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OUTROS TEMAS

Nature, Biopsychosocial Child Behavior and ADHD

Natureza, Comportamento Biopsicossocial Infantil e TDAH
Naturaleza, comportamiento biopsicosocial infantil y TDAH

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Abstract: Along with affective, physical, social, and cultural factors, the environment also affects child biopsychosocial development. Given this reality that pervades specialized studies in the development area, one might ask: how contact with nature might affect the development of children with Specific Educational Needs (SEN)? The aim of this study is to understand the impacts of nature in biopsychosocial development processes of children, especially those with Attention Deficit and Hyperactivity Disorder (ADHD), based on evidence provided by scientific studies. A integrative analysis was used, adopting five search bases: Portal de Periódicos da CAPES; Periódicos Eletrônicos de Psicologia (PEPSIC); Biblioteca Virtual em Saúde (BVS); Science Direct; Scientific Electronic Library Online (SCIELO) e PubMed. Descriptors were the following: Vivências com a Natureza (experiences with nature) AND TDAH (ADHD); Meio Ambiente (environment) AND Aprendizagem (learning); TDAH; ADHD; Nature; Health. A total of 33 results were identified as corresponding to the aim of this study; only four directly addressed the relationship between nature and ADHD, while the others presented an in-depth study of directly correlated topics: human beings-nature/well-being/learning. These 33 papers comprise the *corpus* of this study. It has been shown that contact with natural environments offers significant improvements in ADHD symptoms and positively affects the cognitive and socio-affective development of children with this disorder, providing benefits to health and well-being. Contact with nature can be an excellent resource for those who need calm, concentration, building or recovering self-confidence, which is the case of children with ADHD, but it is not limited to them.

Keywords: ADHD; experiences with nature; environment; learning.

Resumo: Juntamente com os fatores afetivos, físicos, sociais e culturais, o meio ambiente também afeta o desenvolvimento biopsicossocial da criança. Diante dessa realidade que permeia os estudos especializados na área de desenvolvimento, pode-se perguntar: como o contato com a natureza pode afetar o desenvolvimento de crianças com Necessidades Educacionais Específicas (NEE)? O objetivo deste estudo é compreender os impactos da natureza nos processos de desenvolvimento biopsicossocial de crianças, especialmente aquelas com Transtorno de Déficit de Atenção e Hiperatividade (TDAH), com base em evidências fornecidas por estudos científicos. Foi utilizada uma análise integrativa, adotando cinco bases de pesquisa: Portal de Periódicos da CAPES; Periódicos Eletrônicos de Psicologia (PEPSIC); Biblioteca Virtual em Saúde (BVS); Science Direct; Scientific Electronic Library Online (SCIELO) e PubMed. Os descritores foram os seguintes: Vivências com a Natureza AND TDAH; Meio Ambiente AND Aprendizagem; TDAH; TDAH; Natureza; Saúde. Foram identificados 33 resultados que correspondiam ao objetivo deste estudo; apenas quatro abordavam diretamente a relação entre natureza e TDAH, enquanto os demais apresentavam um estudo aprofundado de temas diretamente correlacionados: seres humanos-natureza/bem-estar/aprendizagem. Esses 33 artigos constituem o corpus deste estudo. Foi demonstrado que o contato com ambientes naturais proporciona melhoras significativas nos sintomas do TDAH e afeta positivamente

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o desenvolvimento cognitivo e socioafetivo de crianças com esse transtorno, proporcionando benefícios à saúde e ao bem-estar. O contato com a natureza pode ser um excelente recurso para quem precisa de calma, concentração, construção ou recuperação da autoconfiança, que é o caso das crianças com TDAH, mas não se limita a elas.
Palavras-chave: TDAH; experiências com a natureza; meio ambiente; aprendizagem.

Resumen: Junto con los factores afectivos, físicos, sociales y culturales, el medio ambiente también afecta el desarrollo biopsicosocial del niño. Ante esta realidad que impregna los estudios especializados en el área del desarrollo, cabe preguntarse: ¿cómo puede afectar el contacto con la naturaleza el desarrollo de los niños con necesidades educativas específicas (NEE)? El objetivo de este estudio es comprender los impactos de la naturaleza en los procesos de desarrollo biopsicosocial de los niños, especialmente aquellos con Trastorno por Déficit de Atención e Hiperactividad (TDAH), basándose en las pruebas aportadas por estudios científicos. Se utilizó un análisis integrador, adoptando cinco bases de investigación: Portal de Periódicos de CAPES; Periódicos Electrónicos de Psicología (PEPSIC); Biblioteca Virtual en Salud (BVS); Science Direct; Scientific Electronic Library Online (SCIELO) y PubMed. Los descriptores fueron los siguientes: Experiencias con la naturaleza Y TDAH; Medio ambiente Y Aprendizaje; TDAH; TDAH; Naturaleza; Salud. Se identificaron 33 resultados que correspondían al objetivo de este estudio; solo cuatro abordaban directamente la relación entre la naturaleza y el TDAH, mientras que los demás presentaban un estudio en profundidad de temas directamente relacionados: seres humanos-naturaleza/bienestar/aprendizaje. Estos 33 artículos constituyen el corpus de este estudio. Se ha demostrado que el contacto con entornos naturales proporciona mejoras significativas en los síntomas del TDAH y afecta positivamente al desarrollo cognitivo y socioafectivo de los niños con este trastorno, proporcionando beneficios para la salud y el bienestar. El contacto con la naturaleza puede ser un recurso excelente para quienes necesitan calma, concentración, construcción o recuperación de la autoconfianza, como es el caso de los niños con TDAH, pero no se limita a ellos.
Palabras clave: TDAH; experiencias con la naturaleza; medio ambiente; aprendizaje.

Introduction

Spaces where children have social and environmental interaction directly affect their development process. When it comes to children with Specific Educational Needs (SEN), contact with nature is understood to be relevant due to its effect on the characteristics of several human development phases.

In contemporary world, children spend most of their time in school. However, when the aim is to qualify the cognitive and socio-affective development of SEN children, one must include other potential spaces aside from those specialized in Education.

Although the 1988 Federal Constitution legally ensures education for everyone in its Article 205, regardless of its specificities, it does not contemplate the fact that inserting children only in school grounds is not enough (Brasil, 1988). In the case of SEN children, alternatives must be created for their biopsychosocial development by broadening their cognitive abilities, interests, and motivations, investing in relationships related to subjectivity, sociability, and the environment.

This study aims at understanding the impacts of nature on biopsychosocial development processes of children with Attention Deficit and Hyperactivity Disorder (ADHD), a type of SEN, based on evidence from scientific studies derived from a integrative review on this topic, as debated in literature over the last thirteen years.

Environmental factors, children psychosocial development, and special needs

The contemporary socio-historical context, marked by an increasing distance between human beings and ecological environments calls for a more in-depth study on how contact with nature might affect the relationship of children with themselves, with other people, and with the ecological environment. Renowned authors in the development field indicate that the environment is among the factors that affect child biopsychosocial development (affective, physical, social, cultural etc.). As emphasized by Oliveira (2000, p. 158), "The environment sends messages and those who learn, do respond to them. The influence of the environment, which is felt through the interaction that is enabled by its elements, is ongoing and pervasive".[4]

Lessons learned by exploiting the environment are essential in building autonomy, developing

[4] "O ambiente envia mensagens e, os que aprendem, respondem a elas. A influência do meio através da interação possibilitada por seus elementos é contínua e penetrante" (free translation).

social relationships, and knowledge, and are therefore considered favorable, interventionist, and enablers of child development (Zick, 2010).

The environment allows for building a relationship with the world and with others, thus providing children with "a continuous construction, comparable to a large building that becomes more solid as more and more is added" (Piaget, 1990, p. 12).[5] For Zick (2010), a large part of the individual's behavior involves interacting with and within space. As the author emphasizes, "More than a physical base from which and through which the person receives information (visual, tactile, thermal, auditory, and/or olfactory/taste), the environment is a continuously present agent in human experience" (Zick, 2010, p. 6).[6]

Cornell (2008) considers that, aside from awareness, contact with nature promotes increased perception of both individual and collective consciousness of the environment. This author created the Sequential Learning Method, an existential proposal that aims to facilitate the in-depth interaction of individuals with nature, thus allowing the development of feelings and values required for social change.

The psychogenetic theory by Jean Piaget (1990) sets out to understand human development process in four stages: sensorimotor, preoperational, concrete operational, and formal operational. These stages are reflected in the process of change of the human species, and are observable in whatever the individual does best throughout different age groups (Bock, Furtado & Teixeira, 1999). Individuals experience the four periods through activities typical of each stage, individual differences, and influences from the environment.

People with Specific Educational Needs (SEN) do not necessarily follow this pattern, showing differentiations. Ribas (2003) estimates that people with SEN easily show perceptible differences in the way they learn and develop compared to those who do not have SEN. This is because they do not follow the manner, time, and pace expected and defined as standard development. In this regard, Bronfenbrenner (1996) considers it important to observe the behavior of children interacting with the natural environment and with other people for a significant amount of time.

Caregivers of SEN children often place them in protected spaces that also keep them apart from contact with nature, which is the case of schools with no sites near nature, and do not invest in this type of contact outside school. It is understood that schools need to include nature as an integral part of children's learning and development process, with methodologies and curricula adapted to those who have some type of SEN, considering their difficulties and potentialities.

Architecture has advanced over natural spaces, which have increasingly become restricted in cities, and sometimes even absent in the daily lives either of families or in schools. Parks, gardens, and conservation units are a possibility of tackling this growing lack of contact with natural environments. Kellert (2006) states that even in a modern and urban society, nature remains an indispensable and irreplaceable element for human development. He is supported by empirical evidence in his statement that nature is essential for material and mental human well-being.

Beyond Kellert's (2006) work, studies by Louv (2015), Tiriba (2006) and Godbey (2009) have proven the damages that lack of contact with nature causes to human beings. Among the different age groups, Kellert (2006) indicates that children undergo disproportional suffering when experiences with and within nature are limited. He claims that their development is affected in the long term.

Attention Deficit Disorder and Hyperactivity (TDAH): symptoms and treatments

ADHD involves inattention, hyperactivity, and

[5] "uma construção contínua, comparável à edificação de um grande prédio que, na medida em que se acrescenta algo, ficará mais sólido" (free translation).
[6] "Mais do que base física a partir e por meio da qual a pessoa recebe informações (visuais, táteis, térmicas, auditivas e/ou olfativas-gustativas), o ambiente é um agente continuamente presente na vivência humana" (free translation).

impulsiveness. Difficulty in focusing and being able to channel reasoning are understood as a health issue, which affects school performance and might cause psychological and social problems to those who have this problem (Gomes et al., 2007).

There is a high rate of ADHD children who have significant setbacks in school performance because the characteristics of this condition might impair learning although ADHD does not lie in the category of Learning Disorders (LD). Studies indicate that "students with ADHD are at a twice- to three-times higher risk of failing school than non-ADHD children with equivalent intelligence" (Dorneles et al, 2014, p. 760).

The most recent information on ADHD is in DSM-5, published in May 2013 in San Francisco, United States, which has a set of 18 symptoms – nine inattention symptoms, six hyperactivity symptoms, and three impulsiveness symptoms. Symptoms are organized in two groups: Behavioral problems, such as hyperactivity and impulsiveness, and Attention deficit symptoms (Bonadio & Mori, 2013).

Regarding ADHD characteristics, Rohde, Gomes and Rezende (2000) states that inattention is identified by the difficulty in paying attention to details due to neglect; inattention to people who are speaking; difficulty in following instructions and in completing tasks; disorganization; desire to avoid constant mental effort, losing things; distraction and forgetfulness in routine activities. Hyperactivity refers to the tendency towards excessive physical activity; difficulty in engaging in relaxed activities; excessive talking; and difficulty in keeping silence. On the other hand, impulsiveness is characterized by impatience and by intruding in other people's activities, for instance. Due to some of these symptoms, children are considered undisciplined and with an inadequate behavior, thus suffering prejudice.

ADHD is the most common behavioral disorder diagnosed in children; however, there is no consensus as to its prevalence. Cardoso, Sabbag and Beltrame (2007) indicate that there are discrepancies between authors and that cultural diversity might affect the indication of rates, which vary from 1 to 20% whether it is in the same country or in different countries. In Brazil, this rate varies from 3% to 6% (Bolfer, 2009). According to the Brazilian Association of Attention Deficit (ABDA), there are several statistics, and the frequency among children varies from 3% to 10%. This frequency is more common in boys than in girls according to Cardoso, Sabbag and Beltrame (2007).

Treatments available use pharmacological and behavioral interventions. Rohde and Halpern (2004) claim that literature indicates stimulants as first choice. They can improve control of attention, impulsiveness, and hyperactivity (Brown et al., 2005). There is evidence of long-term gain in academic performance because of their use, according to Scheffer et al. (2009). However, for Barkley et al. (2008), ADHD treatment must not be limited to pharmacological therapy, and in some situations, it is essential to use cognitive-behavioral therapies and either school or occupational support, thus reducing ADHD impact in the person's daily life. Aside from these two forms of treatment, contact with nature has been considered another possibility to mitigate ADHD symptoms by some studies, which were identified in a integrative review.

Method

This integrative review of scientific literature on the relationship between ADHD and contact with nature aimed at identifying the major conclusions about its potential for mitigating the symptoms of this SEN. The starting question used in this integrative review was: how has the relationship between ADHD children and nature been treated in literature?

The inclusion criteria used for choosing papers were: a) completed studies that answered the driving questions; b) studies that contained one or more of the keywords in their titles or abstracts; c) studies conducted from 2003 to 2019: this choice of time interval (between 2003 and 2019), when relevant articles were found. Exclusion criteria were the following: a) studies previous to 2003; b) studies that did not answer the driving questions;

c) papers that showed duplicity in more than one database, maintaining only one occurrence.

Search bases adopted were the Portal de Periódicos da CAPES; Periódicos Eletrônicos de Psicologia (PEPSIC); Biblioteca Virtual em Saúde (BVS); Science Direct; Scientific Electronic Library Online (SCIELO)[7]. The following were used as descriptors: Experiences with Nature AND Specific Educational Needs; Environment AND Learning; Learning Disorders and Difficulties AND Experiences. During the search, it became clear that it was not possible to find any related papers by crosschecking descriptors. Therefore, descriptors were used separately and other descriptors were used, namely: TDAH; ADHD; Nature; *Natureza*; Health.

Of the 94 papers found, 33 were selected for this study. The great majority of the excluded papers addressed nature and others addressed ADHD, but did not relate both topics, and thus, did not meet the study criteria. The predominant language was English, with only five papers selected in Portuguese and only one in Spanish, in addition to a thesis in Portuguese.

Results: impacts of nature on children's biopsychosocial development processes

A total of 33 results were identified corresponding to the object of study, and only ten papers directly tackled the relationship between nature and ADHD, which is the primary study category. Their authors were Taylor and Kuo (2004, 2009, 2011); Gobdey (2009); Arns, Conners and Kraemer (2013); van den Berg and van den Berg (2011); Yang et al. (2019); Donovan et al. (2019); Martins, Peres and Souza (2019) and Damasceno (2019). The others were in-depth studies of human beings-nature/well-being/learning, and because this was a directly correlated topic, these papers were included in the analyses, which created six additional categories.

The papers selected based on the inclusion/exclusion criteria were therefore organized in six categories: a) Nature and learning/inclusion; b) Nature and physical or motor development; c) Nature and stress/psychological effects; d) Nature and well-being/quality of life; e) Nature and environmental behavior/awareness; f) Nature and attention and memory; g) Nature and ADHD.

The years that had the highest production were 2009, with seven papers published, between 2019 there were five and 2011 with four publications.The years 2003, 2010 and 2015, each year with three publications. The years with the fewest publications were 2005, 2012, 2013 and 2014, with only one publication each year. There was an interval between 2007 and 2008, with no papers published. The following charts show the papers separated by categories, with data on the authors, publishing year, and primary results, as shown in Table 1

Table 1 - *Nature and learning/inclusion*

Author(s)/Year	Results
Mannion, G. (2003) Dyment, J. E. (2005) Dyment, J. E., & Bell, A. C. (2006) Mirrahimi, S., Tawil, N. M., Abdullah, N. A. G., Surat, M., & Usman, I. M. S. (2011)	These studies indicate that the presence of nature in school settings leads to the creation of new outdoor learning spaces, which promote higher social interaction, communication, and cooperation, thus improving social behavior, emotional intelligence, and academic performance, as well as broadening inclusion. However, nature is still poorly exploited for its pedagogical potential.

The study by Mannion (2003) aimed at engaging children and adults in building school sites, thus providing opportunities for new socio-spatial forms for identification and learning achievement. It was evident that inclusive educational processes are more effective when they promote shared

[7] CAPES Scientific Journals Portal; Electronic Journals in Psychology (PEPSIC); Virtual Health Library (BVC).

participation between children and adults in these environments, and socio-spatial opportunities are learning generators.

The aim of the study by Dyment (2005) was to check whether green school grounds could reduce barriers that constrained learning in natural environments (fear of and concern about the health and safety of youngsters; confidence and experience of the teacher in outdoor teaching and learning; school curriculum requirements; scarcity of time, resources, and support; wider changes in the education sector, according to studies mentioned by the author). He concludes that when a green school ground is not used for outdoor classes, opportunities to maximize the learning potential are lost, which might be harmful in the long term.

The study by Dyment and Bell (2008), on the other hand, addressed the relationship between green school grounds and social inclusion. Their results indicate that schools with greenspaces are more inclusive for people who might feel isolated due to issues of gender, class, race, and skills.

The aim of Mirrahimi et al. (2011) was to check whether outdoor learning near the natural environment might offer opportunities to improve the academic performance and emotional and social intelligence of students. In their conclusions, they emphasized that the natural environment has potential to promote learning, personal and social development, through sharing, communication, teamwork, self-awareness, self-confidence, self-regulation, and self-discipline, as can be seen in Table 2.

Table 2 - *Nature and physical or motor development*

Author(s)/Year	Results
Fjørtoft, I. (2004) McCurdy, L. E.; Winterbottom, K. E.; Mehta, S. S.; Roberts, J. R. (2010)	These studies had, in common, the evidence that landscape has a beneficial effect on physical activity and motor development of children, emphasizing its influence on physical and mental health.

Based on the perception that free play in stimulating environments seems to be declining, Fjørtoft (2004) investigated the impacts of a natural environment on the motor development of children. He concluded that landscape features affect children's activities, increasing their motor skills, with favorable and significant results in balance and co-ordination.

Understanding that a sedentary lifestyle is one of the causes for declined child health, McCurdy et al. (2010) analyzed evidence of the benefits of outdoor activities for physical and mental health. Finally, they suggested that exposure to natural environments improves physical health, attention, and decreases stress in children, as shown in Table 3.

Table 3 - *Nature and stress/psychological effects*

Author(s)/Year	Results
Wells, N. M.; Evans, G. W. (2003) Maller, C.; Townsend, M.; Leger, L. S.; Henderson-Wilson, C.; Pryor, A.; Prosser, L.; Moore, M. (2009) Godbey, G. (2009) Corraliza, J. A.; Collado, S. (2011)	These studies reinforce that children in contact with nature have physiological benefits, as indicated previously in the 'Nature and physical or motor development' category; however, they also indicate benefits in psychological, spiritual, and social aspects.

The study by Wells and Evans (2003) aimed at assessing if nearby natural elements would buffer the effects of stressful life events and if they would improve the well-being of children. They showed that environments preferred by children predominantly include natural elements

and they suggested that nearby nature might buffer or prevent the impact of stress.

Corraliza and Collado (2015) analyzed the relationship of nearby nature with child stress, assessing its potential positive effects. They concluded that the natural environment might mitigate the effect of some stressful events, since children who liked to have higher contact with nature showed higher ability to deal with adverse situations. On the other hand, Godbey (2009), who enquired about the connection between outdoor recreation and health, indicated that particularly the physical and emotional aspects are positively affected.

The analysis conducted by Maller et al. (2009) about the benefits to health that human contact with nature provides, based on an urban park context, made it evident that human beings create physical, mental, and spiritual bonds with nature, and thus, this type of experience affects their health, as indicated in Table 4.

Table 4 - *Nature and well-being/quality of life*

Author(s)/Year	Results
Kellert, S. R. (2006) Marin, A. A.; Kasper, K. M. (2009) Chawla, L. (2015)	For the authors of this category, aesthetic experiences derived from contact with natural environments affect our quality of life, ways of life and being, reframing our relationships with the world, and comprising an essential element for children's development, health, and well-being.

Kellert (2006) addressed the essential connection between people and nature, and how its loss, due to modern times, results in decreased quality of life. He claims that nature is indispensable and irreplaceable for human development, and for material and mental human well-being.

Marin and Kasper (2009) reached the conclusion that contact with nature is an aesthetic need of the human being that requires daily experiences, especially in large urban centers. The authors alert to the need to be careful with the design of places chosen to dwell in, where life stories and subjectivities will be built, as built settings might lead to the coarsening of senses and weakening of affective bonds.

Chawla (2015) examined both how access to nature contributed with children's well-being and health, and the planning of green spaces in urban environments. He showed that trees and natural elements are essential for building healthy communities, which contribute with children's development. Therefore, he considers that these elements need to be integrated in urban environments at multiple scales. On the other hand, he observed that children's access to nature and health has been more common in countries with high-income levels, as described in Table 5.

Table 5 - *Nature and pro environmental behavior/awareness*

Author(s)/Year	Results
Strife, S.; Downey, L. (2009) Lima-Guimarães, S. T. (2010) Corraliza, J. A.; Collado, S. (2011) Chen-Hsuan, J.; Monroe, M. C. (2012) Collado, S.; Corraliza, J. A. (2015) Assis, de P. A. G.; Mazzarino 2016) Rosa, C. D; Collado, S. (2019)	Children's cognitive, emotional, and physical aspects benefit from higher contact with nature. For the authors in this category, experiences in natural environments provide socio-affective and ecological learning experiences, broaden the ability to deal with adverse situations, and enable restorative psychological experiences. They also generate engagement and awareness, reframing relationships with the natural environment.

Strife and Downey (2009) inquired whether children are disproportionately affected by environmental pollution or whether color and social class would affect the relationship between youngsters and green and natural spaces. The authors considered that the access of youngsters to the natural world and differential exposure to environmental risks are critically important, yet poorly studied, dimensions in environmental inequality.

Cheng and Monroe (2012) developed and tested a connection to nature index to measure the affective attitude of children towards the natural environment and identified four interaction dimensions: enjoyment of nature, empathy for creatures, sense of oneness, and senseinse of responsibility.

On the other hand, Lima-Guimarães (2010) studied the perception and interpretation of landscapes and their impact on awareness and environmental consciousness processes. Using experiences in interpretative paths, he concluded that it is possible to reach a transforming perception of the environmental realities experienced.

In a study conducted in Spain, with the aim to analyze experiences of children in contact with nature, Corraliza and Collado (2015) verified that schoolyards favor a more ecological behavior and that environment restoration perceived by children works as a motivational factor to improve pro environmental attitudes and behaviors.

Through the method of experiences with and within nature, Assis and Mazzarino (2016) aimed to understand which social representations the students of a public school had from a river in their community, investigating how a method contemplating the experience of direct and playful contact with nature could reframe these representations. For the activities experienced, the authors relied on the proposal by Joseph Cornell, a naturalist educator who proposes a series of activities, games, and interaction exercises between the individual and the environment. They concluded that representations were marked by the naturalistic dimension and that experiential activities yielded high engagement and awareness, thus strengthening and reframing their relationships with nature.

And, Rosa and Collado (2019), suggest a positive link between direct experiences in nature and environmental attitudes and behaviors. This relationship has led researchers to encourage more frequent contact with nature, especially during childhood, as a way to increase pro-environmentalism, this content is expanded in Table 6.

Table 6 - *Nature and attention and memory*

Author(s)/Year	Results
Schutte, A. R.; Torquati, J. C.; Beattie, H. L. (2015) Amicone, G.; Petruccelli, I.; De Dominicis, S. et al. (2018)	This study justifies the category as it emphasizes an aspect that has not been mentioned in the others: contact with nature broadens attention and memory quality in children.

"According to attention restoration theory, directed attention can become fatigued and then be restored by spending time in a restorative environment" (Schutte, Torquati & Beattie, 2015, p. 2). This is the authors' conclusion, after conducting a study that examined the restorative effects of nature in the executive function of 77 children. Attention and memory performance were compared in 4- to 8-year-old children who had nature walks. Seven- to eight-year-old children responded more promptly to the attention task after contact with nature, while 4- and 5-year-old children had stable results.

Studies found in Table 7 further elaborate on this scenario.

Table 7 - *Nature and ADHD*

Author(s)/Year	Results
Taylor, A. F. Kuo, F. E.; (2004) Taylor, A. F.; Kuo, F. E. (2009) Taylor, A. F.; Kuo, F. E. (2011) Godbey, G. (2009) Van den Berg e Van den Berg (2011) Arns et al. (2013) Yang, Zeng, Bloom et al. (2019) Donavon et al. (2019) Martins, Peres e De Souza (2019) Damasceno (2019)	These studies indicate that outdoor activities reduce attention deficit/ hyperactivity (ADHD) symptoms and learning difficulties in ADHD children, regardless of the social context in which they live, with benefits to health and well-being.Studies show that outdoor activities reduce symptoms of attention deficit/hyperactivity disorder (ADHD), as well as helping with cognitive and socio-affective development. They also point out that higher levels of green were associated with lower chances of ADHD symptoms. They suggest a link between children's disconnection from nature and the recent surge in childhood disorders such as ADHD.

The paper Taylor et al. (2004) aimed at examining the impact of relatively green or natural situations on ADHD symptoms in several child subpopulations – with ages from 5 to 18 years old – who had been formally diagnosed with ADHD. Parents classified secondary effects of common post-school activities and weekend activities on the ADHD symptoms of their children.

Weekend activities conducted in natural environments were considered effective in reducing ADHD symptoms. If controlled experiences and clinical trials confirm this potential, these accessible, inexpensive, and side effect-free natural treatments are quite promising as supplementary treatment for current approaches in ADHD management, as pointed out by the authors.

On the other hand, the paper published in 2009 examined the impacts of attention environments in ADHD children. The authors worked with seventeen children, 7 to 12 years old, diagnosed with ADHD, who had access to three environments: a park inside the city and two other well-kept urban settings. After each walk, concentration was measured using *Digit Span Backwards*. They concluded that twenty minutes in a park setting elevated attention performance compared to the same amount of time in the other settings.

The research published in 2011 examined whether routine exposures to greenspaces experienced through children's everyday play settings could yield ongoing reductions in ADHD symptoms. At the end of the study, the authors suggested that the overall severity of children's ADHD symptoms were milder among those who regularly enjoy greenspaces compared to children who have their activities restricted to indoor and built environments, regardless of income and gender. For hyperactive children, relatively open green settings offer even better advantages. The authors advocate for the need for randomized clinical trials to test the impacts of regular exposure to greenspaces as ADHD treatment.

The studies conducted by Taylor et al. (2004, 2009, 2011) show that ADHD children had significant improvements in attention and hyperactivity, as well as in other symptoms related to this disorder; thus, nature might be useful as supplementary or preventive therapy for children diagnosed with ADHD. They advocate for regular exposure to green and outdoor spaces due to the variety of benefits provided to children (Taylor et al., 2011, p. 300):

> The evidence to date suggests that exposure to greenspace may be effective for both short and long-term reductions in symptom severity and may be generalisable to a wide range of children. Furthermore, the evidence lends credence to the possibility that children with ADHD—more than 4 million in the United States alone—may find regular doses of greenspace

> to be a valuable supplement to medication and behavioral treatments.

For Taylor et al. (2011), greenspaces promote healthy development of children in many ways and must be part of children's routine lives. This suggestion corroborates the study by Godbey (2009), which (as already mentioned) emphasized that physical and emotional aspects are positively affected by outdoor recreation, thus affecting health.

The study by van den Berg and van den Berg (2011) suggests a link between children's disconnection from nature and the recent outbreak of childhood disorders such as ADHD. Arns, Conners and Kraemer (2013) compared the prevalence of ADHD with solar intensity. The results showed compatibility between a lower prevalence of ADHD and areas with a high incidence of sunlight, indicating that the preventive result of this exposure to sunlight may be alluding to an improvement in circadian cycle disorders, which have recently been linked to ADHD.

More recent studies, such as those by Yang et al. (2019), Donovan et al. (2019) and Damasceno (2019), point to the benefits that contact with nature can bring to children with ADHD. Yang et al. (2019), evaluated the association between greenery around schools or kindergartens and ADHD symptoms in children, concluding that there may be a beneficial association between green spaces in schools and ADHD symptoms in Chinese children. And Donovan et al. (2019) assessed whether exposure to the natural environment was a protective factor in the development of ADHD. For the authors, increased exposure to green environments in a child's life can provide greater protection against ADHD.

Of the articles on this subject, two were carried out in Brazil. The study by Martins, Peres and Souza (2019), which analyzed the sayings taken as truth about the importance of contact with "nature", with the aim of other ways of controlling subjects diagnosed with ADHD. The authors conclude that the term nature deficit disorder (NDD) is "a more comprehensive notion than ADHD, and both disorders could be treated with the prescription of green time/nature therapy" (Martins, Peres & Souza, 2019, p. 12).

The other was the study by Damasceno (2019). When the first author started her thesis on this topic, in 2016, the fact that there were very few studies relating nature and ADHD indicated the relevance of this type of study. In her investigation, she proposed to analyze how children with Attention Deficit and Hyperactivity Disorder (ADHD) are affected by playful contact with nature.[8] This study involved children from public schools in the municipality of Crato, Ceará, northeastern region of Brazil, diagnosed with ADHD. The focus was the impact of nature on ADHD symptoms and on the cognitive and socio-affective development processes of these children.

A complex investigation-action method was created. Technical procedures were organized in nine steps: Integrative Review, Diagnosis of the Municipality, Profile of Subjects, Ex-Ante Assessment, Applying SSRS and WISC tests, Conducting Experiences with Nature, Reapplying SSRS and WISC tests, Follow Up, triangulation, and data analysis. In the last step, retrospective observation of reports and prospective observation of subjects were considered, as well as document analyses, analysis of field report, analysis of the results of SSRS and WISC tests, analysis of data from both interviews with caregivers, teachers, and subjects, and results of the descriptive statistical analysis. The following non-parametric tests were used: U-Mann Whitney, Kruskall Wallis, and Chi-square. Children were divided in two groups: Intervention and Control.

It became evident that the combination of outdoor activities had a positive effect on social relationships, self-perception, and level of engagement of subjects in the Intervention with nature groups. Results of the SSRS and WISC IV tests

[8] The other authors supervised and co-supervised, respectively, the thesis together with the Programa de Pós-Graduação Ambiente e Desenvolvimento da Universidade do Vale do Taquari – Univates (Post-Graduation Program of Environment and Development of the University of Taquari Valley – Univates), titled Educação Ambiental Vivencial e o Desenvolvimento Cognitivo e Socioafetivo de Crianças com TDAH (Experiential Environmental Education and Cognitive and Socio-affective Development of Children with ADHD).

indicated that the Intervention Group showed a tendency to significant evolution in results regarding ADHD symptoms (attention, hyperactivity, impulsiveness) in the second application of tests after "Experiences with Nature" and scores remained the same in some aspects. On the other hand, the Control group showed a tendency towards maintaining the same results between both test steps, with little evolution and some decreased scores. The conclusion was that direct contact with nature provides a genuine experience, with mitigation of ADHD symptoms and better cognitive and socio-affective development of subjects in the Intervention group.

Conclusion

The integrative analysis of the 33 studies that addressed the relationship of children with natural environments leads to the conclusion that different aspects of child development benefited from this relationship.

cognitive: nature constitutes a learning space, capable of improving academic performance, creating engagement and ecological awareness, reframing the relationships with the natural environment, broadening the quality of attention and memory in children, decreasing learning difficulties among ADHD children;

social: possibilities of social interaction, communication, co-operation, emotional intelligence, inclusion, and socio-affective learning are broadened in nature;

physical: activities near nature improve children's motor development, and their physical and mental health;

psychological: children might benefit from the contact with nature due to reduced stress, food disorders, attention deficit, and hyperactivity, improving their ability to deal with adverse situations, having access to states of well-being and having restorative psychological experiences;

spiritual: nature affects quality of life, ways of life and of being, reframing relationships to the self, with others, and with the world.

Among the papers that have a more in-depth focus on the topic human being-nature/well-being/learning, comprised by the first six categories and shown in charts 1 to 6, the discussion focuses on issues such as well-being, physical and mental health/obesity, and stress, followed by topics such as restoring attention, changes in attitude related to greenspaces, considered to be promoters of inclusion. Finally, they indicate that nature stimulates the senses and new ways of living with the environment, thus enabling the learning process, not to mention that games in these environments affect children's motor development.

Exposure to nature is as good for non-ADHD children as for those who have ADHD. In face of these results, it is evident that the more contact with nature, the more child biopsychosocial development is positively affected, including ADHD children. As shown by the results of the relationship 'nature and ADHD', contact with natural environments offers significant improvements in ADHD symptoms and positively affects cognitive and socio-affective development in children with this disorder, providing benefits to health and well-being.

Contact with nature can be an excellent resource for those who need calmness, concentration, building or regaining self-confidence, which is the case of ADHD children, but not limited to them, as it can similarly bring benefits to children who do not have this disorder.

A return to the PubMed database, which integrates reference studies in the area of health, in order to update studies on nature and ADHD, led to the verification that the relationship between the natural environment and the mental health of children with ADHD still receives little scientific attention. Six studies were identified in the last five years following the integrative review.

Hood and Baumann (2024) carried out a systematic review of four electronic databases (PubMED, PsycINFO, Embase and Web of Science) in order to assess the effects of nature on the prevalence and/or severity of ADHD symptoms in populations of schoolchildren. Of the 458 studies identified, seven met the inclusion criteria. Despite the great heterogeneity in methodological

approaches, the included articles consistently reported that exposure to nature is associated with a reduction in ADHD diagnoses and symptom severity.

Exposure to green spaces in the 29 studies reviewed by Sakhvidi et al. (2022) was characterized based on different indices (availability, accessibility and quality). The association of exposure to different types of green spaces was reported for different behavioral outcomes, including total behavioral difficulties, attention deficit hyperactivity disorder (ADHD) symptoms and severity, ADHD diagnosis, conduct problems, pro-social behavior, emotional symptoms, peer relationship problems, externalizing disorders and internalizing disorders. Most of the reported associations suggested a beneficial association of exposure to green spaces with children's behaviors; however, the studies were heterogeneous in terms of their exposure indicators, study design and outcome definition (Sakhvidi et al., 2022).

Different conditions in the interaction with nature affect the results, such as the biodiversity of the environment, the climate, the duration of the experiment or the type of activity carried out. Davis et al. (2025) reviewed studies relating biodiversity to children's mental health, finding that greater diversity of species and ecological communities are associated with improvements in cognitive functioning, behavior and general well-being. Physical activities in natural environments, known as green exercise, can improve the quality of life and mental health of people with chronic conditions, including children, although there are still limitations as to the specific impact on ADHD, according to research by Tsokani et al. (2025).

External conditions can also be created in order to bring about an improvement in the quality of life of children with ADHD. Armitt et al. (2022) describe a research protocol that aimed to co-produce a nature-based intervention for children with ADHD aged 5 to 11, their parents and the professionals involved. The importance of this approach lies in the possibility of involving the children themselves and their families in the process of creating the intervention, ensuring that it is relevant and effective.

Gebhard (2023) relies on models such as Stress Recovery Theory and Attention Restoration Theory, approaches that explain how green spaces can reduce stress, improve mood and promote pro-social behavior, contributing to the prevention of mental disorders, acting as a protective factor in promoting children's mental health.

In short, both the integrative analysis and the most current evidence reinforce the importance of integrating natural environments into ADHD intervention and prevention strategies and of promoting children's contact with nature, considering its potential to improve health in its various aspects, especially psychological, cognitive, social, physical and spiritual. Future research should seek greater methodological rigor in order to consolidate these relationships and guide public policies that favor healthier environments for children.

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