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Original

Active break as a tool for improving attention in the educational context. A systematic review and meta-analysis

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A R T I C L E I N F O

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A B S T R A C T

Active breaks have now been shown to be a tool that helps improve physical health and some executive functions. The objective was to analyse the effects of the interventions carried out through active breaks for the improvement of attention according to the educational stage, duration of the session and duration of the intervention. A systematic search has been conducted until March 2023 including scientific articles reporting on an intervention programme based on active breaks to improve attention and studies using a quasi-experimental or experimental methodological design with pre-test and post-test. The bibliographic search has been carried out in Web of Science, Scopus and Pubmed, specifically in the categories of "*Education Educational Research*" "*Sport Sciences*" "*Psychology*" "*Psychology Applied*" "*Psychology Educational*" and "*Social Sciences*". The sample of the quantitative synthesis consisted of 15 research studies with 1474 participants. Three moderating variables were established: *educational stage*, *session time* and *intervention programme time*. The average effect size has been ($\bar{X}$ = 0.31; CI = [0.21; 0.42]). The moderators' analysis has shown that *high school education* is the most effective stage for developing active breaks ($\bar{X}$ = 0.58; CI = [0.42; 0.74]). It has also been observed that intervention programmes with a *duration of 5 to 8 weeks* ($\bar{X}$ = 0.53; CI = [0.37; 0.69]) with a *30-minute duration per session* ($\bar{X}$= 0.98; CI = [0.74; 1.22]) were the most effective in improving attention. These results have led to the conclusion that the educational stage, the duration of the intervention and the length of the programme sessions are variables to be taken into account when it comes to active breaks.

Los descansos activos como herramienta para mejorar la atención en el contexto educativo. Una revisión sistemática y meta-análisis

Palabras clave:
Descansos activos
atención
educación

R E S U M E N

Se ha demostrado que los descansos activos son una herramienta que ayuda a mejorar la salud física y algunas funciones ejecutivas. Se ha pretendido analizar los efectos que han tenido las intervenciones de descansos activos para la mejora de la atención en función de la etapa educativa, duración de la sesión y duración de la intervención. Se ha realizado una búsqueda sistemática hasta marzo de 2023 incluyendo los artículos científicos que informasen sobre un programa de intervención basado en descansos activos para mejorar la atención y los estudios que utilicen un diseño metodológico cuasi-experimental o experimental con pre-test y post-test. La búsqueda bibliográfica se ha llevado a cabo en Web of Science, Scopus y Pubmed, en las categorías de *"Education Educational Research" "Sport Sciences" "Psychology" "Psychology Applied" "Psychology Educational"* y *"Social Sciences"*. La síntesis cuantitativa ha quedado formada por 15 investigaciones y 1.474 participantes. El tamaño del efecto medio ha sido ($\bar{X}$ = 0.31; CI = [0.21; 0.42]).

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Se han establecido tres variables moderadoras: *etapa educativa*, *duración de cada sesión* y *duración del programa de intervención*. La etapa de *educación secundaria* ha sido la más eficaz para desarrollar los descansos activos ($\bar{X}$ = 0.58; IC = [0.42; 0.74]). Asimismo, las intervenciones con una *duración de 5 a 8 semanas* ($\bar{X}$ = 0.53; IC = [0.37; 0.69]) y con una *duración por sesión de 30 minutos* ($\bar{X}$ = 0.98; IC = [0.74; 1.22]) han sido las más efectivas para mejorar la atención. Se ha concluido que la etapa educativa, la duración de la intervención y la duración de las sesiones del programa son fundamentales a la hora de realizar descansos activos.

Introduction

Scientific evidence shows that any physical activity has a positive impact on many aspects of human being (Martínez-Heredia et al., 2020), including physical and cognitive factors (Wanders et al., 2021). However, in spite of the clear benefits, according to the World Health Organization (World Health Organization, 2019), 84% of females and 78% of males aged 11-17 years are not achieving recommended minimum physical activity levels. These inactivity levels lead to a worsening health status in adulthood (DeWolfe et al., 2020). To increase physical activity hours and improve physical and mental health, active breaks have emerged (Contreras-Jordán et al., 2020). It is described as a brief physical activity break integrated into regular school hours, offering higher physical activity levels to students without reducing learning time (Pastor-Vicedo et al., 2021).

Evidence in published research suggests that regular physical activity is positively related to academic performance (Calvert et al., 2020; Mavilidi, Ouwehand et al., 2020; Mavilidi et al., 2021). Furthermore, studies have shown how regular physical activity in primary and secondary school is associated with higher cognitive performance (Ruiz-Hermosa et al., 2019), improving attention levels (Arabi et al., 2023). In addition, attention is defined as a functioning mechanism affecting and activating the selection, distribution and maintenance processes of psychological activity (Fan & Wang, 2022). Furthermore, attention helps to keep concentration focused by avoiding distracting and irrelevant elements (Contreras-Jordán et al., 2020).

In the above section, physical activity is shown as helping to improve cognitive performance. The study of Altenburg et al. (2016) found that 20-minute active breaks improved attention skills in comparison to participants with no active breaks as well. Janssen et al. (2014) showed that children between ten and eleven years old who performed 15 minutes of physical activity showed a significant improvement in their attention skills. In the Spanish context, Martínez-López et al. (2018) found that after one month of active breaks involving four active breaks per day at a moderate-vigorous intensity level, teenagers achieved better attention and memory levels. Before including active breaks in educational activities, it is necessary to reflect on what physical activity should be performed and how long they should be taken in terms of obtaining significant cognitive improvements. As regards active breaks duration, it has been observed that breaks with a duration between 10- and 20-minutes show better results in adolescents' attention (Janssen et al., 2014). Kubesch et al. (2009) also found that five-minute active breaks were insufficient to improve attention skills. In contrast, Daly-Smith et al. (2018) concluded that five-minute active breaks of vigorous intensity as well as fifteen-minute active breaks after moderate physical activity obtained a higher cognitive engagement improvement.

About physical activity type, Watson et al. (2017) assert that physical activity type can positively or negatively impact on cognition. Chang et al. (2013) showed how coordination exercises improve students' attention. It could be due to coordination activating brain areas related to attention (Chang et al., 2013; Morris et al., 2019). Furthermore, Schmidt et al. (2015) found that physical tasks involving a higher level of attention switching lead to an improvement in concentration skills. De Greeff et al. (2018) confirmed the above, by stating interventions involving physical activity cognitively engaged reported an improvement on cognitive performance, compared to interventions with a low level of physical activity cognitively engaged.

Watson et al. (2019) reported cognitive load physical-sport activities significantly improved concentration skills and selective attention. Moreover, Schmidt et al. (2016) concluded that active breaks with cognitive load enhance cognitive engagement to improve attention and information processing. Pastor-Vicedo et al. (2021) reported active breaks as a good approach to achieve higher cognitive performance. Therefore, tasks with a higher cognitive load than mechanical ones should be applied (Pastor-Vicedo et al., 2021). To improve attention, other techniques like mindfulness are available. Mindfulness studies on cognition are limited (Müller, Otto et al., 2021; Taraban et al., 2017) in comparison to studies on physical activity (Graham et al., 2021; Layne et al., 2021; Luteijn et al., 2022; Robinson et al., 2022; Schmidt et al., 2020). Mindfulness techniques and cognitively loaded physical activity are proven to be successful tools for improving attention (Müller, Dubiel et al., 2021).

Finally, in light of the foregoing, the aims of this study are: (a) to identify and synthesize studies on active breaks to improve attention in the educational setting, (b) to analyze how interventions using active breaks have improved attention at different educational stages (c) to analyze how interventions using active breaks have improved attention as a function of the duration of the session (d) to analyze how interventions using active breaks have improved attention as a function of duration of the intervention programme.

Method

Design

The systematic review study was carried out in accordance with the criteria set out in the PRISMA statement for systematic reviews incorporating meta-analyses (Hutton et al. 2016; Liberati et al., 2009; Moher et al., 2009; Page et al., 2021). Furthermore, this study has been recorded in PROSPERO with the following code CRD42023399076.

Search strategy

The bibliographic search was carried out during February and March 2023 in the Pubmed, Web of Sciences and Scopus databases. After selecting the articles, the reference lists were analysed in order to identify other articles related to active breaks and mindfulness at different educational stages. The following search domain was used as search engines: *"Activity Breaks"* and *"Cognition"* and *"Education"*. A study has been carried out on the evolution of scientific production in the selected databases. It has been found that most of the research was carried out from 2016 onwards. The time range was defined as 2016 to 2022. In addition, only research written in Spanish and English was considered. The search was then narrowed down to the following categories. For Web of Science it has been used its main collection, conducting the search in the areas of "*Education Educational Research*" and "*Sport Sciences*" and "*Psychology*" and "*Psychology Applied*" and "*Psychology Educational*". For Scopus, the search was carried out in the areas of "*Psychology*" and "*Social Sciences*".

For research reporting more than one cognitive variable, attention-related outcomes were selected. In case of multiple outcomes, reviewers were asked to rank them independently according to the degree of relevance for answering the research objectives. For this research, priority was given to the executive function analysed (attention), working memory and global cognitive functions. Table 1 below shows the searches carried out in the various databases.

In order to delimit the study sample a set of inclusion criteria were established, defined as follows: (1) Scientific articles reporting an intervention programme based on active breaks for improving attention or academic performance; (2) Studies using a quasi-experimental or experimental methodological design with pre-test and post-test; (3) Investigations providing statistical results allowing to calculate the effect size of the programme conducted; (4) Peer-reviewed papers; (5) Open access papers; (6) Investigations in Spanish and English; (7) Quantitative papers. Any study that did not meet any of the criteria was not considered for analysis

Bibliographic sample and study population

A total of 436 scientific studies were initially included. After applying the aforementioned search strategy and applying the inclusion criteria filters, the final meta-analysis sample consisted of a total of 15 studies. Figure 1 below shows the flow chart followed for this research.

Codification of research

For data extraction across papers, authors carried out a coding process as follows (Table 2): (1) Author and year of publication; (2) Study country; (3) Research design; (4) Study sample; (5) Educational level in which study is conducted; (6) Length of the intervention programme; (7) Number of sessions per week; (8) Duration of each session; (9) Effect size. Each of the research included in the current research have been coded by each of the authors. This coding was carried out with all authors present. This was to check the degree of agreement between authors for data extraction, to calculate effect sizes, as well as to check the reliability of research coding. For this study, the degree of agreement in the ranking of the research was over 90%. This percentage was obtained by applying the following mathematical formula: Total number of positive responses divided by the total number of categories and the result obtained is multiplied by 100. Due to the distribution of roles, the selection and coding of the research was carried out by all authors, however the calculation of effect sizes was calculated by three authors.

The methodological quality of the study was determined by more than two assessors, using Fleiss' Kappa (*Kf*) (Fleiss, 1971). In addition, Cohen's Kappa (*Kc*) statistical index (Cohen, 1960) has been used to evaluate the coding used. For the first index, a value of $Kf = 0.760$ (0.60-0.85) has been obtained, which shows a high degree of agreement (Landis & Koch, 1977). For the second index, a value of $Kc = 0.815$ (0.810-1.00) has been obtained, showing a high degree of agreement (Landis & Koch, 1977).

Meta-analysis data analysis

The Review Manager 5.3 software (Crochrane, London, UK) has been used for the meta-analysis of this research. A random-effects meta-analysis has been used for the different types of interventions carried out, as it considered the variability of the intra- and inter-study. To calculate the degree of heterogeneity, the I^2 index has been used to assess the degree of heterogeneity of the individual results. In addition, to check whether there is a degree of heterogeneity, the *Q*-index has been used. The *Z*-bias test has been also applied to specify the test of a comparison of hypotheses to test for null effects. Similarly, effect sizes were assessed by visual inspection of a forest plot.

Risk of bias

To examine and assess the influence of bias, the confidence (*Ns*) has been calculated (Orwin, 1983). This allows comparison of the sample of studies, the effect size of the retrieved research and the average effect of the missing studies (Orwin, 1983). When the *Ns* value is higher than the number of missing studies, it can be stated that the rigour of the meta-analysis is not compromised by publication bias (Orwin, 1983). Conversely, if the missing studies are greater than the *Ns*, the meta-analysis study may be threatened. The Cochrane Collaboration's Tool for Assessing Risk of Bias (Higgins et al., 2011) has been used to assess the quality of the articles included in the meta-analysis. This tool has been used with the 15 articles comprising the meta-analysis. This was done in order to ascertain whether there were any biases that influenced the effect of the intervention. Two investigators assessed the risk of bias through the following categories: (1) Random sequence generation; (2) Allocation concealment; (3) Blinding of participants and staff; (4) Incomplete outcome data; (5) Selective reporting; (6) Other sources of bias. The classification levels were as follows: (1) Low risk of bias; (2) Unclear risk of bias; (3) High risk of bias. A high level of agreement has been obtained as the value of Cohen's Kappa coefficient was 0.890.

Calculation of effect size

The Review Manager 5.3 software (Crochrane, London, UK) has been used to calculate the effect size and standard error. To calculate the effect size together with the standard error that has more than one follow-up measure, the values of the means and standard deviations of the pre-test and post-test measures of the control and experimental groups were taken. These data have been extracted directly from the original studies. The effect size has been obtained from the difference of standardised mean changes corrected for sample size (Botella-Ausina & Sánchez-Meca, 2015; Morris, 2008). The outcome measures obtained have been grouped into different areas to assess the effects of active breaks. The first area, called the *educational stage*, aimed to analyse the educational level at which the intervention programme has been carried out. This has been classified into three sub-variables: *Pre-school and elementary education, high school education* and *university education*. The second area has been formulated according to the *session time*. This had three variables: *Short duration (maximum 10 minutes), medium duration (between 10 and 30 minutes)* and *long duration (more than 30 minutes)*. The third area focused on the *intervention programme time*. This was classified into the following levels: *Short duration (0-4 weeks), medium duration (5-8 weeks)* and *long duration (more than 9 weeks)*.

Table 1
Search strategies applied

Database	Search type	Search strategy	Number of researches
Web of Science	Basic Search	"Activity Breaks" (All Fields) and "Cognition" (All Fields) and "Education*" (All Fields)	14
Scopus	Basic Search	(ALL ("Activity Breaks") AND ALL ("Cognition") AND ALL ("Education*"))	422
Pubmed	Advance Search	(("Activity Breaks") AND ("Cognition")) AND ("Education*")	7

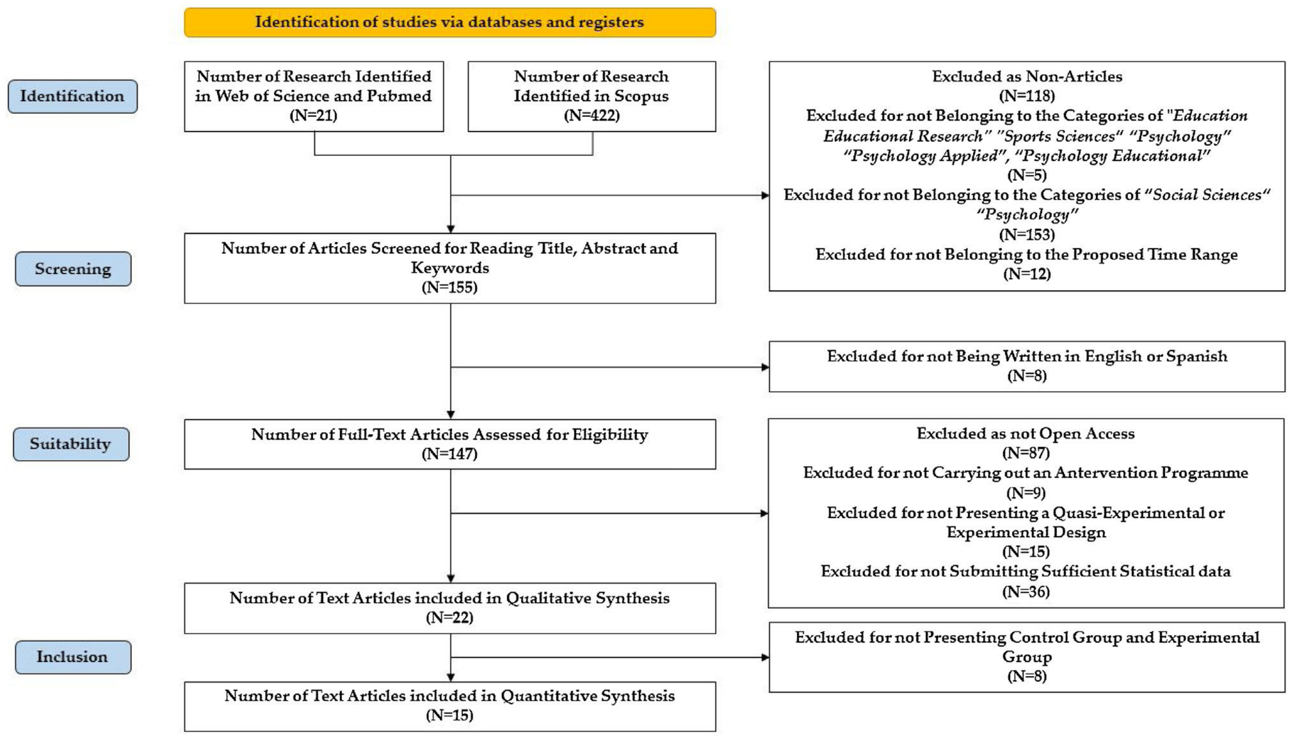

Figure 1. Flowchart of the systematic review study.

Statistical analysis

A random-effects meta-analysis model has been used to combine effect sizes. The effectiveness of the active-breaks intervention in improving attention has been examined. The subgroup analysis evaluated the impact of three moderating variables, each composed of three subvariables: *educational stage* (*pre-school and primary education; high school education; university education*), *session time* (*short duration; medium duration; long duration*) and *intervention programme time* (*short duration; medium duration; long duration*). Cluster-adjusted estimates from randomised controlled trials have been used where data were available. Where studies had not been cluster-adjusted, they were adjusted using an estimate of the intracluster correlation coefficient (Higgins et al., 2011). Publication bias has been studied through Egger's regression test (Egger et al., 1997). This test is based on a simple linear regression model where the effect is denoted as significant if $Z \geq 1.96$ or $Z \leq -1.96$. The reason for not using Begg's test is that Egger's test has a higher degree of specificity (Fernández-Castilla et al., 2021; Rubio-Aparicio et al., 2018).

To assess the degree of heterogeneity, Cochran's *Q* statistic has been used (Molina-Arias, 2018). This statistic considers the deviations between the results of each study and the overall result, weighted according to the contribution of each study to the overall result (Molina-Arias, 2018). *Q* is a conservative parameter, so some authors propose using a statistical significance value of $p < 0.1$ (Molina-Arias, 2018). This statistic does not allow us to quantify the degree of heterogeneity and loses statistical power when the number of studies is small (Molina-Arias, 2018). Due to the above, it has been decided to also include the I^2 statistic symbol. The value of this allows us to provide an estimate of the total variability between studies with respect to the total variability (Molina-Arias, 2018). Its value ranges from 0 to 100%, with the limits of 25%, 50% and 75% usually considered to delimit when there is low, moderate and high heterogeneity, respectively (Molina-Arias, 2018).

Results

Analysis of scientific production

Regarding scientific production evolution in the addressed topic, Figure 2 shows a graphical summary of production in the addressed topic area according to different databases used. It shows an increase trend in the period 2016-2020. A further growth of the topic can also be seen between 2021-2022. On the other hand, a slight relapse is shown between 2020-2021. It is observed also that the database with the highest number of research papers is Scopus (n = 84; 83.16%), followed by Web of Science (n = 9; 8.91%) and concluding with Pubmed (n = 8; 7.93%).

Descriptive characteristics of the studies that make up the meta-analysis

A total of 1.474 participants have been included in the 15 articles composing the present meta-analysis. The participants were divided according to educational level: 675 belonged to *pre-school and primary education*, 673 to *high school education* and 126 to *university education*. A total of nine studies with a quasi-experimental

Table 2
Characteristics of the sample

Authors (Year)	Country	Design	Sample	Educational Stage	Programme duration	Sessions per week	Session duration	Efect Size [IC 95%]
Robinson et al. (2022)	Australia	Quasi-experimental pre-test post-test design	97 students (15.78 ± 0.44) (44 girls) (53 boys)	High School Education	4 weeks	3	6-8 minutes	1.36 [0.72; 2.00]
Latino et al. (2021)	Italy	Quasi-experimental pre-test post-test design	30 students (14.53 ± 0.50) (12 girls) (18 boys)	High School Education	8 weeks	2	60 minutes	2.23 [1.30; 3.17]
Arribas-Galarraga & Maiztegi-Kortabarria (2021)	Spain	Quasi-experimental pre-test post-test design	31 students (12.13 ± 0.341) (14 girls) (17 boys)	High School Education	7 weeks	4	5-10 minutes	−0.41 [−1.12; 0.31]
Layne et al. (2021)	USA	Quasi-experimental pre-test post-test design	40 students (8-9 years) (31 boys) (9 girls)	Elementary Education	4 weeks	5	10 minutes	−1.63 [−2.36; −0.91]
Müller, Dubiel et al. (2021)	Germany	Quasi-experimental pre-test post-test design	162 students (Age 1: 121.56 months) (Age 2: 136.68 months)	Elementary Education	Both Studies: 2 weeks	Both Studies: 5	Both Studies: 10 minutes	0.12 [−0.19; 0.43]
Müller, Otto et al. (2021)	Germany	Quasi-experimental pre-test post-test design	91 students (Age 1: 25.85 ± 5.06) (Age 2: 23.69 ± 3.12)	University education	Both Studies: 4 weeks	Both Studies: 5	Both Studies: 15 minutes	0.03 [−0.32; 0.38]
Ruiz-Ariza et al. (2021)	Spain	Quasi-experimental pre-test post-test design	136 students (12.92 ± 0.43) (-)	High School Education	(-)	(-)	Low Intensity: 4 minutes High Intensity: 4 minutes	−0.11 [−0.51; 0.30]
De Bruijn et al. (2021)	Netherlands	Quasi-experimental pre-test post-test design	62 students (9.20 ± 0.61)	Elementary Education	14 weeks	4	30 minutes	−0.42 [−1.06; 0.21]
Graham et al. (2021)	Canada	Experimental pre-test post-test design	116 students (12.19 ± 0.93) (58 girls) (58 boys)	High School Education Elementary Education	3 weeks	5	10 minutes	0.20 [−0.17;0.57]
Pinto-Silva et al. (2020)	Brasil	Experimental pre-test post-test design	36 students (14-16 años) (17 boys) (19 girls)	High School Education	(-)	2	30 minutes	0.57 [0.09; 1.04]
Mavilidi, Lubans et al. (2020)	Australia	Experimental pre-test post-test design	283 students (9.81 ± 0.68)	Elementary Education	6 weeks	3	40 minutes	0.90 [0.65; 1.14]
Schmidt et al. (2020)	Switzerland	Experimental pre-test post-test design	189 students (5.34 ± 0.59) (91 girls) (98 boys)	Early Childhood Education	6 weeks	4	15 minutes	0.13 [−0.21; 0.46]
Vazou et al. (2020)	USA	Experimental pre-test post-test design	39 students (7.69 ± 1.52) (18 girls) (11 boys)	Elementary Education	7 weeks	2	30 minutes	0.30 [−0.34; 0.93]
Egger et al. (2018)	Switzerland	Experimental pre-test post-test design	216 students (7.94 ± 0.44)	Elementary Education	6 weeks	5	20 minutes	0.25 [−0.13; 0.63]
Fedewa et al. (2018)	USA	Quasi-experimental pre-test post-test design	460 students	Elementary Education	9 months	5	10 minutes	0.43 [0.11; 0.76]

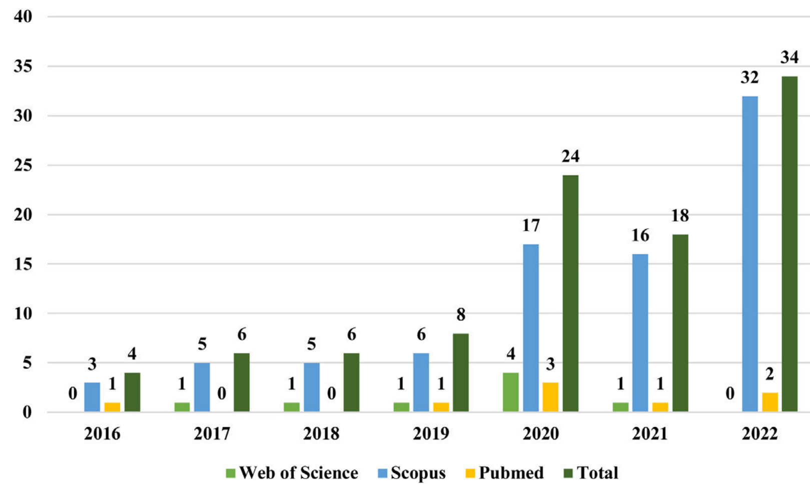

Figure 2. Scientific production of the subject matter addressed during the 2016–2022-time frame.

design with a pretest-posttest group have been registered. This type of study represents 60% of the articles selected for meta-analysis. A total of 1.109 participants participated in this type of study. A total of six studies with an experimental design with a pretest-posttest group have been collected. This type of study represents 40% of the articles selected for meta-analysis. These studies accounted for 879 participants.

Assessment of risk of bias

A low risk of bias is observed for incomplete outcome data (93.33%), blinding of outcome assessment (79.33%), random sequence generation (40.0%), blinding of participants and personnel (40.0%), allocation concealment (26.66%), selective reporting (26.66%) and other bias (20.0%). In contrast, a high risk of bias is evident for selective reporting (20.0%), other bias (13.33%), allocation concealment (13.33%) and blinding outcome assessment (6.66%). In the other cases, the risk of bias is unclear. Figure 3 presents the risk of bias of the selected studies. Figure 3 presents the individual risk of bias for each of the investigations.

Effectiveness of interventions based on active breaks

The 15 studies comprising the meta-analysis have been analysed. The mean effect size for all interventions is $\bar{X} = 0.31$; CI = [0.21; 0.42]; $p < .00001$; $I^2 = 85\%$. The effect size estimate shows that interventions based on active breaks are effective in improving attention (Figure 4). In this case the effect size is low (Cohen, 1988). To assess the risk of bias it has been used Egger's test ($Z = 5.80$, $p < .00001$).

The risk of bias analysis of each study shows that only one study shows a high risk of bias in random sequence generation (selection bias) and blinding of outcome assessment (detection bias). Two studies show a high risk of bias in allocation concealment (selection bias) and other bias. Four studies are presented that show a high risk of bias in selective reporting (reporting bias). Continuing with the studies with a low risk of bias, six studies show a low risk of bias for random sequence generation (selection bias) and blinding participants and personnel (performance bias). Four studies show a low risk of bias for allocation concealment (selection bias). Eleven studies have a low risk of bias for blinding of outcome assessment. Fourteen studies show a low risk of bias for incomplete outcome data (attrition bias). Finally, two articles show a low risk of bias for selective reporting bias (reporting bias).

Influence of moderating variables on active breaks intervention programmes

Having identified that the effects of intervention are not common to all the research included and that the effects obtained are not homogeneous, an analysis of moderating variables has been carried out to identify variability. The variables used as a moderating effect were *educational stage*, *session time* and *intervention programme time*. Table 3 shows the groupings of each moderator effect, the mean effect size, the confidence interval at the 95% level and the significance level. Figure 5 presents the effect sizes for the moderating variable *intervention programme time* and its subvariables. Egger's test has shown for this moderator variable a value of $Z = 5.75$ ($p < .00001$). The heterogeneity test has shown the following results: $Q = 90.45$; $df = 12$; $p < .0001$; $I^2 = 87\%$. This variable is found to have an average effect size of $\bar{X} = 0.33$; CI = [0.22; 0.44]. The effect size is low (Cohen, 1988). Statistically significant differences are observed between the sub-variables that make up this moderator variable. It is noted that *medium duration (5-8 weeks)* are the ones with the largest effect sizes ($\bar{X} = 0.53$; CI = [0.37; 0.69]; $p < .00001$; $I^2 = 86\%$). It has also been found that programmes with a *long duration (more than nine weeks)* have the following average effect size: $\bar{X} = 0.25$; CI = [−0.04; 0.54] ($p = 0.02$; $I^2 = 82\%$). Finally, lowest average effect sizes are those of *short duration (0-4 weeks)* ($\bar{X} = 0.11$; CI = [−0.08; 0.29]; $p < .00001$; $I^2 = 89\%$).

Figure 6 presents the effect sizes for the moderator variable *session time* and its sub-variables. Egger's test showed a value of $Z = 5.75$ ($p < 0.00001$) for this moderator variable. The following results have been obtained for the heterogeneity test: $Q = 95.66$; $df = 13$; $p < .0001$; $I^2 = 86\%$. The effect size for this moderator variable was $\bar{X} = 0.32$; CI = [0.21; 0.43] $p < .00001$; $I^2 = 86\%$. This effect size is low (Cohen, 1988). With respect to the sub-variables that make up this moderating variable, it is observed that programmes with a *long duration (more than 30 minutes)* are those with the highest average effect size ($\bar{X} = 0.98$; CI = [0.74; 1.22]; $p = .007$; $I^2 = 86\%$). In addition, programmes with a *short duration (maximum 10 minutes)* had the following effect size: $\bar{X} = 0.14$; CI = [−0.02; 0.30]; $p < .00001$; $I^2 = 86\%$). Finally, an average effect size of $\bar{X} = 0.14$; CI = [−0.06; 0.33]; $p < .15$; $I^2 = 41\%$) for intervention programmes whose sessions were of *medium duration (between 10 and 30 minutes)*.

Figure 7 presents the effect sizes for the moderator variable *educational stage* and its different sub-variables. Egger's test showed a value of $Z = 5.80$ ($p < .00001$) for this moderator variable. The following results have been obtained for the heterogeneity test: $Q = 95.76$;

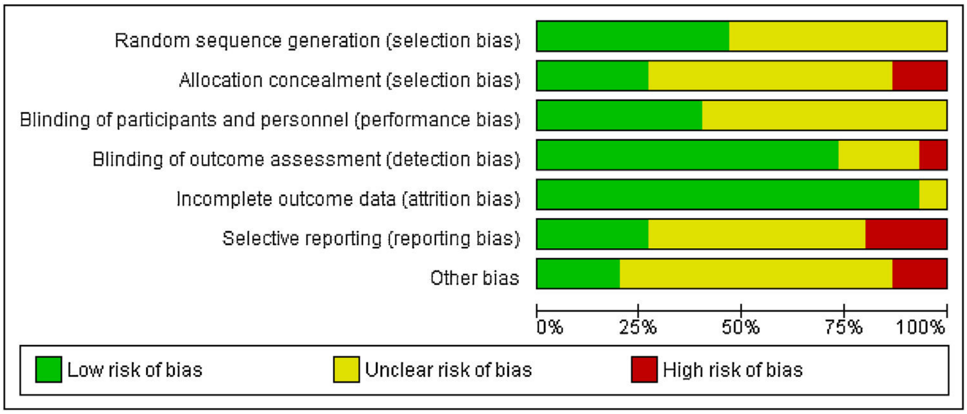

Figure 3. Risk of bias of selected articles.

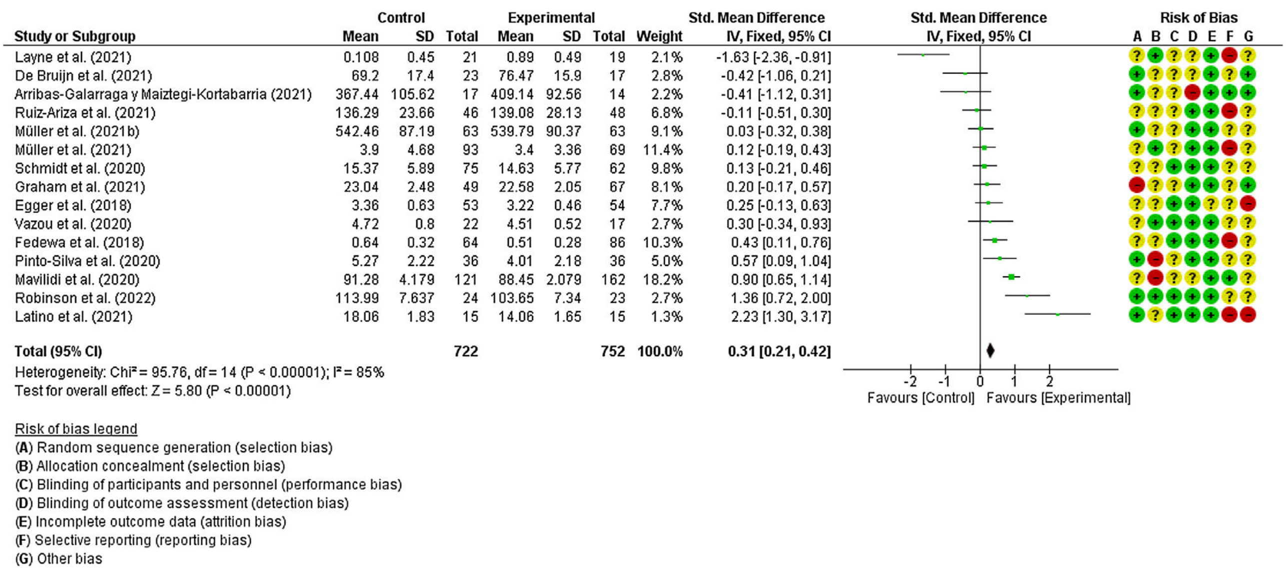

Figure 4. Forest plot of the studies forming the meta-analysis.

Table 3
Analysis of the sample in terms of moderating variables

Study Groups	K*	ES**	CI to 95%	*p****
Educational stage				
Pre-school and Elementary Education	7	0.11	[-0.04; 0.27]	≤ 0.05
High school Education	7	0.58	[0.42; 0.74]	
University Education	1	0.03	[-0.32; 0.38]	
Session time				
Short Duration (Maximum 10 minutes)	7	0.14	[-0.02; 0.30]	≤ 0.05
Medium Duration (Between 10 and 30 minutes)	5	0.14	[-0.06; 0.33]	
Long Duration (More than 30 minutes)	2	0.98	[0.74; 1.22]	
Intervention programme time				
Short Duration (0-4 weeks)	5	0.11	[-0.08; 0.29]	≤ 0.05
Medium Duration (5-8 weeks)	6	0.53	[0.37; 0.69]	
Long Duration (More than 9 weeks)	2	0.25	[-0.04; 0.54]	

Note. * Number of researches; ** Effect size; *** Statistical value.

$df = 14$; $p < .0001$; $I^2 = 85\%$. For this moderator variable it is obtained a mean effect size of $\bar{X} = 0.31$; CI = [−0.32; 0.38]. This effect size has been low (Cohen, 1988). It is observed that the sub-variable *high school education* is the one with the highest average effect size ($\bar{X} = 0.58$; CI = [0.42; 0.74] $p < .0001$; $I^2 = 87\%$). The mean effect size is then observed to be $\bar{X} = 0.11$; CI = [−0.04; 0.27] $p < .0001$; $I^2 = 80\%$ for the *pre-school and elementary school education*. Finally, the smallest effect size is presented for the sub-variable *university education* ($\bar{X} = 0.03$; CI = [−0.32; 0.38]).

Discussion

The current study presents a meta-analysis and systematic review of active breaks on improving attention executive function. It has been observed that active breaks are an effective tool for improving attention, as well as different executive functions (Pastor-Vicedo et al., 2021). It has been observed that different factors affect active breaks, such as physical activity intensity, duration of each session and duration of intervention programme

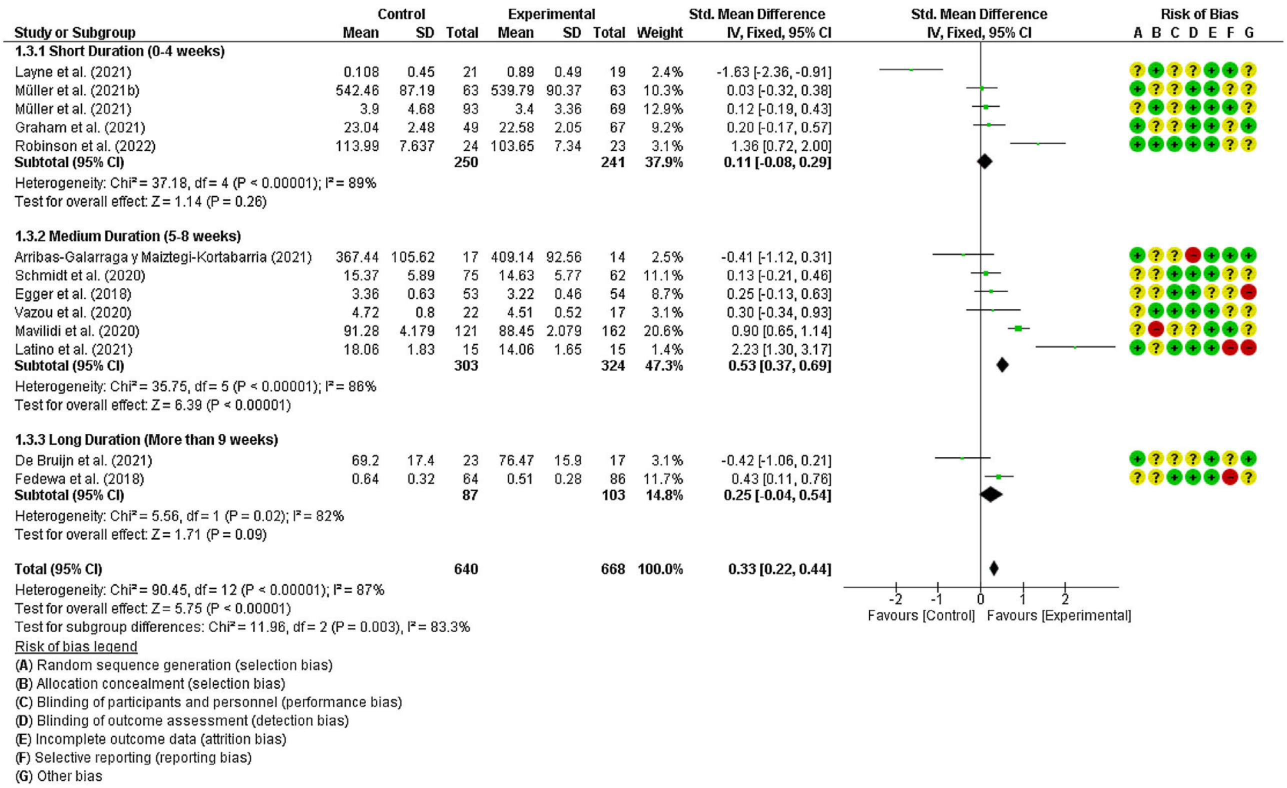

Figure 5. Forest plot of the moderator variable programme duration.

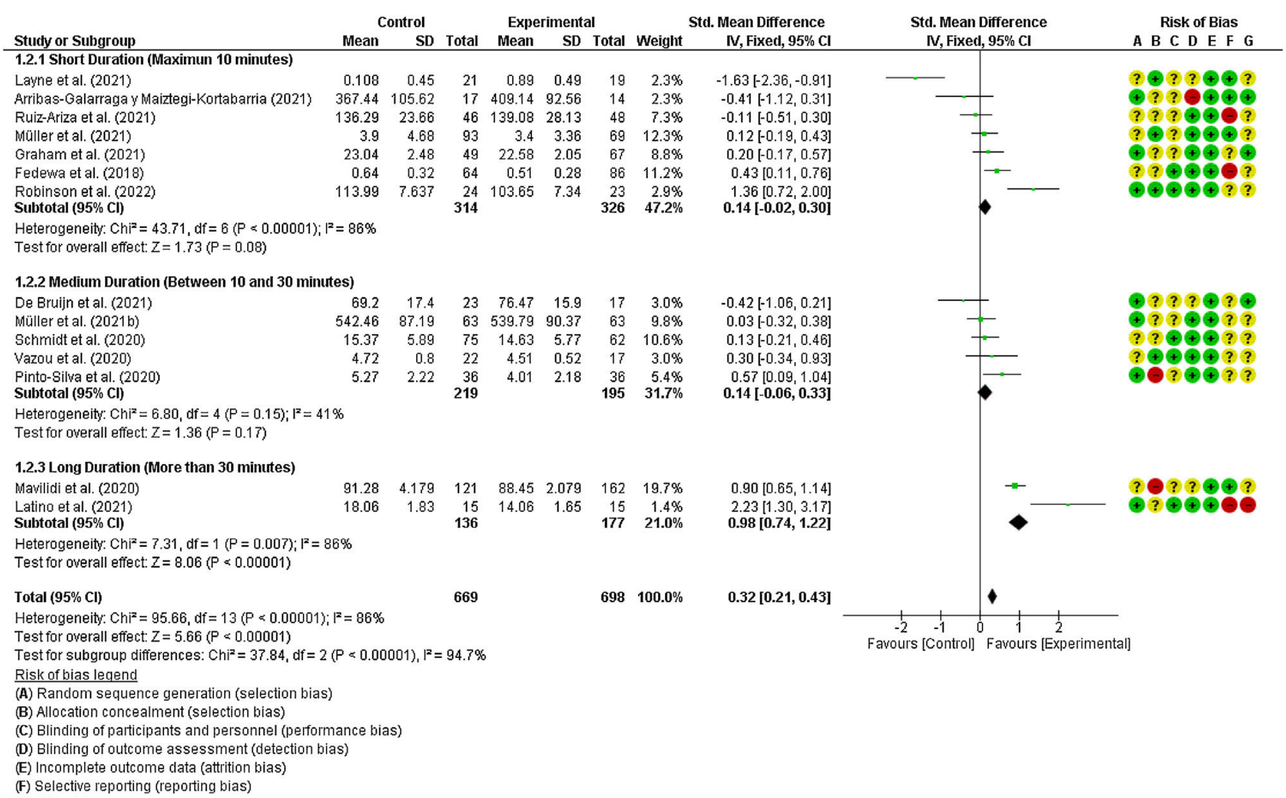

Figure 6. Forest plot of the moderator variable session duration.

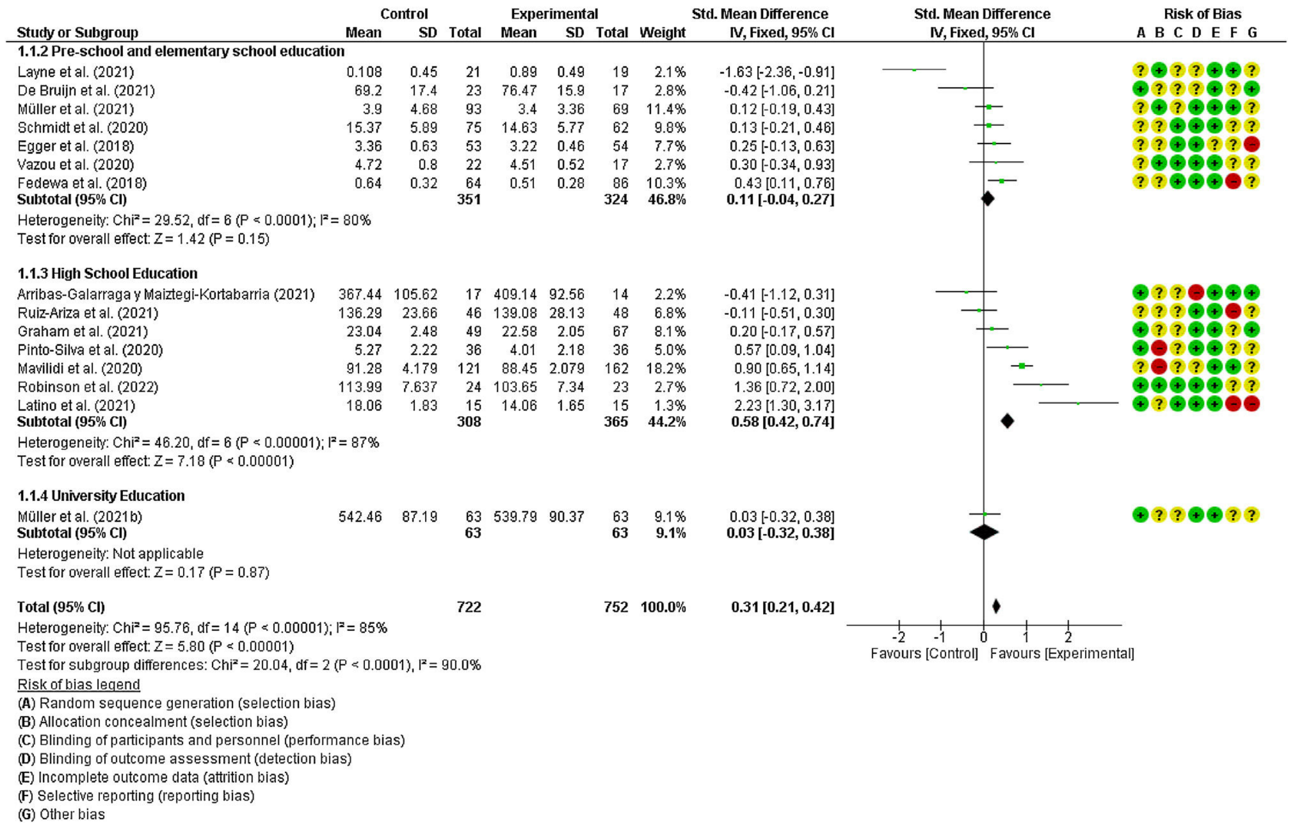

Figure 7. Forest plot of the moderator variable educational stage.

duration (Contreras-Jordán et al., 2020). Several issues related to active breaks duration in order to obtain improvements in cognitive function are discussed. According to the study by Ruiz-Ariza et al. (2021), active breaks of 5-10 minutes duration were found to have a greater effect on improving concentration and attention levels when performing an academic task. The current meta-analysis shows longer sessions have a greater effect on improving anxiety. Kubesch et al. (2009) showed how cognitive aspects changed after breaks of 5 and 30 minutes. The investigation found improvements after five minutes at vigorous intensity compared to 30 minutes at moderate intensity (Kubesch et al., 2009). In addition, active breaks of less than five minutes show improvements in attention (Ma et al., 2015).

Regarding physical activity intensity, it has been observed to have an impact on executive function development. Research by Coe et al. (2006) found no results in the group who developed active breaks through interventions focused on physical activity at moderate intensity, while participants who followed a vigorous intensity reported benefits in executive function improvement. Reloba et al. (2016) confirm these findings, establishing high aerobic capacity to be associated with better executive function performance. Research by McKown et al. (2022) establishes physical activity at a moderate-vigorous intensity is associated with improvements in attention, as well as in different executive functions.

Improvements in cognitive functions have also been shown to be related to physical activities involving cognitive demands. Schmidt et al. (2020) found participants who engaged in physical-cognitive activities had an improvement in their performance compared to control group participants. The study by Ruiz-Ariza et al. (2021) found active breaks without cognitive involvement helped to improve mathematical calculation, although these differences were not significant. Research by Schmidt et al. (2016) carried out a programme of active breaks with cognitive load and another group with only cognitive exercises. They concluded cognitive engagement was a key element for improving speed information processing as well as for attention, regardless of physical activity load (Schmidt et al., 2016). Indeed, this study is complemented by findings from Buchele-Harris et al. (2018) which concluded that active breaks based on bilateral coordination exercises help to improve attention, processing speed and concentration.

Focusing on the effect of active breaks on learning a given subject, research by Arribas-Galarraga and Maiztegi-Kortabarria (2021) shows how active breaks are not a useful tool for improving content related to Spanish Language, Literature and Spelling. The research carried out by Pinto-Silva et al. (2020) concludes that 30 minutes of moderate-intensity physical activity produces significant improvements in mathematics and Portuguese exam performance. In relation to academic subjects, it is observed that analysed research shows a greater effect at secondary education level.

Based on meta-analysis data, it is observed a greater effect is obtained at compulsory secondary education level. Based on the results, it is argued that school level has an influence on executive function development. The study by Flores-Lázaro et al. (2011) found most executive functions are more sensitive to school activity than number of years in school. Also, it has been observed other variables affecting executive function development within the school level such as parental lifestyles, family socio-economic status, educational process development based on bilingualism (Zelazo & Carlson, 2020). Family educational level has been found to have a significant effect on children's executive performance (Helmershorst et al., 2023), as a household affluent with more intellectual and academic stimulation promotes better cognitive development (Flores-Lázaro et al., 2011).

Limitations and applicability

Even though this study is a systematic review and meta-analysis, it presents some limitations. The first limitation relates to the temporal range, since only research conducted between 2016 and 2022 has been analysed. It must also be taken into account that the analysed research focuses on a very specific population, leaving aside other populations in which intervention programmes have been carried out. Furthermore, it would have been interesting to carry out an analysis based on intensity of physical-sports practice. Another limitation is the high heterogeneity observed when assessing effect sizes. This heterogeneity is mainly due to a large number of different measures used in the studies. In terms of applicability, this meta-analysis shows that active breaks help to improve executive functions. Based on the results obtained, a comparative study would be carried out with primary and secondary school students to compare attention skills according to participants' educational level. Therefore, it would be interesting to carry out an active methodological sequence from a physical point of view in order to achieve a better academic performance in different subjects.

Conclusions

The present study shows an increase of publications on active breaks on executive functions in education. In terms of educational levels in which these intervention programmes have been developed, it has been observed that most of these programmes have been carried out in primary education, followed by secondary education. The importance of executive functions in people's life, it should be suggested to promote further research in secondary education, since this educational level also coincides with adolescence. Concerning effect sizes according to moderator variables, it has been observed for educational level that active breaks show a greater effect for secondary education. In terms of session duration moderator variable, it has been observed that longer active breaks of more than 30 minutes showed a greater effect compared to shorter or medium duration active breaks. For intervention duration, it has been observed more effect for programmes lasting between five and eight weeks. In addition, theoretical research should be applied in classrooms, since moderating variables should be taken into account in active breaks intervention programmes.

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Conflicts of interest

The authors declare that the research was carried out in the absence of financial and personal absence of financial and personal relationships that could be considered a as a potential conflict of interest.

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