KOTULSKA, Maria, JĘDRZEJEWSKA, Barbara, LICHMAN, Martyna, BORYCKA, Aleksandra, LUBCZYŃSKA, Zuzanna, POTOCKA, Zofia, PRZERADZKI, Jakub, LASKUS, Paulina, RZĄD, Katarzyna & SZYCA, Magda. The influence of physical activity on reducing ADHD symptoms – a systematic review. Journal of Education, Health and Sport. 2023;31(1):46-54. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2023.31.01.004
https://apcz.umk.pl/JEHS/article/view/43645
https://zenodo.org/record/7942642

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 21, 2021. No. 32343.
Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences).
Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 21 grudnia 2021 r. Lp. 32343. Posiada Unikatowy Identyfikator Czasopisma: 201159.
Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 21.04.2023. Revised: 10.05.2023. Accepted: 16.05.2023. Published: 16.05.2023.

The influence of physical activity on reducing ADHD symptoms – a systematic review

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Abstract

Introduction and objective

Attention deficit hyperactivity disorder (ADHD) is a disease affecting children and adults. Quality of life of patients suffering from ADHD is often significantly reduced . The most common treatment includes medication and psychotherapy. Although the treatment is often efficient there is still a necessity of exploring other types of therapy due to the material reasons and side effects of the medications.

The aim of the study was to asses the state of the knowledge about the influence of physical activity on the occurrence of symptoms in patients suffering from ADHD.

State of knowledge

The most common ADHD therapy is based on pharmacological agents. Mechanism of action of the drugs is often based on the inhibition of the reuptake of noradrenaline and dopamine. It leads to the enhancement in their transmission and causes the alleviation in ADHD symptoms. Many studies indicate that physical activity increases the level of catecholamines as well. The effects of physical activity on ADHD symptoms could be similar to those invoked by stimulants then. In comparison to drug therapy, physical activity is devoid of side effects and less expensive.

Methods and materials

We conducted a literature review in march 2023 using PubMed and Google Scholar databases. We used the terms “Physical activity in ADHD treatment”, “ ADHD in adults”, “ ADHD in children”, “ADHD symptoms”, “ADHD treatment”.

Summary

According to many studies physical activity seems to be efficient in reducing ADHD symptoms. The benefits are more reliable in children due to the bigger amount of conducted studies. Further clinical, randomized trials especially in a group of adults are needed to access the efficiency of physical activity as a ADHD treatment.

Key words: ADHD; physical activity; ADHD symptoms; ADHD treatment; ADHD in adults; ADHD in children

Abstrakt

Wprowadzenie i cel pracy

ADHD to częste zaburzenie dotykające dzieci i dorosłych. Choroba prowadzi do znacznego obniżenia jakości życia pacjentów. Najbardziej powszechne leczenie obejmuje farmakoterapię i psychoterapię. Mimo, że leczenie często jest skuteczne, z powodu jego wysokich kosztów i skutków ubocznych, wciąż istnieje potrzeba poszukiwania nowych metod terapii.

Celem pracy była ocena aktualnego stanu wiedzy na temat wpływu wysiłku fizycznego na występowanie objawów u pacjentów cierpiących z powodu ADHD.

Opis stanu wiedzy

Podstawowa terapia pacjentów z ADHD opiera się na leczeniu farmakologicznym. Mechanizm działania najczęściej stosowanych leków polega na blokowaniu zwrotnego wychwytu dopaminy i noradrenaliny. Powoduje to wzrost transmisji neuroprzekaźników i przekłada się na zmniejszenie objawów ADHD. Badania wykazały, że wysiłek fizyczny również prowadzi do zwiększenia stężenia katecholamin. Mógłby zatem przynosić efekt podobny do stosowanego leczenia farmakologicznego, a jednocześnie jest mniej kosztowny i pozbawiony skutków ubocznych.

Metody i materiały

W marcu 2023 przeprowadzono przegląd dostępnych prac naukowych na temat wpływu aktywności fizycznej na objawy ADHD z wykorzystaniem baz danych PubMed i Google Scholar. W wyszukiwaniu użyto terminów “Wysiłek fizyczny w terapii ADHD”, “ADHD u dorosłych”, “ ADHD u dzieci”, “Objawy ADHD”, “Leczenie ADHD”.

Podsumowanie

Według wielu badań aktywność fizyczna prowadzi do zmniejszenia nasilenia objawów ADHD. Korzyści płynące z aktywności fizycznej są lepiej udokumentowane dla populacji pediatrycznej z powodu większej ilości przeprowadzonych badań. W celu dokładnej oceny wpływu aktywności fizycznej na występowanie objawów ADHD potrzeba większej ilości randomizowanych badań, szczególnie w populacji dorosłych.

Słowa kluczowe: ADHD; aktywność fizyczna; objawy ADHD; leczenie ADHD; ADHD u dzieci; ADHD dorosłych

INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a psychiatric disorder being progressively recognized in adults with the prevalence range about 2,5-5%(1-5). Despite its debilitating influence on patient’s life it still often remains unrecognized and under-treated. The main symptoms include inattention, hyperactivity and impulsivity. However frequency, intensity and persistence of some symptoms may differ depending on patient’s age. Inattention seems to persist in adolescence more often than hyperactivity/impulsivity and manifests itself as difficulties in staying focused, not paying attention to details and bad time management (6, 7). It is also considered that difficulty in managing emotions and emotional instability are more common in adult’s ADHD (2). Disorder significantly affects different areas of patients life- family and social life as well as career.

ADHD frequently coexists with different psychiatric disorders. The most commonly occurring comorbid psychopathologies include: anxiety disorder, personality disorders, substance abuse and depression (8).

The etiology of ADHD is still unclear. Studies of twins (mean heritability of 77%) available in literature indicate strong genetic connection. The role of dopamine and noradrenaline imbalance in frontosubcortical systems pathways is also emphasized and constitutes a target site of pharmacological treatment of ADHD (7).Neuroimaging studies show common abnormalities in the structure of brains in patients suffering from ADHD. The most typical findings are lower volume of frontal cortex, cerebellum and subcortical structures (9).

The most common treatment uses pharmacological agents including stimulants as methylphenidate and non stimulants as atomoxetine and bupropion. Stimulants show up to 75% effectiveness in reducing ADHD symptoms and are considered to be the most effective agents (10). Despite of pharmacological treatment effectiveness there are still some concerns regarding its use. The medications can cause different adverse effects as insomnia, appetite loss, headache, nausea, tachycardia, and elevations of blood pressure leading to lowering the quality of patients life. Moreover they must be taken regularly to reach a desired effect (11). Non-pharmacological treatment include psychotherapy, psychoeducation and behavioral interventions. The studies prove that multimodal approach- combining both pharmacological and non-pharmacological treatment shows the best effectiveness in reducing the core symptoms of ADHD (8). Unfortunately access to the common treatment is often difficult due to the significant costs. In Poland medications for adult ADHD are still not refunded and waiting period for psychiatric or psychological consultation in public sector is often long.(12) That is why searching for more accessible and sustainable treatment methods is still needed.

There is increasing number of studies exploring the influence of physical activity on the intensity of ADHD symptoms. Physical activity is easily accessible and does not require financial outlays so it could be taken into consideration as an alternative or an addition to the common treatment. In this paper we would like to present the review of the studies and literature concerning the influence of physical activity on ADHD therapy.

Physical activity and ADHD symptoms -neurobiology

The role of moderate physical activity is well known in prevention and treatment of many cardiovascular and metabolic diseases. There are also many studies confirming its positive influence on cognitive functions, quality of sleep and depression (13, 14). Mechanisms in which exercising affects brain include activation of neurotransmitter systems, up-regulation of neurotrophic factors and an increase of neurogenesis (15).

In ADHD- suffering patients levels of dopamine and noradrenaline are reduced causing the occurrence of attentional and executive impairments. Stimulants increase the availability of dopamine and noradrenaline in prefrontal cortex leading to alleviation of the symptoms (16). Physical activity induces an elevated release of catecholamines causing a similar effect to stimulants. Moreover physical activity increases levels of brain growth factors, among others, brain- derived neurotrophic factor (BDNF). BDNF plays a major role in neuronal development and physiological brain functions. Disruptions of the normal functioning of BDNF occur in ADHD suffering patients. Studies conducted on animals showed that exercise-related release of catecholamines and BDNF causes an improvement in cognitive functions (16).

In the study the influence of the different duration of treadmill exercise on the ADHD symptoms in rats with ADHD were investigated. Due to the results 30-minute treadmill exercise one a day brought the best effects on alleviating the hyperactivity symptoms comparing to 10-minute and 60-minutes exercise. (17)

Further the other study conducted on rats with ADHD and deficits in spatial learning ability compered the different duration of treadmill exercise on BDNF and it's receptor TrkB expression. The results showed that exercise improved the spatial learning abilities through the increase of the BDNF and TrkB levels.(18) However the results of the studies conducted on humans are more ambiguous. It indicates the difference depending on the duration and intensity of the physical activity (16).

Physical activity causes an increase in the level of endogenous opioids and 5-hydroxytryptamine which leads to the enhancement of mood and attention (11).

ADHD diagnostic

ADHD diagnostic is based on DSM- V criteria of American Psychiatric Association. To diagnose ADHD the symptoms of inattention and hyperactivity must be presented. The criteria differ depending on the patient's age.

Inattention	**Hyperactivity/ Impulsivity**
Fails to give close attention to details or makes careless mistakes in schoolwork, at work, or with other activities	Fidgets with or taps hands or feet, or squirms in seat
Has trouble holding attention on tasks or play activities	Leaves seat in situations when remaining seated is expected
Does not seem to listen when spoken to directly	Runs about or climbs in situations where it is not appropriate
Does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace	Unable to play or take part in leisure activities quietly
Has trouble organizing tasks and activities	Is "on the go" acting as if "driven by a motor"
Avoids, dislikes, or is reluctant to do tasks that require mental effort over a long period of time	Talks excessively
Loses things necessary for tasks and activities	Blurts out an answer before a question has been completed
Is easily distracted	Has trouble waiting their turn
Is often forgetful in daily activities	Interrupts or intrudes on others

1. Inattention: Six or more symptoms of inattention for children up to age 16 years, or five or more for adolescents age 17 years and older and adults; symptoms persist for at least 6 months, and they are inappropriate for developmental level.
2. Hyperactivity and Impulsivity: Six or more symptoms of hyperactivity-impulsivity for children up to age 16 years, or five or more for adolescents age 17 years and older and adults; symptoms of hyperactivity-impulsivity persist for at least 6 months to an extent that is disruptive and inappropriate for the person's developmental level.

   Additional requirements:

- Several inattentive or hyperactive-impulsive symptoms were present before age 12 years.
- Several symptoms are present in two or more settings, (such as at home, school or work; with friends or relatives; in other activities).
- There is clear evidence that the symptoms interfere with, or reduce the quality of, social, school, or work functioning.
- The symptoms are not better explained by another mental disorder (such as a mood disorder, anxiety disorder, dissociative disorder, or a personality disorder). The symptoms do not happen only during the course of schizophrenia or another psychotic disorder (19).

Physical activity and ADHD symptoms in children

There are many studies indicating that physical activity brings a positive effect on the reduction of symptoms in children and adolescents with ADHD. There is a difference in the influence on ADHD symptoms depending on the type of physical activity and its duration and insensitivity.

In the study performed in 2015 two groups of adolescents suffering from ADHD were compared. While both groups were obtaining methylphenidate as a pharmacological treatment one of them was additionally undergoing

an ADHD educational sessions for 6 weeks and another one was performing aerobic exercises 3 times a week for 6 weeks. Results showed that aerobic exercises improved the effectiveness of methylphenidate on attention and cognitive symptoms as well as brain activity compared to the educational sessions for behavior control (20).

Den Heijer et al. indicate a different influence of cardio and non-cardio exercise and makes a distinction between acute and chronic effects of physical activity. Cardio exercise shows an acute improvement in response time and executive functions like impulsivity. Meanwhile the chronic effects of cardio exercise include enhancement in attention, behavior and executive functions as well. Benefits from non-cardio exercises remain unclear but seem to be mostly positive too (21-23) .

Yongtao Xie et al. in their meta-analysis conducted a subgroup analyses stratified by different parameters as : ADHD diagnostic status, age, type of motor skills, intensity and frequency of physical activity. The analysis showed significant enhancements in core ADHD symptoms: lack of attention, behavioral and emotional problems, hyperactivity and impulsivity. Physical activity brought better results in reducing inattention and behavioral troubles among the confirmed ADHD patients than suspected ADHD cases. In the subgroup of children/adolescents results revealed a significant improvement in inattention symptoms compared to adults. However basing on the different studies authors assign the result to inadequate amount of analyzed studies in the group of adults.

In the study authors distinguish two types of motor skills: open skills and closed skills. Open motor skills as tennis, basketball, football or boxing are performed in unpredictable environment and require adaptability and quick decision making. On the other hand close motor skills like running, swimming or cycling are repetitive and performed in predictable environment. Analysis revealed open- skill sports to be more beneficial in alleviation of inattentive symptom while closed-skill sports showed better results in decreasing hyperactive- impulsive symptoms.

The further considered factor was the intensity and frequency of physical activity. The analysis suggested that physical activity of moderate intensity brings better effect on hyperactive/impulsive symptoms than physical activity of moderate-vigorous intensity. Results concerning the influence of exercising frequency were inconsistent.

Based on the results coming from the subgroup of unmedicated patients authors indicate physical activity to be an effective adjunctive treatment as well as stand-alone treatment of ADHD (11, 24, 25).

In the study from 2015 researchers conducted an experiment where they explored the influence of intensive physical activity on the attention of children with ADHD. Both, healthy and ADHD suffering participants performed 5-min continuous run without a rest. After the run they were asked to accomplish specific tasks in the computer game in the shortest possible time. The tasks were also accomplished by healthy and ADHD suffering children who didn't perform the physical activity before. The analysis indicated similar results of the task in the group of the children with ADHD who performed physical activity and children without ADHD who didn't perform the physical activity. Moreover, compared to the participants suffering from ADHD who didn't perform the exercise the children with ADHD who performed the exercise showed better results of the attention require task with a difference of 30,52 %. The experiment proves that physical exercise brings a positive and immediate effect on attention in children suffering from ADHD(26).

There are also studies showing that an environment where physical activity is being performed plays a major role in the ADHD symptoms incidence. Andrea Faber Taylor in his study compared the level of attention in children after a guided walk. Each child made a 20-minute walk in each of three areas: park, downtown, neighborhood. The walks took place in the interval of the week. Results indicated that the level of concentration increased more after a walk in the park than in the other areas. This study proves that physical activity in the proper environment can decrease the core symptoms of ADHD (27).

Linda S. Pagani et al. in their prospective study assessed the impact of performing an extracurricular sport in the middle childhood on the development of ADHD symptoms in older life. The participation in sport or a physical activity was reported by parents at the age of 6,7,8,10. At the age of 12 teachers submitted observed symptoms of hyperactivity and inattention. The researchers found that the girls who participated in sports between the age of 6 to 10 more often, presented lower levels of inattention and hyperactivity at the age of 12 than girls who participated sports less often. What's interesting the similar correlation hasn't been found in the group of boys.

According to the results, practicing the extracurricular sports in the middle childhood could be particularly beneficial for the further behavioral development of girls (28).

Physical activity and ADHD symptoms in adults

There is a limited number of studies investigating the relationship between physical activity and ADHD symptoms performed on adults.

In 2013 Amitai Abramovitch et al. investigated a correlation between physical activity and the presence of intrusive thoughts, worry and impulsivity in adults suffering from ADHD. The group of 30 patients was divided into “high activity” and “low activity” subgroups basing on self-report questionnaire. Low activity subgroup performed physical activity up to once a week while high activity subgroup performed any aerobic physical activity at least twice a week. Severity of the symptoms was measured with the help of proper questionnaires. The findings showed that participants assigned to “high activity group” reported lower impulsivity and less anxiety about intrusive thoughts. What’s worth to notice the study didn’t reveal that higher physical activity resulted in decreased frequency of intrusive thoughts but in the decrease of unpleasant feelings accompanying the intrusive thoughts (29).

Kathryn M Fritz et al. in their study performed in 2016 studied the influence of 20-min moderate-intensity cycling exercise on level of motivation, mood , hyperactivity and attention of 32 adult men presenting ADHD symptoms. The parameters were measured using suitable scales once before and twice after the exercise and compared with the control group. The results demonstrated an enhancement in motivation for cognitive tasks and increase of the energy while a decrease in the feeling of fatigue, depression and confusion was indicated. The study didn’t reveal any effect on the measures of attention and hyperactivity (30).

Claudia Kallweit et al. in their study checked the influence of 13-min bicycle-ergometer ride on ADHD symptoms and cognitive functions. During first 3 minutes of the ride participants had to reach a heart rate of at least 70% of their maximum pulse and later for the next 10 minutes maintain it in the range of 70%-85%. After the ride they performed a task consisting in finding the errors in presented texts. Level of concentration, accuracy and operation speed were measured as regards the pulse frequency. The results indicated less inattention and less calmness in both healthy and ADHD groups. However compared to healthy controls participants with ADHD scored higher in concentration after exercise. Moreover higher subjective concentration was confined to adults suffering from ADHD. On the other hand more hyperactivity was reported only in the control group (31).

Aerobic exercise could be used as an adjunctive treatment for children with ADHD according to Sivan Klil-Drori and Lily Hechtman suggestions in their analysis. Physical activity improves cognitive functions in both children and adults groups. Moreover in adult group physical activity revealed an enhancement in executive functions. The article emphasize the importance of multimodal treatment approach to relieve ADHD symptoms. The medication treatment should be completed by non-pharmacological therapy. Authors also point out the necessity of conducting controlled clinical trials in adults and children (32).

The study conducted in 2019 by Aylin Mehren et al. on adults tested the effect of single bound of aerobic exercise on executive functions and attention. The functional MRI was used to investigate the brain activation. The group of 23 adults with ADHD from the study group and 23 adults from the control group took part in an arrow version of the Eriksen flanker test. The test verified the selective attention and interface control. The tests were conducted after 30 minutes of stationary cycling with moderate intensity in the study group and after 30 minutes of watching a movie in the control group. During the tests MR images were taken. Reaction times of flanker task were significantly improved in the study group while the control group didn’t reveal any improvement. The MRI images didn’t show changes in brain activation between examinated groups . The results confirm the improvements in attention and processing speed after a single bout of aerobic exercise among adult patients with ADHD. (33)

Summary

Many studies indicate that physical activity is associated with a significant improvement in ADHD symptoms. The evidence is stronger in pediatric population. Majority of studies showed an alleviation in the inattention symptoms and an improvement in executive and cognitive functions. Moreover due to the research regular physical activity in childhood can reduce the risk of ADHD occurrence in the future. In the adult population the

evidence is encouraging. Most of the studies showed an enhancement in inattention symptoms, impulsivity and general concentration. However the amount of studies conducted in the group is limited.

What is important to note, the improvement in attention, processing speed and concentration was more significant in the groups suffering from ADHD than in the control- healthy groups. The results might be associated with the mechanisms which are responsible for ADHD symptoms appearance. Disturbances in dopamine and noradrenaline levels occurring in patients with ADHD might be leveled by physical activity. More clinical randomized trials are needed to access the best type and intensity of physical activity that affects positively on ADHD symptoms as well as to conclude if physical activity could be an effective adjunctive or stand-alone treatment.

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