classrooms on educational and enjoyment outcomes in school age children. PLOS ONE, 14(6), e0218633. https://doi.org/10.1371/journal.pone.0218633

Calvert, H., Barcelona, J., Melville, D., & Turner, L. (2019). Effects of acute physical activity on NIH toolbox-measured cognitive functions among children in authentic education settings. Mental Health And Physical Activity, 17. https://doi.org/10.1016/j.mhpa.2019.100293

Contreras Jordán, O. R., León, M. P., Infantes-Paniagua, Á., & Prieto-Ayuso, A. (2020). Effects of active breaks in the attention and concentration of elementary school students. Revista Interuniversitaria de Formacion del Profesorado, 34(1), 145-160. https://doi.org/10.47553/rifop.v34i1.77723

Daly-Smith, A. J., Zwolinsky, S., McKenna, J., Tomporowski, P. D., Defeyter, M. A., & Manley, A. (2018). Systematic review of acute physically active learning and classroom movement breaks on children's physical activity, cognition, academic performance and classroom behaviour: Understanding critical design features. BMJ Open Sport & Exercise Medicine, 4(1), e000341. https://doi.org/10.1136/bmjsem-2018-000341

Donnelly, J., Hillman, C., Greene, J., Hansen, D., Gibson, C., Sullivan, D., Poggio, J., Mayo, M., Lambourne, K., Szabo-Reed, A., Herrmann, S., Honas, J., Scudder, M., Betts, J., Henley, K., Hunt, S., & Washburn, R. (2017). Physical activity and academic achievement across the curriculum: Results from a 3-year cluster-randomized trial. Preventive Medicine, 99, 140-145. https://doi.org/10.1016/j.ypmed.2017.02.006

Egger, F., Benzing, V., Conzelmann, A., & Schmidt, M. (2019). Boost your brain, while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement. PLoS ONE, 14(3). https://doi.org/10.1371/journal.pone.0212482

Erwin, H., Fedewa, A., Wilson, J., & Ahn, S. (2019). The Effect of Doubling the Amount of Recess on Elementary Student Disciplinary Referrals and Achievement Over Time. Journal of Research in Childhood Education, 33(4), 592-609. https://doi.org/10.1080/02568543.2019.1646844

Fedewa, A., Fettrow, E., Erwin, H., Ahn, S., & Farook, M. (2018). Academic-Based and Aerobic-Only Movement Breaks: Are There Differential Effects on Physical Activity and Achievement? Research Quarterly for Exercise and Sport, 89(2), 153-163. https://doi.org/10.1080/02701367.2018.1431602

Fiorilli, G., Buonsenso, A., Di Martino, G., Crova, C., Centorbi, M., Grazioli, E., Tranchita, E., Cerulli, C., Quinzi, F., Calcagno, G., Parisi, A., & Di Cagno, A. (2021). Impact of active breaks in the classroom on mathematical performance and attention in elementary school children. Healthcare (Switzerland), 9(12). https://doi.org/10.3390/healthcare9121689

Infantes-Paniagua, Á., Silva, A. F., Ramirez-Campillo, R., Sarmento, H., González-Fernández, F. T., González-Víllora, S., & Clemente, F. M. (2021). Active School Breaks and Students' Attention: A Systematic Review with Meta-Analysis. Brain Sciences, 11(6), 675. https://doi.org/10.3390/brainsci11060675

Janssen, M., Chinapaw, M. J. M., Rauh, S. P., Toussaint, H. M., Van Mechelen, W., & Verhagen, E. A. L. M. (2014). A short physical activity break from cognitive tasks increases selective attention in primary school children aged 10-11. Mental Health and Physical Activity, 7(3), 129-134. https://doi.org/10.1016/j.mhpa.2014.07.001

Loturco, I., Montoya, N. P., Ferraz, M. B., Berbat, V., & Pereira, L. A. (2022). A Systematic Review of the Effects of Physical Activity on Specific Academic Skills of School Students. Education Sciences, 12(2), 134. https://doi.org/10.3390/educsci12020134

Ma, J. K., Mare, L. L., & Gurd, B. J. (2015). Four minutes of in-class high-intensity interval activity improves selective attention in 9- to 11-year olds. Applied Physiology, Nutrition and Metabolism, 40(3), 238-244. https://doi.org/10.1139/apnm-2014-0309

Macdonald, K., Milne, N., Pope, R., & Orr, R. (2022). Evaluation of a 12-Week Classroom-Based Gross Motor Program Designed to Enhance Motor Proficiency, Mathematics and Reading Outcomes of Year 1 School Children: A Pilot Study. Early Childhood Education Journal, 50(5), 811-822. https://doi.org/10.1007/s10643-021-01199-w

Magistro, D., Cooper, S. B., Carlevaro, F., Marchetti, I., Magno, F., Bardaglio, G., & Musella, G. (2022). Two years of physically active mathematics lessons enhance cognitive function and gross motor skills in primary school children. Psychology of Sport and Exercise, 63. https://doi.org/10.1016/j.psychsport.2022.102254

Mahar, M. T., Murphy, S. K., Rowe, D. A., Golden, J., Shields, A. T., & Raedeke, T. D. (2006). Effects of a classroom-based program on physical activity and on-task behavior. Medicine and Science in Sports and Exercise, 38(12), 2086-2094. https://doi.org/10.1249/01.mss.0000235359.16685.a3

Masini, A., Marini, S., Gori, D., Leoni, E., Rochira, A., & Dallolio, L. (2020). Evaluation of school-based interventions of active breaks in primary schools: A systematic review and meta-analysis. Journal of Science and Medicine in Sport, 23(4), 377-384. https://doi.org/10.1016/j.jsams.2019.10.008

Mavilidi, M., Drew, R., Morgan, P., Lubans, D., Schmidt, M., & Riley, N. (2020a). Effects of different types of classroom physical activity breaks on children's on-task behaviour, academic achievement and cognition. Acta Paediatrica, 109(1), 158-165. https://doi.org/10.1111/apa.14892

Mavilidi, M., Ouwehand, K., Riley, N., Chandler, P., & Paas, F. (2020b). Effects of An Acute Physical Activity Break on Test Anxiety and Math Test Performance. International Journal of Environmental Research and Public Health, 17(5). https://doi.org/10.3390/ijerph17051523

Méndez-Giménez, A. (2020). Academic, cognitive and physical outcomes of two strategies to integrate movement in classroom: Active lessons and active breaks: Resultados académicos, cognitivos y físicos de dos estrategias para integrar movimiento en el aula: clases activas y descansos activos. Sport TK-Revista EuroAmericana de Ciencias del Deporte, 63-74. https://doi.org/10.6018/sportk.412531

Mok, M., Chin, M., Korcz, A., Popeska, B., Edginton, C., Uzunoz, F., Podnar, H., Coetzee, D., Georgescu, L., Emeljanovas, A., Pasic, M., Balasekaran, G., Anderson, E., & Durstine, J. (2020). Brain Breaks (R) Physical Activity Solutions in the Classroom and on Attitudes toward Physical Activity: A Randomized Controlled Trial among Primary Students from Eight Countries. International Journal of Environmental Research and Public Health, 17(5). https://doi.org/10.3390/ijerph17051666

Morris, J., Daly-Smith, A., Archbold, V., Wilkins, E., & McKenna, J. (2019). The Daily Mile (TM) initiative: Exploring physical activity and the acute effects on executive function and academic performance in primary school children. Psychology of Sport and Exercise, 45. https://doi.org/10.1016/j.psychsport.2019.101583

Mullender-Wijnsma, M. J., Hartman, E., de Greeff, J. W., Bosker, R. J., Doolaard, S., & Visscher, C. (2015). Improving Academic Performance of School-Age Children by Physical Activity in the Classroom: 1-Year Program Evaluation. Journal of School Health, 85(6), 365-371. https://doi.org/10.1111/josh.12259

Mullender-Wijnsma, M. J., Hartman, E., de Greeff, J. W., Doolaard, S., Bosker, R. J., & Visscher, C. (2019). Follow-Up Study Investigating the Effects of a Physically Active Academic Intervention. Early Childhood Education Journal, 47(6), 699-707. https://doi.org/10.1007/s10643-019-00968-y

Norris, E., Shelton, N., Dunsmuir, S., Duke-Williams, O., & Stamatakis, E. (2015). Physically active lessons as physical activity and educational interventions: A systematic review of methods and results. Preventive Medicine, 72, 116-125. https://doi.org/10.1016/j.ypmed.2014.12.027

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, n71. https://doi.org/10.1136/bmj.n71

Peiris, C. L., O'donoghue, G., Rippon, L., Meyers, D., Hahne, A., De Noronha, M., Lynch, J., & Hanson, L. C. (2021). Classroom movement breaks reduce sedentary behavior and increase concentration,

alertness and enjoyment during university classes: A mixed-methods feasibility study. International Journal of Environmental Research and Public Health, 18(11). Scopus. https://doi.org/10.3390/ijerph18115589

Peiris, D. L. I. H. K., Duan, Y., Vandelanotte, C., Liang, W., Yang, M., & Baker, J. S. (2022). Effects of In-Classroom Physical Activity Breaks on Children's Academic Performance, Cognition, Health Behaviours and Health Outcomes: A Systematic Review and Meta-Analysis of Randomised Controlled Trials. International Journal of Environmental Research and Public Health, 19(15), 9479. https://doi.org/10.3390/ijerph19159479

Podnar, H., Novak, D., & Radman, I. (2018). Effects of a 5-minute classroom-based physical activity on on-task behaviour and physical activity levels. Kinesiology, 50(2), 251-259. https://doi.org/10.26582/k.50.2.17

Raney, M., Henriksen, A., & Minton, J. (2017). Impact of short duration health & science energizers in the elementary school classroom. Cogent Education, 4(1), 1399969. https://doi.org/10.1080/2331186X.2017.1399969

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. Preventive Medicine, 52, S10-S20. https://doi.org/10.1016/j.ypmed.2011.01.027

Ruhland, S., & Lange, K. W. (2021). Effect of classroom-based physical activity interventions on attention and on-task behavior in schoolchildren: A systematic review. Sports Medicine and Health Science, 3(3), 125-133. https://doi.org/10.1016/j.smhs.2021.08.003

Ruiz-Ariza, A., Suárez-Manzano, S., López-Serrano, S. & Martínez-López, E. J. (2021). La actividad física como medio para cultivar la inteligencia en el contexto escolar. Revista Española de Pedagogía, 79(278). https://doi.org/10.22550/REP79-1-2021-04

Scholz, L., Schulze, J., & Ohlendorf, D. (2019). Influence of additional exercise in class on the concentration behaviour of first grade primary school pupils: A pilot study. Manuelle Medizin, 57(3), 169-175. https://doi.org/10.1007/s00337-019-0544-4

Sneck, S., Viholainen, H., Syväoja, H., Kankaapää, A., Hakonen, H., Poikkeus, A.-M., & Tammelin, T. (2019). Effects of school-based physical activity on mathematics performance in children: A systematic review. International Journal of Behavioral Nutrition and Physical Activity, 16(1), 109. https://doi.org/10.1186/s12966-019-0866-6

Snyder, K., Dinkel, D., Schaffer, C., & Colpitts, A. (2017). Purposeful Movement: The Integration of Physical Activity into a Mathematics Unit. 14.

Solberg, R., Steene-Johannessen, J., Fagerland, M., Anderssen, S., Berntsen, S., Resaland, G., van Sluijs, E., Ekelund, U., & Kolle, E. (2021). Aerobic fitness mediates the intervention effects of a school-based physical activity intervention on academic performance. The school in Motion study-A cluster randomized controlled trial. Preventive Medicine Reports, 24. https://doi.org/10.1016/j.pmedr.2021.101648

Van den Berg, V., Singh, A., Komen, A., Hazelebach, C., van Hilvoorde, I., & Chinapaw, M. (2019). Integrating Juggling with Math Lessons: A Randomized Controlled Trial Assessing Effects of Physically Active Learning on Maths Performance and Enjoyment in Primary School Children. International Journal of Environmental Research and Public Health, 16(14). https://doi.org/10.3390/ijerph16142452

Vazou, S., Long, K., Lakes, K. D., & Whalen, N. L. (2021). "Walkabouts" Integrated Physical Activities from Preschool to Second Grade: Feasibility and Effect on Classroom Engagement. Child & Youth Care Forum, 50(1), 39-55. https://doi.org/10.1007/s10566-020-09563-4

Watson, A., Timperio, A., Brown, H., Best, K., & Hesketh, K. D. (2017). Effect of classroom-based physical activity interventions on academic and physical activity outcomes: A systematic review and meta-

analysis. International Journal of Behavioral Nutrition and Physical Activity, 14(1), 114. https://doi.org/10.1186/s12966-017-0569-9

Young-Jones, A., McCain, J., & Hart, B. (2022). Let's Take a Break: The Impact of Physical Activity on Academic Motivation. 9.

Zawacki-Richter, M. Kerres, S. Bedenlier, M. Bond, & K. Buntins (2020). Systematic Reviews in Educational Research. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-27602-7_1