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Does being physically active and engaged affect reading ability? A review of the literature

¿Ser físicamente activo y comprometido afecta a la capacidad lectora? Una revisión de la literatura

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Abstract. Reading ability is one of the basic skills to open the horizons of knowledge and bring authentic input for a performance of the mind. Learning programs in higher education are aimed at equipping students to have comprehensive critical thinking-based reading skills. Learning to read is an abstract process of cognition which is the performance of the sense of sight, a cognitive process consisting of critical thinking and self-awareness elaboration. It is suspected that students who are active will have better speed in reading comprehension. This research aims to examine based on research evidence by reviewing the literature. Materials were searched using the keywords "physical activity to reading skill". Searches were conducted in Scopus and PubMed accounts. Based on the analysis step using PRISMA, 13 relevant articles were finally obtained in accordance with the purpose of writing. Based on this study and review, it can be concluded that physical activity can be in the form of walking, cycling, play programs, gross motor interventions, providing motor stimulation to the whole body, has a positive effect on reading ability. The positive results of physical activity are the acquisition of fine and gross motor skills, the achievement of a good level of fitness that bridges the enthusiasm and endurance of learning so that it affects reading skills. The second conclusion from this study, besides specifically affecting reading skills, is also evidenced by 7 articles mentioning activity, activeness and the results of these two things affecting academic achievement.
Keywords: Physical Activity, Active, reading ability

Resumen. La capacidad lectora es una de las habilidades básicas para abrir los horizontes del conocimiento y aportar insumos auténticos para un desempeño de la mente. Los programas de aprendizaje en la educación superior están dirigidos a equipar a los estudiantes para que tengan habilidades de lectura integrales basadas en el pensamiento crítico. Aprender a leer es un proceso abstracto de cognición que es el rendimiento del sentido de la vista, un proceso cognitivo que consiste en el pensamiento crítico y la elaboración de la autoconciencia. Se sospecha que los estudiantes que son activos tendrán mejor velocidad en la comprensión lectora. Esta investigación pretende examinar, basándose en pruebas de investigación, mediante la revisión de la bibliografía. Los materiales se buscaron utilizando las palabras clave «physical activity to reading skill». Las búsquedas se realizaron en las cuentas Scopus y PubMed. Basándose en el paso de análisis utilizando PRISMA, se obtuvieron finalmente 13 artículos relevantes de acuerdo con el propósito del escrito. Sobre la base de este estudio y revisión, se puede concluir que la actividad física puede ser en forma de caminar, montar en bicicleta, programas de juego, intervenciones de motricidad gruesa, proporcionando estimulación motora a todo el cuerpo, tiene un efecto positivo sobre la habilidad lectora. Los resultados positivos de la actividad física son la adquisición de habilidades motoras finas y gruesas, el logro de un buen nivel de aptitud que tiende un puente sobre el entusiasmo y la resistencia del aprendizaje de modo que afecta a la capacidad de lectura. La segunda conclusión de este estudio, además de afectar específicamente a las habilidades lectoras, también se evidencia en 7 artículos que mencionan la actividad, la actividad y los resultados de estas dos cosas que afectan al rendimiento académico.
Palabras clave: Actividad física, activo, capacidad lectora

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Introduction

There are not many cross-curricular studies, especially studies between physical activities or sports and their effect on reading skills. Reading is a cognitive process that is not easy. It is undeniable that reading skills are the foundation for academic achievement. Learning to read starting from one letter, combined into parts, parts become bigger and bigger, is one way to teach reading to children. (Iyengar et al., 2016). One of the factors for successful reading is parental intervention (Wako & Gebru, 2022). This is evident when covid occurs. Reading at a high level requires cognitive or metacognitive skills (Mannheimer, 2016). Because reading is an abstract activity, two things are important to make it easy to learn to read, first, mastering the alphabet in the form of symbols associated with phonemes, second, direct teaching (Rayner et al., 2001). Furthermore, in order to understand reading, you must understand and map letters to sounds, the meaning of speech, and assemble the meaning of many words so that you understand the text (Landi et al., 2013). Reading and writing are identical skills (Aaltonen et al., 2021). Reading as a skill is a cognitive activity that includes recognition skills, comprehension, and analysis of linguistic symbols. This ability is very important for the benefit of students to be able to obtain education to increase knowledge and skills. In order to facilitate the understanding of reading content, the provision of short, short and simple sentences will provide support for fluency in reading activities (Ineu Herawati et al., 2022). The impact of physical activity on academic performance is not uniform (Loturco et al., 2022). There is a lack of research evidence on the relationship between physical activity and academic achievement, including reading. There is still inconsistent research evidence of the link between reading and physical activity, some stating that it is positively related or contributing. It is stated that physical activity is not directly related to academic performance and academic skills, academic skills cannot be used to predict motor performance

(Haapala et al., 2023). There are research results on sports have a positive impact on the formation of emotional and behavioral qualities, but have a low effect on academic achievement (Gadzic, 2009; Papaioannou et al., 2008; Zanevskyy & Zanevska, 2021).

Another study stated differently and concluded that low levels of physical activity were associated with low reading ability in boys as well (Haapala et al., 2017). Additionally, other research has linked gross motor competence to academic performance, particularly in subjects like math and reading (Macdonald et al., 2018). Engaging in physical movement is beneficial for children, while excessive screen time has negative effects. Physical activity is closely connected to the stimulation of both physical and cognitive development (Kuzik et al., 2020). According to a literature review by (Martin-Martinez et al., 2023), physical activity effectively enhances language skills. Integrated physical activity in classroom settings has been found to positively influence academic performance, classroom behavior, and cognitive functioning (Gennari & Valentini, 2023).

Given these findings, it is crucial to further investigate the relationship between physical activity and reading ability. This need is supported by studies demonstrating that physical activity and reading activate the same brain regions, as shown through MRI imaging (Kujawa et al., 2023). When learning to read, the brain engages in specific activities that can be observed through functional MRI (fMRI), which can identify the dominant brain regions involved in reading (Stevens, 2015). Some challenges in reading, such as recognizing consonant similarities, arise even when children can memorize letters, form words, and group syllables (Damaianti et al., 2020). Interestingly, individuals learning physical activities often encounter similar challenges.

Executive brain function is significantly influenced by regular sports activities, which in turn impact academic performance, including reading ability (Veraxa et al., 2020). Furthermore, research on auditory processing shows that hearing requires focused concentration, especially when there are distracting sounds, which demands increased brain activity (Ikeda et al., 2010). This has been demonstrated through MRI imaging studies. While previous literature reviews have explored the connection between physical activity and academic achievement (James et al., 2023), they have not specifically focused on reading skills. Thus, this study aims to explore the impact of physical activity on reading ability in greater detail.

Research Methods

Search Strategy

The search was conducted using two search addresses, Scopus and PubMed. Finally, the search was conducted with the keywords "physical activity to reading skill". The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Suryadi, Komaini, et al., 2024; Suryadi, Nasrulloh, et al., 2024). In addition, PRISMA emphasizes review reports evaluating randomized trials that can also be used as a basis in reporting systematic reviews for other types of research (Mohamed Shaffril et al., 2019).

Exclusion Criteria

The exclusion criteria used were as follows: (1) Articles that were not published in journals indexed in Scopus and WoS, (2) Articles in languages other than English, (3) Articles published from 2019-2024, (4) Articles that did not explicitly mention physical activity and reading.

Procedure

Searching in Scopus initially obtained 268 documents, limited to publications between 2019-2024 found 109 documents, then only on research articles to 68 documents. Searching in PubMed with the same keywords initially found 231 documents, limited to 2019-2024, 71 documents were left, limited to research articles to 48 documents. The results of PubMed 48 and Scopus 68 were then read abstract to determine articles that were really relevant to the purpose of writing obtained 22 documents. Furthermore, it is studied more deeply by looking at the full text, there are only 13 documents that are really relevant to the purpose of writing. More details are shown in figure 1.

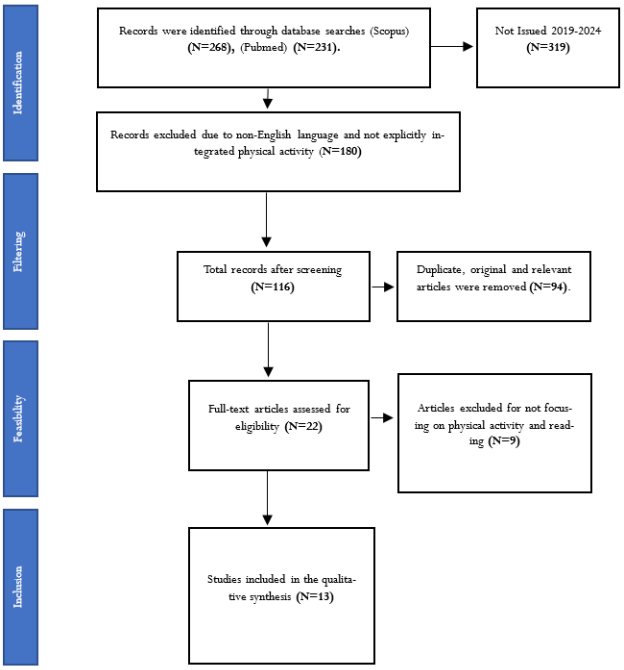

Figure 1. PRISMA Flow Chart

Results

Research studies on the link between physical activity, student engagement, and participation in sports have proven to be influential. Not only on reading ability but also on academic achievement. The results are clarified and listed in table 1.

Table. 1.
Search results of review article data

Author and title	subject	Design and intervention	Conclusion
The Mediating Influence of Physical Activity Levels on 3rd-Grade Academic Achievement (Caldas & Reilly, 2019)	526 3rd grade students	survey with physical activity questionnaire and academic achievement report	Academic achievement ability including reading is influenced by the level of physical activity of students
Importance of aerobic fitness and fundamental motor skills for academic achievement (de Bruijn et al., 2019)	A total of 891 students (mean age = 9.17 years, SD = 0.66) from 22 primary schools	agility, coordination tests, Bruininks-Oseretsky Tests, documentation of overall academic performance, achievement in reading, math, and spelling (assessed by standardized academic achievement tests).	There is a relationship between motor skills, fitness and academic achievement including reading.
Effects of aerobic and cognitively-engaging physical activity on academic skills: A cluster randomized controlled trial (De Bruijn et al., 2020)	20 grade 3 and 4 primary schools, 891 children aged 9-10 years.	20 schools in grades 3 and 4 were divided into an aerobic activity intervention group 4 times a week and a control group for 14 weeks. Pre-test and post-test were conducted	Providing moderate to high levels of physical activity has an effect on academic performance, including reading. The results of the experiment confirmed that the group that received aerobic exercise 4 times per week performed better than the control group.
Motor-Enriched Encoding Can Improve Children's Early Letter Recognition (Damsgaard et al., 2020)	127 children with a mean age = 7.61 ± SD = 0.44 years).	Experiment Group I received fine motor enrichment, II gross motor enrichment, III both enrichment, IV no enrichment.	The results of gross motor enrichment improved letter recognition, in addition to a higher increase in motivation in children who received motor treatment.
Associations between motor proficiency and academic performance in mathematics and reading in year 1 school children: A cross-sectional study (Macdonald et al., 2020)	The sample was 83 children with a mean age of 6.77 ± 0.40 years, 55 boys and 30 girls.	Bruininks-Oseretsky motor skills test (2nd Edition) and Wechsler Individual Achievement Test II (Australian Edition) as well as a reading ability test were conducted.	Bruininks-Oseretsky motor skills test (2nd Edition) and Wechsler Individual Achievement Test II (Australian Edition) as well as a reading ability test were conducted.
Participation in activities fostering children's development and parental concerns about children's development: Results from a population-health survey of children aged 0-5 years in Quebec, Canada (Pratte et al., 2020)	Parents with children aged 0-5 years n = 895	A telephone survey was conducted with parents of children aged 0-5 years. The questions were (1) to describe children's participation in developmental coaching activities, (2) to document parents' concerns about their children's development, and (3) to explore the influence of family characteristics on children's activity participation and parents' concerns.	Motor development, physical activity, reading skills, communication, independence are parents' concerns and worries.
Motor-enriched learning for improving pre-reading and word recognition skills in preschool children aged 5-6 years - study protocol for the PLAYMORE randomized controlled trial (Gejl et al., 2021)	Children aged 5-6 years from four schools in Copenhagen, Denmark.	A three-group experiment by grade with 8 weeks of treatment with: 1) instruction involving whole body movements, 2) instruction involving hand movements (i.e. arms and hands) or 3) instruction involving minimal motor movements (i.e. sitting on a chair using paper and pencil).	PLAYmore's research has proven to have an impact on pre-reading skill readiness and word recognition.
The factors in older adults' health literacy in the field of physical activity: a qualitative study (Babak et al., 2022)	55 grade 1 students, 25 boys and 30 girls mean age 6.77 ± 0.40 years)	Experiment, group I received a normal program, group II a gross motor circuit program and physical activity, for 12 weeks. Motor skills were tested with the Bruininks - Oseretsky (2nd Edition) and the Wechsler Individual Achievement Test-2nd Edition-Australian Standard Edition.	It turns out that the motor program is beneficial for improving academic outcomes, one of which is reading with an average change in reading scores (11.54 ± 7.51, p = 0.017).
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 (Macdonald et al., 2022)	27 teenagers	16 weeks treated with supervised physical exercise program with strength, balance training and control group n=14, with the same exercise without supervision n=13.	The supervised exercise intervention contributed to general cognitive intelligence ($p < 0.05$, $g = 0.90$),
Effects of 8 Weeks with Embodied Learning on 5-6-Year-Old Danish Children's Pre-reading Skills and Word Reading Skills: the PLAYMORE Project, DK (Damsgaard et al., 2022)	140 children (5-6 years old) consisting of 10 classes in 4 schools.	Children were intervened with Group I whole body movement, Group II only hand movement, Group III no movement for 8 weeks. Pre-reading, word reading evaluations were conducted.	The result is that the group with whole body movement intervention, hand movement has better ability than the control group.
Are active school transport and leisure-time physical activity associated with performance and wellbeing at secondary school? A population-based study (Jussila et al., 2023)	34,103 Finnish adolescents (mean age 15.4 years; 53% female)	Survey and documentation of academic performance	Commuting to school by activity (walking or bicycling) has been found in studies with a travel distance of 10-30 minutes, this group of students has higher academic performance and reading competence.

Enhancing Time Reading and Recording Skills in First-Grade Children with Learning Difficulties Using the "Clock Motor Game" (Hawani et al., 2023)	232 first graders (6-7 years old)	Students were divided into a control group, which received conventional teaching on time without additional motor activities, and an experimental group, which combined the concept of time with the "Clock Motor Game", for 3 weeks.	The results showed that the experimental group had much better reading skills than the control group.
Associations between physical activity, screen time, sleep time and selected academic skills in 8/9-year-old children (Korcz et al., 2023)	With 114 8-9 year olds from grade 2.	Cross-sectional study. Students were given a questionnaire to assess physical activity. Academic tests including reading and writing were conducted.	Participating in PA, limiting screen time, and adequate sleep can benefit/support children's academic skills. Higher levels of physical activity will improve visual-auditory integration abilities useful for reading skills

Especially physical activity on reading ability according to research (Caldas & Reilly, 2019), motor skills, fitness to reading (de Bruijn et al., 2019), aerobic exercise treatment 4 times a week (De Bruijn et al., 2020), gross motor improves letter recognition (Damsgaard et al., 2020), motor skills (Macdonald et al., 2020), motor development and physical activity (Pratte et al., 2020), with positive play programs on reading readiness (Gejl et al., 2021), motor program on reading (Babak et al., 2022), supervised strength training program (Macdonald et al., 2022), Whole-body movement learning is more effective for improving reading ability (Damsgaard et al., 2022), Walking to school is better for reading ability (Jussila et al., 2023), Additional motor activity has more influence on reading ability (Hawani et al., 2023). The higher physical activity the higher the visual-auditory ability increases which serves to improve reading ability (Korcz et al., 2023)

Overall, these 13 articles contribute and influence reading skills. Furthermore, based on another point of view, it turns out that this motor intervention also affects academic achievement, at least among these 13 studies there are 7 articles that state this. Physical activity in addition to reducing activity layers, stimulating good sleep also supports academic (Korcz et al., 2023; Macdonald et al., 2020), children who go walking and cycling (Jussila et al., 2023), motor program intervention (Babak et al., 2022), high physical activity (Caldas & Reilly, 2019; De Bruijn et al., 2020), fitness and motor skills (de Bruijn et al., 2019).

Discussion

This study aims to explore the relationship between physical activity and reading ability through a review of relevant literature. Research has consistently demonstrated that active engagement in physical activity and sports positively impacts reading skills (Babak et al., 2022; Caldas & Reilly, 2019; Damsgaard et al., 2020, 2022; de Bruijn et al., 2019; De Bruijn et al., 2020; Gejl et al., 2021; Hawani et al., 2023; Jussila et al., 2023; Korcz et al., 2023; Macdonald et al., 2020, 2022; Pratte et al., 2020). Additionally, physical activity and sports also enhance academic performance (Babak et al., 2022; Caldas & Reilly, 2019; de Bruijn et al., 2019; De Bruijn et al., 2020; Jussila et al., 2023; Korcz et al., 2023; Macdonald et al., 2020). Phonological skills and literacy education are vital for developing language and reading skills, particularly in young children (Goswami & Bryant, 2016). Therefore, it is crucial for educators who teach reading.

In relation to reading, physical activity, and sports, structured movement exercises positively influence brain regions associated with learning, which benefits subsequent learning processes (Mashud et al., 2024; Samodra et al., 2023). For instance, warm-up activities incorporating STEAM have been shown to improve reading comprehension (Sabeghi & Rahimi, 2024). Evidence suggests that moderate to vigorous physical activity stimulates cognition in children, ultimately affecting academic success, including reading (De Bruijn et al., 2020). Motor games also contribute to improving reading skills (Hawani et al., 2023). Moreover, play fosters emotional, social, physical, and sensory development (Essame & Duffy, 2023), while reading narratives strengthens cognitive areas of the brain, supporting emotional and social development (Whalen, 2010).

Phonological processing during reading is aligned with earlier neural development (Wagley & Booth, 2022). Other reading-related processes, such as reading speed, memory, attention, and emotional regulation, are interconnected (Sánchez Trujillo & Rodríguez Flores, 2022). Physical activity enhances cardiovascular and lung function, boosts mental fitness, supports growth, improves emotional regulation, and positively impacts attention, cognition, and executive functioning (Feng, 2022). The child's age significantly affects how physical activity influences reading skills. For younger children (ages 4-7), activities involving gross motor skills like running, jumping, and throwing are essential for motor development, which supports cognitive skills such as reading (Macdonald et al., 2018). The younger the child, the more crucial physical activity becomes in stimulating brain development and learning. In older children (ages 8-12), structured physical activities, like coordinated sports, have a more pronounced impact on academic skills, including reading (Kujawa et al., 2023). The type of exercise also affects reading outcomes. Aerobic exercises like cycling, swimming, and soccer are generally beneficial for enhancing executive function, which influences academic abilities (Veraxa et al., 2020). On the other hand, exercises focused on fine motor skills and balance, such as yoga, improve attention and focus, which are also vital for reading (Martin-Martinez et al., 2023). Exercises that involve hand-eye coordination, such

as table tennis or basketball, specifically aid in the visual skills required in the reading process. The duration of the physical exercise session is an important factor in the effectiveness of the intervention on reading ability. Sessions that are too short may not have a significant effect, while sessions that are too long may cause fatigue and decreased concentration. According to some studies, an exercise session of 30 to 45 minutes is considered ideal to maximize cognitive benefits without causing excessive physical fatigue (Haidar et al., 2024). Research has also shown that regular and consistent duration of exercise is more important than short-term intensity in improving academic abilities such as reading (James et al., 2023).

The intended outcome of physical interventions also plays a role. If the goal is to enhance general cognitive function, moderate to high-intensity aerobic exercise is often effective (Gennari & Valentini, 2023). However, if the intervention aims to improve visual or coordination skills directly linked to reading, exercises involving specific movements may be more suitable (Stevens, 2015). Clearly defined goals lead to more targeted improvements in reading ability. Frequency of physical activity is another key factor. Studies indicate that regular exercise (3-5 times per week) contributes to better cognitive and academic development than sporadic activity (Winding et al., 2018). A balance of low to moderate intensity and high frequency helps maintain cognitive gains without overexerting children.

Active reading approaches, which incorporate play, storytelling, and humor, have been found to improve reading outcomes (Almsbhieen et al., 2023). Reading themes related to physical activity have also been shown to enhance engagement in physical exercise (Damsgaard et al., 2020; Gejl et al., 2021; Wadsworth & Spring, 2024). Integrating physical movement into reading instruction, such as with motion-based activities, can improve basic literacy skills (Diana Putri Amalia. M et al., 2022). Research has also shown that inactive or obese children tend to perform poorly on motor tests, cognitive assessments, and academic evaluations compared to their more active peers (Wu et al., 2017). Neuroscience plays a vital role in education (Gabrieli, 2016; Lopez et al., 2020; Tong & McBride, 2020). Understanding brain activity during learning, especially reading, is crucial. Studies have shown that physical activity benefits academic outcomes in higher education (Khan et al., 2012). A positive relationship between sports participation and GPA has been observed in the Philippines (Montecalbo-Ignacio et al., 2017), and students who participate in sports for longer durations tend to perform better academically (Tubic et al., 2015). However, some studies, like that of (Sævarsson et al., 2017) indicate no clear relationship between physical activity and academic achievement. Socioeconomic status, parental support, and other variables must also be considered (Dyer et al., 2017; Qurban et al., 2018).

In conclusion, while physical activity and sports do not directly guarantee improved reading ability or academic achievement, their benefits on physical, neurological, and psychological health lay the foundation for enhanced learning and academic performance. Factors such as the child's age, the type of exercise, session duration and frequency, and the goals of the intervention play crucial roles in determining the impact of physical activity on reading skills. Designing interventions with these elements in mind can maximize literacy development.

Conclusion

There are at least several points that can be proposed in the conclusion. First, physical activity is identical to gross motor movements, which will have an influence on the mastery of movement skills. The more skillful the child is, the more the intensity of movement and enjoyment of movement will increase. The next result is the achievement of higher levels of movement skills and fitness. These movement skills and fitness achievements based on research and studies have an effect on reading skills, whether it starts from readiness in learning to read or reading skills. It cannot be concluded directly that it is only enough to be treated or children are freed to move that reading skills will improve or get better, but there is an indirect relationship between the skill level of motor activity and reading skills. Another important conclusion is that there is also a relationship between physical activity and academic achievement. Recommendations that can be stated based on this study are that physical activity is very important for children, the experience of moving will be a wealth of both sensory and motor skills that can ultimately have a transfer value to learning. So for students it is more advisable to move more in order to have a high mastery of movement, in the end after the ability to abstraction becomes higher, then the results of this level of movement skills and fitness have a positive transfer value. Future researchers can add keywords and other databases such as ERIC, EBSCO (SPORTDiscus and Psychology & Behavioral Sciences Collection) and other databases in searching for articles.

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