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The Role of Physical Activity in the Rehabilitation of Children with Fetal Alcohol Syndrome: Why It Should Be Considered a Vital Part of Treatment

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Abstract

Introduction

This literature review examines the pivotal role of physical activity in the treatment and rehabilitation of children with Fetal Alcohol Syndrome (FAS). By analysing a range of research studies, this review identifies the beneficial impact of structured physical activity programmes on motor skills, cognitive functions, and behavioural outcomes in children with FAS. Furthermore, it proposes educational recommendations for integrating physical activity into therapeutic interventions.

Purpose of work

This work reviews studies on the impact of regular physical activity on the rehabilitation and development of children with Fetal Alcohol Syndrome (FAS). It emphasizes the necessity of incorporating physical activity into treatment plans to enhance motor skills, cognitive functions, and overall well-being in children with FAS**.**

Material and methods

This article was based on articles obtained from PubMed scientific database The search included the keywords: FAS, FASD, fetal alcohol syndrome, maternal alcohol usage.

Summary

The objective of this study is to provide a comprehensive review of existing research on the impact of regular physical activity on the rehabilitation and development of children with Fetal Alcohol Syndrome (FAS). This underscores the crucial role of physical activity in enhancing motor skills, cognitive functions, and overall well-being in children with FAS, advocating for its integration into their treatment plans as a vital component of effective rehabilitation strategies. By examining the benefits of various physical activities, this review emphasises the necessity for tailored exercise programmes to address the specific needs of children with FAS, thus promoting a holistic approach to their care and development.

Keywords (2-6): FAS; fetal alcohol syndrome; neurological disorders; alcohol; Review.

1. Introduction

The term fetal alcohol spectrum disorders (FASD) encompasses a variety of physical, behavioral, and cognitive impairments resulting from maternal alcohol consumption in pregnancy. The disorders categorized as FASD include**:**

- **FAS (Fetal Alcohol Syndrome)**.
- **pFAS (Partial Alcohol Syndrome)**.
- **ARND (Alcohol Related Neurodevelopmental Disorders**
- **ARBD (Alcohol Related Birth Defects)**
- **ND-PAE** (Neurobehavioral disorder associated with prenatal alcohol exposure)[1].

A common denominator in all FASD diagnoses is the abnormal development of the central nervous system (CNS). FAS is the most visible and most commonly diagnosed disorder of the FASD group. The four areas of clinical features that constitute the diagnosis of FAS include selected facial malformations, growth retardation, CNS abnormalities and maternal alcohol consumption during pregnancy. The safety of alcohol use by pregnant women remains unproven; there is no established safe level of alcohol consumption during pregnancy. Alcohol can interfere with fetal development at any point in the pregnancy, even before a woman is aware of her pregnancy.[2] In addition to the CNS, damage to other internal organs may also occur, including the heart, skeletal system, urinary system, hearing and vision. [3]. Alcohol is the most common teratogenic factor, while FASD is the leading cause of non-genetic intellectual disability. At present, there is no effective prevention or treatment strategy for this condition other than abstinence from alcohol both during pregnancy and while attempting to conceive.[4]

Current treatment methods are multidisciplinary and include managing co-morbidities, providing nutritional support, managing behavioural and learning difficulties, referral to different types of therapy to improve function in deficit areas, and parent education[5]. A study conducted in Poland as part of the "Alicja" project estimated that the incidence of fetal alcohol spectrum disorder (FASD) is at least 20 per 1,000 people. In particular, the study found that fetal alcohol syndrome (FAS) was diagnosed in 4 out of 1,000 people, partial fetal alcohol syndrome (pFAS) in 8 out of 1,000, and alcohol-related neurodevelopmental disorder (ARND) also in 8 out of 1,000. Nevertheless, the authors of the study emphasise, that due to significant difficulties encountered in conducting the study, only the lower limit of the occurrence of FAS could be established.[6]

2. State of knowledge

2.1 The effect of Fetal Alcohol Syndrome on children's physical development.

a. Dysmorphic features and growth deficiency

The presence of certain facial features is essential for the diagnosis of FAS. These include a thin upper lip, a smooth philtrum, which is the vertical groove between the base of the nose and the border of the upper lip, and a short palpebral fissure[7]. In addition to the basic diagnostic criteria, the following other dysmorphic features may be idenitfied: drooping eyelids, wide-set eyes, short, upturned nose, wide nose bridge, flat middle part of the face, small, underdeveloped jaw, small head in relation to age, large or deformed ears, underdevelopment of fingernails and toenails, short neck, and frontal eye-hand coordination [8]. It is often observed that infants with fetal alcohol spectrum disorder (FAS) tend to have low birth weight, as well as difficulties in gaining weight. Furthermore, it has been documented that these children frequently exhibit problems in their growth both prior to and after birth[9].

b. Congenital defects

A multitude of congenital malformations associated with in utero alcohol exposure have been documented in almost all organ systems. Cardiac defects are prevalent, encompassing congenital anomalies of major vessels, atrial septal defects, and ventricular septal defects. These heart conditions can potentially give rise to significant cardiovascular issues and therefore require early intervention in order to achieve optimal outcomes. Prenatal alcohol exposure may also lead to renal abnormalities, which may manifest as aplastic, dysplastic, or hypoplastic kidneys, a horseshoe kidney, hydronephrosis, or ureteral duplication. These renal abnormalities may result in impaired kidney function and the development of various complications. Another consequence of prenatal alcohol exposure is the development of skeletal defects, which may take the form of conditions such as camptodactyly (flexion contracture of the fingers), clinodactyly (curvature of the fifth finger), flexion contractures, hypoplastic nails, radioulnar synostosis, spinal deformities, and congenital spine defects. Such abnormalities can also affect mobility and physical development. Neurological abnormalities are of particular significance and include microcephaly, epilepsy, congenital spinal cord defects, and structural brain abnormalities affecting areas such as the corpus callosum, cerebellum, caudate nucleus, and hippocampus. Such neurological issues can lead to cognitive and developmental impairments; thus, there is an urgent need for early diagnosis and intervention. Gastrointestinal system defects involve disturbances in the autonomic nervous system of the intestines, which can impact digestive function and overall gastrointestinal health.

It is noteworthy that vision and hearing problems are also prevalent. Visual issues may manifest as ptosis (drooping eyelids), retinal abnormalities, strabismus (crossed eyes), and impaired vision. Hearing problems may occur as a result of chronic serous otitis media, conductive hearing loss, and/or sensorineural hearing loss, which can have a significant impact on communication and learning.The extensive range of congenital abnormalities associated with prenatal alcohol exposure highlights the necessity for preventive measures and comprehensive care for affected individuals [10,11,12,13].

2.1 The effect of Fetal Alcohol Syndrome on children's cognitive and behavioral development

Fetal Alcohol Spectrum Disorders (FASD) encompass a broader range of conditions than just dysmorphia and damage to various organs. The primary concern for patients with FASD is the presence of neurodevelopmental disorders. Such deficits include impairments in social, interpersonal, communication, and language skills, as well as a low level of emotional maturity [14,15]. Specific neurodevelopmental challenges include:

- Lack of self-control. Children with FASD frequently encounter difficulties in regulating their behaviour and emotions.
- Hyperactivity is a further neurodevelopmental challenge. It is not uncommon for individuals with FASD to display elevated levels of activity and difficulty maintaining stillness, often diagnosed as ADHD [16].
- Individuals with fetal alcohol spectrum disorder (FASD) may exhibit hypersensitivity or hyposensitivity to auditory, tactile, and visual stimuli. This can significantly impact their daily functioning. [17].
- Children with FASD frequently encounter difficulties in processing external stimuli. The management of an excess of sensory input can be particularly challenging for these children.
- Sleep disorders: Issues such as difficulty falling or staying asleep are common [18]
- Impulsivity: Children may act without considering the potential consequences of their actions, which may result in them getting into trouble or engaging in dangerous activities[19].
- Adaptation challenges: The process of adapting to new environments or changes can be stressful and challenging[20].
- Attachment disorders: It is possible that difficulties may arise in the formation of secure attachments with caregivers.
- Anxiety is a common emotional response to new situations. The advent of novel circumstances frequently elicits sentiments of trepidation and circumspection.

Furthermore, cognitive development may be impaired, resulting in:

- Delayed intellectual development: Children with Fetal Alcohol Spectrum Disorder (FASD) often exhibit slower intellectual development than their peers. [21]
- Deficits in executive function: This encompasses difficulties with shifting attention, planning, inhibition, memory, causal and abstract thinking, spatial selection, and problem-solving skills [22,23].

The cognitive deficits observed in individuals with fetal alcohol syndrome (FAS) are not simply behavioural problems, rather they represent the consequences of long-term brain damage induced by prenatal alcohol exposure. It is important to note that these symptoms are not typically within the child's control. Nevertheless, the social and communication skills of these children frequently fall below the average. This, in addition to the influence of their environment and the manner in which they are treated by parents, can result in a number of secondary consequences in the future. These may take the form of the following: anxiety, anger, avoidance, and withdrawal, dropping out of school, dependency on others and a strong desire to please, unemployment and homelessness, self-isolation, assuming the role of either victim or bully and numerous other examples. The presence of these factors is a significant contributing factor to the onset of a multitude of mental disorders, including behavioural disorders, depression, and anxiety. Additionally, they may potentially lead to an increased likelihood of engaging in criminal activities and developing an addiction to alcohol or other psychoactive substances [24,25,26,27,28]. In order to address the complications described above, it is essential to implement an intensive, multidisciplinary approach from the earliest stages of the patient's life.

3. The significance of physical activity for children with fetal alcohol syndrome (FAS)

Regular physical activity confers numerous benefits to children, including enhancement of physical fitness, development of motor abilities and strengthening of the immune system. Additionally, regular physical activity contributes to healthy development of the skeletal and muscular systems as well as to improved cardiovascular and respiratory function. Furthermore, regular exercise has been shown to regulate emotions and reduce stress levels, which are of particular significance in the context of children's mental health. Studies indicate that children who engage in regular physical activity exhibit superior academic performance, higher self-esteem and more proficient social skills [29,30,31,32]. Regular physical activity can be beneficial in improving motor skills, cognitive functions, and overall well-being in children with FAS [33]. The following section delineates the particular requirements of children with FAS and the prospective advantages of physical activity in satisfying these needs:

a. **Cognitive needs:**

It has been demonstrated that physical activity can enhance various aspects of cognitive function in both the healthy and the damaged brain. This is achieved by increasing the levels of neurotransmitters, such as norepinephrine, dopamine and serotonin, in specific regions of the brain, including the prefrontal cortex, hippocampus and striatum [34]. The literature indicates that elevated levels of norepinephrine are linked to enhanced executive function, augmented memory, reduced distraction, and regulated arousal. The increase in dopamine levels resulting from physical activity is thought to improve cognitive functions, particularly attention span, concentration and the ability to learn[35]. By increasing blood flow and regulating brain-derived neurotrophic factor (BDNF), exercise promotes morphological changes in the brain[36]. This factor is of crucial importance for hippocampal function, long-term potentiation, synaptic plasticity, neurogenesis and neuroprotection. The results of animal studies indicate that exercise can reduce oxidative stress and improve neuroendocrine regulation[37]. In contrast, alcohol exerts its primary effect on neurons by acting as an N-methyl-D-aspartate (NMDA) antagonist and a gamma-aminobutyric acid (GABA) agonist.

In the short term, these alterations in cellular excitability can disrupt glutamatergic paired-pulse plasticity, enhance presynaptic GABA release, and suppress the formation of long-term potentiation (LTP)[38]. Long-term potentiation (LTP) is a neuronal mechanism that underlies the processes of memory formation and learning, resulting in the increased intensity of synaptic conduction. This process involves the intensification of signal transmission between two active neurons. A number of studies have demonstrated that aerobic exercise, such as running, dancing, cycling, and swimming, is capable of increasing hippocampal volume and improving memory function. Such exercises enhance neurogenesis and the production of brain-derived neurotrophic factor (BDNF) [39, 40]. Practices such as yoga or Tai Chi have been found to reduce stress and anxiety and enhance cognitive performance [41]. The intense physical effort involved in HIIT (High-Intensity Interval Training) may also lead to greater BDNF production and neuroplasticity [42].

b. **Physical and motor skills development**

Motor skills: learned sequences of movements that are combined to produce a smooth, efficient action in order to master a particular task. There are different categories of motor skills including fine and gross motor skills, locomotor and object control skills, and body coordination. The motor development of children with FAS is impaired as a consequence of complex and multifaceted brain damage and neurological abnormalities resulting from prenatal alcohol exposure[43]. The following factors contribute to this phenomenon:

• Damage to the central nervous system (CNS): This can manifest as brain hypoplasia, a reduction in the number of neurons, damage to the cerebral cortex and a reduction in the size of the cerebellum, which is a crucial structure for motor coordination.

• Changes in the structural organisation of the brain: These can be evidenced by a reduction in the volume of the corpus callosum, which is critical for communication between the cerebral hemispheres. Such alterations may give rise to difficulties in maintaining equilibrium and coordination [44].

• Disruption of Neurotransmitter Transmission: Alcohol has been demonstrated to affect neurotransmitter systems, including the dopaminergic and serotonergic systems. Such effects may also impact motor functions, potentially leading to difficulties in coordination and the planning of movements.

• Delayed physical development, encompassing both growth and motor development. Children with FAS may demonstrate diminished muscle strength, impaired physical performance, and challenges with coordination and balance.

• Sensory integration issues: children with FAS may experience difficulties in processing and responding to sensory information from the environment, which can result in challenges with movement coordination and fine motor skills.

Research indicates that targeted motor skill interventions can lead to significant positive outcomes in motor performance in children with developmental disorders, including FAS. To address these issues, engaging in activities that enhance both gross and fine motor skills can be highly beneficial. Participation in physical activities that require climbing, such as the use of playground equipment or climbing walls, has been associated with the development of better muscle coordination and strength in children.

The engagement in ball-related games, for example, football and basketball, can facilitate the development of hand-eye coordination, timing, and balance. Such activities require children to track the ball visually, time their movements, and coordinate their hand movements with great accuracy. Furthermore, the setting up of obstacle courses that involve crawling, jumping, balancing, and running can be particularly effective in this regard [45,46,47]. It should be borne in mind that incorporating regular exercise into children's routines can provide numerous health benefits, which are also of great benefit to children who are repeatedly burdened with additional diseases or defects resulting from fetal alcohol syndrome (FAS). Sport has a positive effect on cardiovascular health, muscle strength, weight maintenance, metabolism and immune system function.

c. **Other needs:**

Regular physical activity helps in channeling excess energy in a productive way, reducing symptoms of hyperactivity. Structured physical activities with clear rules can help children learn to control their impulses and follow directions [48]. It is also worth mentioning that group sports or specially created sports programmes for children with FAS i.e. FAST Club counteract their self-isolation and sense of exclusion. By engaging in regular physical activity that is tailored to their abilities or interests, children can not only improve their physical health, but also their mental health or social skills. This provides holistic support for these children, enhances self-esteem, a sense of belonging to a group and improves their overall wellbeing [49,50,51].

4. Challenges and barriers to implementing physical activity programmes

The early years of life represent a critical and rapid period of complete and healthy motor and cognitive development. That is why developing and implementing effective interventions to support the needs of young children suffering from fetal alcohol syndrome should become a priority. No one particular treatment is correct for everyone with fetal alcohol syndrome. FAS exists on a spectrum of disorders and the way each person is impacted by the condition can vary greatly. The implementation of physical activity programmes for children with FAS presents a number of challenges, which can be broadly categorised as health-related, behavioural, social and environmental. Nevertheless, the implementation of appropriate strategies, such as individualised training approaches, behavioural support, social integration and the development of community resources and programmes, can significantly enhance children's capacity to engage in and derive benefits from regular physical activity.

5. Recommendations and future research directions

Integrating regular physical activity into rehabilitation programmes designed for children with FAS can confer considerable benefits in terms of their physical, cognitive and emotional development. It is vital to develop programmes that are tailored to the specific requirements of each child, and to provide ongoing support from parents, teachers and other professionals. This can be achieved, for instance, by working in collaboration with physiotherapists, special educators and psychologists to devise effective programmes, or by organising workshops and training for parents and carers to enhance their ability to support their children. Additionally, it would be beneficial to incorporate elements of social and emotional skills training within such programs.

Future research should prioritize investigations into the long-term effects of physical activity, the identification of the most efficacious forms of exercise, and the integration of disparate forms of therapy. It is also crucial to acknowledge that FAS is a lifelong condition, with the consequences of which the affected individual will continue to struggle throughout their lifetime. Nevertheless, it is one of the few diseases that can be completely prevented by abstaining from alcohol during pregnancy and while attempting to conceive. Consequently, it is of paramount importance that both researchers and health professionals give due consideration to the enhancement and wider dissemination of education regarding the deleterious effects of alcohol on the developing foetus.

6. Conclusion

Physical activity plays a crucial role in the treatment and rehabilitation of children with FAS. The review of existing literature underscores the multifaceted benefits of physical activity, from enhancing motor and cognitive functions to improving behavioral outcomes and overall well-being. Given the complex and pervasive effects of FAS on children's development, incorporating regular physical activity into therapeutic and educational programs is essential. Tailored physical activity interventions can address specific deficits and promote holistic development, ultimately improving the quality of life for children with FAS. Future research should continue to explore the optimal types and intensities of physical activity for this population to further refine and enhance intervention strategies.

7. Disclosures

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