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Motor Skills in Children with ADHD: Comparative Study from the Farmacological Treatment

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1. Introduction

(Gaillard et al., 2004) affirm that the term Hyperactivity is about a type of disturbing behavior that was always stigmatized by the terms agitation, psychomotor instability and hiperkinesia. And the terms "psychomotor" and "hiperkinesia" refer to a motor behavior resulting from attention and excitation problems becoming an outer presence, on the other hand, (Vidarte et al., 2009) on the Psychomotor profile of the children clinically diagnosed with TDAH in the city of Manizales, concluded how the mobility factors of the diagnosed children presented normal rank values which were significantly worse when comparing them with the healthy children in all the ages, this chapter tries to demonstrate the results obtained in a research process, that shows the differences happened in the psychomotor profile in children diagnosed with the TDAH that receives pharmacological treatment with two variables of analysis (sex and the type of TDAH) as a basis.

The neurochemical hypothesis which poses a dysfunction of fronto striatal connections either of anatomical or functional origin, has been the justification for the use of pharmacotherapy (including methylphenidate or Ritalin, a stimulant that activates the inhibitory network behavior). This hypothesis remains attractive from a heuristic point of view, it tends to consider all the cortex as a reflecting organ of frontal lobe, rather than seeing it as the control center of social behavior, which also addresses environmental responses (Pliszka et al., 1996 y Tannock, 1998) and where it is considered the expression of the motor skills as a socializing element.

In this paper the authors try to provide elements that show the motor skills behaviors in children diagnosed with ADHD and taking medications and also this paper allows new hypotheses to the scientific evidence for this relationship. For this reason, the objective of this paper is to establish the differences in the behavior of the psychomotor profile of children clinically diagnosed with ADHD and taking phramochological treatment in the city of Manizales, Colombia.

The development of this paper has primarily a theoretical and conceptual approach of the disorder from the scientific evidence established by different authors where issues as the definition, prevalence, etiology, comorbidities and therapeutic implications arise, making emphasis on motor skill and comorbidity; secondly the results obtained in the study show the relationship between the psychomotor profile of children diagnosed from pharmachological treatment.

2. Attention Deficit Disorder and hyperactivity

The attention deficit disorder with hyperactivity is an important health problem, for its own characteristics, and for its alterations that are associated or triggered as a result of inattention or hyperactivity. People with this syndrome, not only suffer the direct effects of the disorder, but also the academic, social or labor impact involved, and it often persists even after you have submitted the disorder. The attention deficit disorder with hyperactivity (ADHD) is, along with dyslexia, the most important cause of school failure.

Disorder Attention Deficit is known by the acronyms: ADD (Attention Deficit Disorder), ADS (Attention Deficit Syndrome), AD (Attention Deficit), ADHD (Atention Deficit Hiperactivity Disorder), and more commonly ADHD (Attention Deficit Hyperactivity Disorder). The (American Psychiatric Association, 2002) characterizes it as "a persistent pattern of inattention and / or hyperactivity-impulsivity that is stronger and severe than typically observed in individuals of a similar level of development". These three dimensions: inattention, hyperactivity and impulsivity are the axes of the disorder and they are characterized as follows:

Attention disorders are the inability to maintain the standard care for long periods of time, characterized by fleeting attention and inhibited impulses, in the waking state is one of the manifestations of this disorder. People who are inattentive have difficulty concentrating on one thing and become bored with a task after only a few minutes. Lack of attention can be inferred from the observation of behavior, as, for example, if a child is not performing a task for the required time, a task that is available to other children with the same age, intelligence and schooling, from which is different (Barkley, 1991b).

The diagnostic criteria for attention deficit disorder in DSM-IV version (1995) and DSM-IV-TR (2002) have often not enough attention to details or careless mistakes done in schoolwork, in the work or other activities. It often has difficulty sustaining attention in tasks or playing activities. It often does not seem to listen when spoken to directly. It often does not follow instructions and fails to finish schoolwork, chores or duties in the workplace (not due to oppositional behavior or failure to understand instructions). It often has difficulty organizing tasks and activities. It often avoids, dislikes or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or household). It often loses things necessary for tasks or activities (e.g. toys, school assignments, pencils, books or tools). It is often distracted by irrelevant stimuli. It is often forgetful in daily activities.

Hyperactivity is the second component of ADHD and typically manifested by excessive and continuous movement when it is inappropriate to do so, restlessness, nervousness and inability to sit without getting up, to "be running" continuously, as having an internal engine; and talking too much. The problems of children with ADHD include both an excess of activity and inappropriate activity depending on their age and circumstances (Barkley, et

al., 1990b). It is also said to be desobidient, who do not stop tapping their fingers, moving in their seats or to annoy their classmates, (Whalen, 1986; Whalen y Henker, 1991a; Arnold, et al., 1997b).

Hyperactive children seem to have problems regulating their actions according to the wishes of others or the demands of context, (Teichner, et al., 1996; Solanto, et al., 2001; Slusarek, et al., 2001). Hyperactive behavior is usually extended to a group of behaviors such as aggression, constant activity, distractibility, impulsiveness, inability to concentrate and difficulty in participating in "silent" activities such as reading and activities that require a similar behaviors, although they may relate to each other, they do not always correspond with hyperactivity itself.

The diagnostic criteria for hyperactivity in the version of the DSM-IV (1995) and DSM-IV-TR (2002) are: He often fidgets with hands or feet or squirms in seat. He often leaves seat in classroom or in other situations in which remaining seated is expected. He often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults it may be limited to subjective feelings of restlessness). He often has difficulty playing or engaging in leisure activities quietly. He often "is ongoing." He often talks excessively.

Impulsivity is the third component of ADHD, this behavior turns into impatience, inability to postpone a reply, to answer before the question has been made in full, and to stop frequently, causing problems in social situations. Also, individuals can make inappropriate comments, display a lack of attention to understanding the rules, buffoonery, etc.. That is, children are unable to control themselves, to adapt their behavior to environmental demands and delay gratification. (Barkley, 1997) described the multidimensional nature of these symptoms, according to it, including cognitive and behavioral aspects. Behaviors associated with hyperactivity and impulsivity are: social disinhibition, lack of caution in dangerous situations and impulsively breaking social norms, so that these children suffer continuous accidents and are easily rejected by equal groups.

The diagnostic criteria for impulsivity in the DSM-IV version (1995) and DSM-IV-TR (2002) are: It often blurts out answers before questions have been completed. It often has difficulty awaiting a turn. It often interrupts or intrudes on the activities of others (eg, butts into conversations or games.

From these components ADHD has been classified: predominantly hyperactive, predominantly combined and predominantly inattention. For many authors, ADHD is the most common disorder in childhood (Shaywitz y Shaywitz, 1991; Barkley, et al., 1971; Biederman et al., 1996a; Wolraich et al., 1996) and it appears to be persistant into adolescence and adulthood (Barkley, et al., 1990b; Ferguson, et al., 1993). The prevalence of ADHD ranges between 3% and 7% in general population and between 10% and 15% in clinical population (Fischer, et al., 1990).

The prevalence of ADHD symptoms varies depending on who reports (parents or teachers), age and sex of children and the evaluation criteria used (Amador y Forns, 2001). Epidemiological studies indicate that the prevalence of ADHD varies by age, subtype of the disorder (ADHD inattentive type or hyperactive-impulsive type) and gender. In this sense, ADHD hyperactive-impulsive type is four times more common in boys than girls (4:1), and ADHD inattentive type is in 2:1 ratio. Both subtypes are more common between eight and ten years, (Wolraich et al., 1996; Bathia et al., 1991).

In Colombia, there has been several prevalence studies, such as one involving children of 5 to 7 years in the city of Manizales, in which individual interviews were used based on DSM-IV. The prevalence of the disorder was 8.2%. These data comfirmed those provided by different literature sources, finding that the disorder was more common in children who were 6 years old, the male / female ratio was 5 to 1, the most common age of onset of symptoms, according to parents was at 5 years and according to teachers at 6 years (Vidarte y Vélez, 1999).

Subsequently, these authors developed a second phase with children 8 to 12 years, it was found that the prevalence was 7.1%. Comparatively, the prevalence was lower than the one found in the first study, with the differential variable between the age of the subjects. Both studies also suggest the importance of the problem of ADHD in this city of Colombia and the need to continue to advance knowing about the problem (Vidarte y Vélez, 2001). Another study found a prevalence of 16.1%. The diagnostic criteria used a list of symptoms that corresponded exactly to the 18 items of DSM-IV criterion for diagnosis of ADHD. Data were obtained from parents of children and adolescents from 4 to 17 years in the city of Manizales (Pineda et al., 2001).

In the city of Cali, a study on the neuropsychological and behavioral profiles of children with ADHD (Bará et al., 2003) was done. In addition to describing the neuropsychological profiles of children, a prevalence of ADHD of 16% was showed. In 2005, it was established from the study on the prevalence of ADHD in Colombian adolescents from Sabaneta town (Antioquia) a prevalence according to DSM-IV 15.86% (Cornejo et al., 2005).

Previous studies show that in Colombia there is a high prevalence of ADHD, much higher than in studies elsewhere. This discrepancy could be explained as a result of several factors which include the use of more or less restrictive criteria in establishing the diagnosis, or the existence of psychosocial risk factors of the environment from which population samples are extracted. Added to this, there are other important elements as follows: from the total population diagnosed, only 7.4% received a diagnosis confirmed by a structured psychiatric interview, and only 6.6% of patients have treatment which could indicate that there could be a subregister in the diagnosis in developed countries.

Although the DSM itself in its different versions indicates the absence of evidence to suggest organic disorders in the etiology of ADHD, recent studies have been providing relevant information in this area. For example, there is strong evidence that genetic factors are important in causing the disorder, but also other factors are considered: biochemical, neurological, environmental, viruses, problems during pregnancy, working and others that alter brain development.

Since genetic factors, research in this field in the etiology of ADHD are based on studies of twins and families. The studies results with families have shown a higher incidence of ADHD or symptoms thereof, in biological parents of these children (Shaywitz y Shaywitz, 1991; Biederman, et al., 1992; Faraone, 1996). Also, a higher proportion of psychiatric disorders in biological parents of children with ADHD was found, a higher incidence of anxiety disorders and depression in mothers and antisocial personality disorders and alcoholism in parents was found (Biederman, et al., 1990; Biederman, et al., 1991; Faraone, et al., 1998a; Schaill, et al., 1999).

A study shows that the biological parents of children with ADHD have higher risk of attention deficit (Frick, 1994). However, some studies have shown the existence of environmental factors involved in the presentation and severity of ADHD symptoms and their association with other pathologies such as aggressive behavior (Shaywitz y Shaywitz 1991; Biederman, et al.,1991; August, et al., 1996a; Biederman, et al., 1997). In a study conducted to evaluate the association between ADHD and disorders of first-degree biological parents and adoptive parents of children with ADHD, it is supported in the hypothesis that ADHD has a significant biological component (Sprich, et al., 2000). The data found in twins studies support the hypothesis of a genetic component in the manifestation of ADHD. A greater concordance between monozygotic twins than in dizygotic twins was found. These results support the idea of a genetic influence in the etiology of the disorder (Gillis, et al., 1991; Sherman, et al., 1997b).

It has been found then the manifestation of ADHD is explained in 50% by genetic factors. It was also found a concordance for ADHD of 81% in monozygotic twins and dizygotic twins 29% (Goodman y Stevenson, 1989; Sherman, et al., 1997a; Silberg, et al., 1998). Similarly it was found a genetic influence in the a etiology of ADHD in childhood, while the emergence in adolescence with aggressive behavior explained would preferably be in an environmental influence (Silberg, et al. 1996 p.803). According to the data above, it could argue that the results obtained from studies of twins and families support the hypothesis of polygenic inheritance in the transmission of ADHD.

From the neurochemical factors, recent findings suggest a neurochemical disorder in the etiology of ADHD, finding changes in cerebral blood flow and metabolism (Teeter y Semrud-Clikeman, 1995). These changes produce less activation in the frontal, temporal, and limbic areas. After conducting various researches, it has been conjectured an underlying genetic predisposition to the etiology of ADHD, which carries a hypofunctional of dopaminergic pathways in the prefrontal and limbic system, involved in the mechanism responsible for the manifestation of symptoms ADHD (Barkley, et al., 1992).

From a behavioral point of view, the deficiency of dopamine in the prefrontal region results in an inability to control impulses and a difficulty in planning and carrying out a sequence of actions aimed at achieving a goal, the difficulty in delaying gratification and excessive motor skill activity, key features of attention deficit disorder with hyperactivity. Both norepinephrine and epinephrine, and dopamine have been related to the pathophysiology of ADHD (Pliszka, et al., 1996). These chemical mediators are responsible for transmitting stimuli from neuron to neuron and they are involved in explaining many psychopathologic changes. The authors suggested that these three neurotransmitters had some kind of problem, namely one in neurotransmitters dopamine hypofunctional.

Other studies (Castellanos, et al., 1996b; Arnstein, et al., 1996) have reformulated the catecholamine hypothesis by emphasizing the role played by dopamine and norepinephrine in the pathophysiological explanation for ADHD. These authors propose the existence of a subactivación and overactivation in two dopaminergic regions as mechanisms in the genesis of ADHD. The subactivación would be located in the cortical region (e.g. anterior cingulate) and it would be responsible for cognitive deficits of these children, and overactivation in the region would be subcortical (e.g. caudate nucleus) and it would explain the excessive neural activity (Swanson, et al., 1991b), noting that it seems unlikely that ADHD is associated with just one hypofunctional of the dopaminergic system.

In fact, the selective dopamine agonist administration has not shown improvement in symptoms of ADHD (Navarro y Manzanaque, 1998). Add to that the complex web of connections available to the dopamine neurotransmitter. Today, it has been discovered up to five different subtypes of these neurotransmitters, each one with different routes and different roles or behavioral circuits (Navarro, 2000). It might be concluded that in the results of research on the neurochemical components in explaining the pathophysiology of ADHD there are many questions to be answered, as a failure to demonstrate a direct relationship between one type of neurotransmitter and its effects on the child's behavior.

From the neuroanatomical factors, studies using neuroimaging techniques have found differences, although discordant in brain morphology of children with ADHD (Castellanos et al., 1996b; Castellanos et al., 1996a). Early studies with these techniques had numerous methodological biases, (Casey et al., 1997; Swanson et al., 1998). A hypothesis currently supported in a neuroanatomical study of ADHD is involving the prefrontal lobe in explaining the symptoms of this disorder, (Catellanos et al., 1996a; Colby, 1991; Catellanos et al., 1994). This area, in particular, the frontal lobe, is responsible for planning, directing, making decisions and evaluating the results of our actions, what has been referred to as the general system of self-regulation of behavior (Barkley et al., 1992).

The relationship between dysfunction in the prefrontal cortex areas and deficits in response inhibition in visual-motor tasks in a sample of 13 children with ADHD and 10 normal (Ross et al., 1994) has been examined. Children with ADHD showed significant differences compared with the control group, in the execution of response inhibition tasks, but not in visuospatial memory tasks or response latency. The authors associated these deficits to a dysfunction in the dorsolateral cortex, other authors, based on studies of neuronal circuits interconnected identifies five anatomical structures that may represent an important pathophysiological model in explaining the genesis of ADHD (Ross et al., 1994). These structures have connections with motor and sensory cortex.

Studies using MRI indicate that some regions of the frontal lobe (anterior, superior and inferior) and basal ganglia (caudate nucleus and globus pallidus) are lower in children with ADHD than in normal children. Thus, it has found a total brain volume 5% smaller in children with ADHD than in normal ones, particularly in the area of the caudate nucleus, a deficit in prefrontal neural processing in children with ADHD compared to the control group and a smaller volume of white matter in the right frontal lobe (Silberstein et al., 1998; Semrud-clikeman e t al., 2000). These authors suggest that morphological changes in the frontal lobe and the caudate nucleus are inversely correlated with measures of inhibition and externalizing behavior of children with ADHD. The results of these studies are consistent with theoretical models of the altered function of fronto-striate and parietal lobes.

With regard to risk factors, several studies have indicated the existence of risk factors in the explanation of ADHD (Johnston y Pelham, 1986;Burnley, 1993; Milberger et al, 1997; Max et al., 1998). Among the proposed risk factors include: smoking in pregnant women, complications during pregnancy and childbirth, exposure to chemicals and brain injury (Wozniak et al., 1999). Ultimately, and based on the checked results on etiology, it is likely to be a neuroanatomical and neurochemical basis in the explanation of ADHD. The findings in family studies of twins and genetics support the hypothesis of a polygenic inheritance in the transmission of ADHD. The results in neurochemistry and neuroanatomy of the etiology of

this disorder pose many questions to be answered, as the failure to demonstrate a direct relationship between one type of neurotransmitter and its effects on behavior. Although the mechanisms responsible are unknown in the genesis of ADHD, studies on pathophysiology point to the existence of neuroanatomical, genetic and environmental factors as well as in the expression and severity of ADHD (Kasdejo et al., 2001).

2.1 Therapeutic implications

At present, the treatment of subjects with ADHD moves in three directions: first, a re-education orientation which has several variants depending on the emphasis given to academics or cognitive-behavioral disturbances; the second one is an interdisciplinary approach in which different professionals (physician, psychologist, educator, physical educator, etc.). have their respective areas in the various manifestations of this disorder, and the third one that is pharmacological in nature, not without controversy, but it offers research on results, not only more numerous but also more accurate than the others.

In general, neuropharmacological treatment of ADHD, aims to improve the nerve impulses that act on certain frontostriatal circuits. Dopaminergic and noradrenergic mediation between nerve impulses and the optimal functioning of these circuits would result in a substantial reduction in symptoms of ADHD, especially in regard to executive functions. Medication treatment was started in 1937 when Bradley described the effects of benzedrine in the behavior of children. Since then it has clearly documented the role and efficacy of stimulants and it has been demonstrated their effectiveness in the treatment of motor skill activity and lack of attention. Methylphenidate (MPH) and dextroamphetamine (DA) are the medications most commonly used stimulants. Alternatively, the tricyclic antidepressants have benefited some patients.

Although treatment of the hyperactive child is based on four therapeutic pillars, the medical pharmachologic approach has a special relevance. For years, alternative treatments for ADHD have been confined to the use of psychostimulants, and their favorable effects in reducing the symptoms and manifestations of ADHD are the medications of first-line treatment. These medications improve the behavior between 70 and 90% of children older than 5 years (Barkley, 1988). The efficacy of these stimulants has been shown from placebo-controlled double-blind study in children and adults, a 65-85% of ADHD patients had a clinical response to methylphenidate, compared to 4-30% with placebo (Wilens y Spencer, 2000). Scientific evidence suggests that methylphenidate and amphetamine salts are equally effective in the treatment of ADHD in children (Vitiello et al., 2001; Montañes-Rada et al., 2009).

The new formulations of these compounds have demonstrated long-acting, at least, similar efficacy to the immediate release (Faraone e t al., 2006), which is similar throughout the different stages of life, including preschool, children, adolescents and adults (Jensen et al., 2001; Ramos-Quiroga et al., 2006; Conners et al., 2001). Despite the high efficiency, approximately 20-35% of patients do not respond to these treatments (Conners et al., Barkley, 1977).

The benefit with the use of stimulants is 75% to 90%. subjects receiving this treatment not only are less impulsive, restless and distracted and they internalize the information better, have better relationships, establish commitments in a better way and thus they autocontrol

more efficiently, and they let them be more accepted and liked by their peers and receive less punishment, improving self-esteem. However, this type of pharmacological intervention has some restrictions, such as misuse of medication, the pharmacodependency that occurs in some people and the misconception that the pharmacological treatment is sustained as the only alternative to the problem of attention, ignoring other alternatives such as integral treatment (Fernández Jaen, 1999).

Recently there have been results referred to a Multimodal Study of Children with Attention Deficit / hiperactivity Disorder (MTA Cooperative Group, 2003). This study has shown that stimulant medication had clearly superior results to those obtained with behavioral treatment and environmental care. In addition, combined therapy (behavioral and pharmacological) was not significantly superior to medical therapy alone. The use of stimulants often produces an immediate improvement in behavior, it also improves self-control, attention, aggression, and interpersonal relationships, especially at family and school level. It states that it is important for teachers to know that medication do not control the child, they simply help filter distractions allowing them to concentrate on the tasks they perform, helping to reduce impulsiveness and facilitate better decision-making (Arias, 2003).

Concerning the effects of some medication used in ADHD on the motor skill, studies are scarce. A study on the effect of methylphenidate in children with ADHD and DCD on fine motor skills of these two groups and a control group. The results showed that children with ADHD-DCD, performed the motor tasks with greater motor skill deficiency than children in the control group. In particular, the activities of manual dexterity subtests had poorer quality of handwriting, and drew more quickly but less accurately than healthy graphomotor tasks. Applying methylphenidate, manual dexterity and improved quality of the handwriting and the beats in the graphomotor task were less rapid and more accurate (Houwe y Schoemaker, 2006). In short, the most widely used medication to treat ADHD is methylphenidate. Its effectiveness is supported by numerous studies over five decades (Conners et al., 2001; Artigas-Pallarés, 2004; Rapport et al., 1994; Whalen et al., 1979). The action of methylphenidate is a selective inhibition of dopamine reuptake and acts to improve both academic performance, such as social interaction, and a general behavior, since it reduces hyperactivity and keeps attention. Under research there are medicines derived from nicotine, which use improves dopaminergic neurotransmission, memory and executive functions (Faraone et al., 1997).

From the known components or integrated multimodal treatments, two issues should be highlighted: first, variations in the number of professionals integrated into the program, and the second, in terms of objectives and methods that are oriented primarily to reduce or prevent dysfunctions associated with ADHD symptoms (aggression, negativism, antisocial behavior, etc.). In this regard, it is noted the effectiveness of treatments made from conduct modification, when recognizing the child working with parents and educators in parallel. Physical activity, and TDH-oriented therapeutic modality could be a route of considerable interest, when in advance, accurately described motor abnormalities in these patients have been found.

In adulthood, about 15 to 20% of children with attention deficit disorder and hyperactivity continue to experience symptoms of this disorder; another third have symptoms of antisocial personality disorder. A significant percentage shows medication abuse (16%), especially when two are provided before adolescence behavioral problems and academic

partners are corrected. If this is done, a group formed by the most severe cases will struggle in adulthood with persistent symptoms of the disorder. (Conners et al., 2001). Literature refers to only 20%. The children who do not receive a treatment or it is incomplete, an 80% has a bad long-term prognosis with emergence of explosive conduct disorders in adolescence, disocial conduct disorder, criminal-type personality disorder, alcoholism, drug abuse, job instability and difficulties in personal relationships.

It is generally considered that 80% of children with ADHD have a favorable long-term prognosis, when prior to adolescence behavioral problems are corrected and academic partners. If this is done, the literature speaks of only 20%, a group formed by the most severe cases will struggle in adulthood with persistent symptoms of the disorder (Conners et al., 2001). Of the children who did not receive any treatment or it is incomplete, 80% have a poor long-term, explosive emergence of behavioral disorders in adolescence, conduct disorder, personality type of crime, alcoholism, drug abuse, job instability and difficulties in personal relationships.

In adulthood, about 15 to 20% of children with attention deficit disorder and hyperactivity continue to experience symptoms of this disorder and another third have symptoms of antisocial personality disorder. it shows a significant percentage of medication abuse (16%), especially when there are two. Evidence has been compiled in order to indicate that a high percentage of cases, ADHD is accompanied by other psychopathologic dirorders (Zarin et al., 1998; Bennett, 2000). This makes the clinical study of hyperactivity difficult and raises the inevitable question of differential diagnosis between ADHD and various disorders that may coexist, such as patterns of major depression, anxiety disorders, oppositional defiant disorder, the dissocial and learning disorders (August et al., 1996a; Epstein et al., 1992; Abikoff y Klein, 1992).

Comorbidity refers to a high probability of association of these diseases in one person, and it does not necessarily imply a causal relationship or interdependence between different coexisting disorders. (Artigas-Pallares 2003) states that at least two conditions to give a useful meaning to the term comorbidity are required.

These conditions are that the presence of comorbidity conditions a presentation, a prognosis and a therapeutic approach for each comorbidity process. The condition of the frequency with which one appears when the other is present is higher than the isolated prevalence in the general population isolated.

Approximately 45% and 65% of children with ADHD have other behavioral and emotional problems, such as conduct disorder, oppositional-defiant disorder, anxiety-dipression disorders, etc. (Abikoff y Klein, 1992). This has led to consider ADHD as a heterogeneous disorder, usually seen as a disorder, which usually occurs with other psychopathological problems, which interact and modify the diagnosis significantly in the clinical phenomenology, not only in the psychological characteristics but also in the psychosocial consequences, in the clinical course, in the prognosis and in response to the treatment of this complex association (McBurnett et al., 1999).

From the clinical perspective, children with ADHD associated with other disorders are of greater severity, they are affected in several domains of child development (social, academic, emotional and physical interaction) and they continue to develop more favorably

than children with ADHD without comorbidity (Abikott y Klein, 1992; Jensen et al., 1996; Rapport et al 1999). The studies establish the following associated disorders: Comorbidity with conduct problems, comorbidity with learning disorders, comorbidity with anxiety disorders, comorbidity with mood disorders with changes of the motor skills.

It is clear that one of the comorbidity disorders of ADHD is showed in the motor skill. These motor skill dysfunctions seem to affect many individuals with ADHD, to the point that the quality of motor skill performance during the first 5-6 years could be a predictor of subsequent onset of symptoms of ADHD, and even the association between clumsy motor skill and ADHD is a worse prognosis of the pattern (Kroes et al., 2002; Pascual-Castro Viejo, 2004; Kasdejo y Gillberg, 1999).

Some studies that have compared the fine motor skills of individuals with ADHD to a control group have found that the first ones showed less motor skill ability than the latter and the type of difficulties observed differed by the subtypes of the disorder (Piek et al., 1999; Steger et al., 2001). In this sense, the authors found that men affected by attention deficit and corresponding to the combined type (ADHD amd Hyperactivity) displayed less skill than those attached to the hyperactive-impulsive type and the control group. Also, in general, all children with ADHD had poorer fine motor skill performance than controls. These deficiencies are reflected in both the clumsiness to be with their body to occupy a space and move in it with a willful and symbolized motility fluid enough (Mazet y Houzal, 1981).

However, some studies disagree with these results, noting the absence of differences among people motor skills with ADHD and controls (Leung y Connolly, 1998). Based on motor skills characteristics prevalent in children with ADHD, it shows the existence of a high proportion of children with such deficits who have difficulties in gross motor skills development (Bauermeister, 2002). As a result of these deficiencies, subjects may appear awkward in their movements, expressing difficulty when running and jumping. With regard to fine motor skill development, the difficulties are manifest in tasks that involve grasping objects (such as a fork and a knife), buttoning clothes, playing with a ball, coloring within the limits of the figure, write lines or write in a uniform size, or run the script with an acceptable calligraphy and complete the written work in the classroom.

On the other hand, hyperactivity in children has been associated with motor coordination problems, and ot is stated that, currently, there are enough data to argue that hyperactive children have visual motor skill deficits, higher motor skill reaction times (they need more time to respond a motor skill at the onset of a stimulus) and make more errors (Orjales, 2002).

The study aimed to compare the performance of fine motor skill development, gross motor skill, visual motor skill in children of 6 years, the study worked with 49 children with ADHD and 48 normal children comparing their performances. The results showed significant differences between groups, indicating that the motor skill development of children with ADHD was significantly low compared to other children, all perceptual-motor skill measures. They also showed the existence of significant correlations among all variables considered motor skills in relation to hyperactive and inattentive children. Also, regression analysis indicated that the total visual motor skill and motor skill outcomes were significant predictors of group classification with and without ADHD. These results confirm the importance of early assessment and treatment of the disorder (Yochman et al., 2006).

The authors cited above indicate that, while performing a neurological examination, it is usually not complete and also it does not outline the motor skills abnormalities that could be seen. The low importance attached to psychomotor development, and more specifically to the motor skills within the ADHD symptoms, with the prevalence of these disorders in patients affected by this syndrome, constitutes a gap in the knowledge of ADHD. Overcoming this ignorance could be a concern from the theoretical and applied point of view. Another study on the influence of disorder of the development coordination and attention deficit disorder in children associated movements, aimed to determine the relationship between associated movements (AMs) and the level of motor performance of children. It was researched whether children with Development Coordination Disorder (DCD), those with ADHD and healthy subjects differed in the severity of associated movements. The total sample was 10 children with DCD, 10 with ADHD and 10 belonged to a control group, it was found that two groups with limited motor skill had AMs significantly more severe than the healthy group. These results suggest that the level of motor performance should be considered in future research, trying to understand individual differences in the severity of AMs, as well as a function of motor learning, as well as a deficit linked to ADHD (Licari et al., 2006).

In general, it is estimated that over 50% of children with ADHD may have motor skill problems (Arnstein et al., 1996; Yochman et al., 2006). However it also noted that the diagnosis and clinical monitoring of patients (including neurologic examination) is mostly very superficial (Yochman et al, 2006; Licari et al., 2006). These authors explain that this situation could result from the fact that those who made the diagnosis and treatment tend to be doctors and psychologists that focus primarily on the symptoms of their field and, they are usually unaware of the nuances of the motor skill.

The study on the relationship between ADHD and the ability for the sport (Yochman et al., 2006), the study sample was 100 men with ADHD, aged 6 to 16 years with normal IQ, that is on the 85 percentile, motor skill was evaluated by the views of parents regarding their children's skill for drawing, writing, and problems for walking, jumping and playing; children answered a questionnaire of 8 questions related to their love of sport, type of sport, the position they played football if they practiced it, the assessment of sports performance (both staff and parents and peers), the frequency and discipline in sport practice and also if sport was practicedi or instead of football what other physical activity was practiced. The results showed that the most common neurological involvement was hypotonia, it was expressed in all joints in the form of hyperextension and hyper-flexibility in the feet, where hypotonia was more evident and it was present in plano-valgus feet, forcing an awkward walk, in general, the excessive shoulder and trunk elasticity coexisted with a significant global muscle power.

A 67% said they play sports and a 20% chose football, followed by cycling with a 12%. Swimming, taekwondo, basketball, etc., were the less chosen by children. A 42% of those who conistently practiced sport expressed their motivation for this activity, while 58% acknowledged that they continued practicing sports at the behest of their parents. Almost all considered to have a satisfactory performance in sports, but the parents of half of them recognized that the implementation was poor compared with other children. In general, this study is interested in reseraching the possible relationship between the motor skill efficiency of children with ADHD and sports practice. However, the evaluation of the motor skills based solely on parental opinions and sports performance, measured only by the opinions

of children themselves and their parents is far from meeting the methodological requirements of a rigorous motor skill assessment.

The therapeutic potential value of motor skills in the treatment of ADHD has been the subject of various studies in recent years. In most of them, it is considered within a multimodal treatment, which hampers the assessment of the effects of exercise in isolation. In other cases, the effect of the activity is evaluated (exercise and others) on various manifestations of the syndrome. For example, it has been shown that motor skill practice on cognitive functioning, and especially to vigorous physical activity can benefit children suffering from attention deficit disorder and hyperactivity (Lemura et al., 2000).

In another study, aerobic exercise was used (walking on treadmill) in children with ADHD and it was found that exercise could have a positive effect on the typical behaviors of the disorder, it may provide the child with ADHD the following benefits: On a physical level: correct laterality problems or coordination and to work gross and fine motor skill. At level of education: to promote motor skill learning, facilitate the understanding of body structure and promote understanding of the movement. At the social level: sharing a group activity, learn to respect rules, to accept others and be respected by the group (Tantillo et al., 2002).

However, this work does not specify the results obtained after an aerobic exercise program, merely proposing the supposed benefits that could result of the program. Some of these benefits, such as the ones the authors propose at a social level, would be difficult to get through the treadmill walk, as this activity does not imply, in principle, social relations nor the development of respect for self and others. Nor it is easy to understand how lateral or coordination problems could be corrected, nor improving the fine motor skills by working in the treadmill, and so on. In addition, studies of this nature, far from clarifying the relationship between physical exercise and ADHD, may even lead to confusion.

In relation to the exercise as part of treatment, (Barkley, 2003) presents some case studies of ADHD patients whose treatment included physical exercise and/or sports, mainly intense aerobics, affirming to have seen a clear benefit. In any of these studies, the type of exercise prescribed to the subjects is not made operative, nor the improvements obtained are quantified. What the author offers is a brief description of the treatment, indicating the exercise prescription and adding an anecdotal comment on the effects obtained.

Studies of children with ADHD taking stimulants and noted that the performance of these children in terms of fitness and gross motor skills was below average, when it is compared with the standards established for children of this age and gender. They also showed that athletic incompetency and academic failure could contribute to these children maintain a low self-concept, which caused them a feeling of worthlessness and frustration with social activities (Winnick, 2004).

Motor skills can provide a large field of learning to improve social skills in individuals with ADHD. If there are different causes and forms of ADHD, there must be several ways to teach children with this disorder. It is suggested specific instructional strategies for teachers to help children with ADHD to maintain focus and concentration in different school settings (Winnick, 2004). These strategies involve a highly structured approach and consistent routines, establishing rules, the use of behavior management programs, clearly express the expectations expected, choose activities that involve slow, controlled movements to reduce

hyperactivity and impulsivity, to highlight relevant commands, to encourage the child permanently, to change the motor skill tasks permanently, to minimize competitive games and activities to encourage cooperation.

In the same way, physical activity is recommended to children with ADHD, as far as possible. It is considered that at least an hour a day of aerobics, karate do, swimming, dancing, gymnastics and other sports should be provided. These authors consider that energy expenditure made by the child to exercise will allow higher levels of stillness. They also argue that higher-level of exercise of the child requires more concentration, which generalize to intellectual tasks. Although both arguments may be reasonable, to reduce hyperactivity by increasing energy expenditure, which would achieve in all cases, a temporary reduction and not a modification of the neuropsychological mechanisms that underlie the etiology of the disorder. Also, to expect a transfer from the alleged concentration generated by exercise to intellectual tasks suggests a very superficial knowledge of the functioning of attention processes.

2.2 Development disturbances in ADHD

Although initially motor skill difficulty was used as a catch-all room where all the paintings were more heterogeneous, now it tends to rigorously define its scope. For example, lesions and neurological symptoms are excluded and the concept of motor skill difficulty for motor impairments of the child whose etiology is of another nature is reserved. These shortcomings are reflected in both the awkwardness to be with their body to occupy a space and to move in it with a symbolized and intentional mobility (Barkley, 2003).

The interest in studying motor skill functioning in ADHD and in discriminating children with ADHD from those with neurological disorders is not new (Konrad et al., 2000). This interest has been revitalized in part by research on DAMP (Gillberg, 2003; Kasdejo y Gilbert, 1998) conducted in Sweden and also by other contributions on neuroimaging studies related disorders, indicating that both clinical experience and experimental evidence suggest the role of motor skill factors in ADHD.

A variety of neurological tests have shown that children with ADHD are different from the control group in motor size skills. This includes repetitive movements (Carte y Hinshaw, 1996; Denckla y Rudel, 1978), difficulties in fine motor skills associated with hyperactive-impulsive or disantención symtomps (Pitcher et al., 2003); coordination failures (Jucaite et al., 2003), problems in controlling the movements and especially when there is no visual feedback (Eliasson et al., 2004); balance deficiencies (Raberger y Wimmer, 2003); maladjustment in rhythmic beating sequential tasks (Lemura et al., 2000); excessive unnecessary movement (Mostofsky et al., 2003); difficulty with motor skills Acquisitions (Karatekin et al., 2003); and slow central motor skill processing (Ucles et al., 2000); lower motor skills and intervals and number of errors increase (Tantillo et al., 2002).

In general, it is estimated that over 50% of children with ADHD may have motor skill problems (Barkley et al., 1990b; Yochman et al., 2006). The low importance attached to psychomotor development, and more specifically to the motor skills within the ADHD symptoms, with the prevalence of these disorders in patients affected by this syndrome constitute a gap in knowledge of ADHD. Overcoming this ignorance could be of interest from the theoretical and applied point of view.

The differentiation between subtypes of ADHD have shown that the “mixed” subtype has greater difficulties in gross motor skills, while the "inattentive" subtype is less in fine motor skills and manual skill tests (Piek y Skinner, 1999). Meanwhile, clinical studies have highlighted the presence of motor skill dysfunction in ADHD, but it does not indicate what specific process is ADHD involved: motor skill programming, preparation, adjustment, etc.

3. Motor skills in children with ADHD: Comparative study from a pharmacological treatment

This research work aims to show the practical elements, as evidenced by the results presentation that seek a statistical approach to the existing theoretical claim that affirms that children with ADHD who are undergoing medication therapeutically present a different psychomotor profile compared to children with ADHD who are not receiving medication. This established a methodology process that starts with a descriptive correlational study. Sampling frame was used as 422 children between 5 and 12 years old from Manizales Colombia with a medical diagnosis of ADHD, which exceeded the representative sample size of 397 subjects, calculated by using the EpiInfo program , v. 6.04, designed by the Center for Disease Control in Atlanta, in its Spanish version, and considering a total population of 46,387 children, with 95% confidence and a margin of error of 5%. Their distribution by age and gender was 306 male (72,5%) and 116 female (27,5%).

Also 308 children from the total sample did not use methylphenidate and 114 did not use methylphenidate if consumed. Regarding the subtype of ADHD it was found that 84 (20.6%) were diagnosed with predominantly inattentive, 184 (43, 6%) predominantly hyperactive and 151 (35.8%) with combined dominance. An age range between 5 and 12 was chosen, because 5 years is usually set when first diagnosed ADHD and because in previous studies (Vidarte and Velez, 1999, 2001) it had worked with these ages and they had shown elevated levels of disorder prevalence. Inclusion criteria for healthy children were: being aged between 5 and 12 years, belonging to any genre, being physically fit to develop the respective evaluations and having the corresponding informed consent. For children diagnosed with the disorder, in addition to the above requirements, an ADHD diagnosis is required by a certified physician.

Children who had any other pathology such as cerebral palsy, mental disorders, language disorders and anxiety disorders, among others, or who have had traumatic processes that alter the mobility during the last month were excluded from the sample. Once all administrative authorizations were obtained in order to know in which schools were children with ADHD. The integral service unit was (interdisciplinary unit under the Ministry of Education of the city, which is made up of physicians, psychologists, speech therapists and occupational therapists, and who are responsible for therapeutic intervention in children with different problems and to provide pedagogical support to teachers and parents).

The sociodemographic variable data were obtained through a questionnaire of open and closed questions and the corresponding psychomotor variables by using the psychomotor observation battery (POB) proposed by Da Fonseca. It is a system for observing the various components of the motor system, and the data obtained allow to reflect the degree of

neurological organization of the child, allowing the identification of alterations. The theoretical basis on which the BPM based its proposal consists of contributions from Luria, reformulated and repurposed by Da Fonseca provide justification for the neuropsychological data.

The assessment was conducted individually with each of the children in their own school and in their study schedule. In the case of the only hospital care center, the procedure was similar and the children were assessed during the time they went to receive their treatments. Except in this case, and in order to avoid information bias due to convenience, a blind process of measurement was condected: the evaluators did not know which were children diagnosed with ADHD. Finally, the physician of integral service unit reported which of the children assessed were diagnosed with the disorder, allowing the review of medical records to prove the diagnosis of ADHD and to confirm the inclusion and exclusion of children.

The study results are described first through a univariate analysis then a bivariate analysis that shows the relationship between psychomotor profiles and variable subtypes and gender.

Psyichomotor profile	Frequency	Percentage
Apraxic (weak)	1	0,2
Dispraxico(Satisfactory)	73	17,3
Eupraxic (Good)	336	79,6
Hiperpraxic (Excellent)	12	2,8
Total	422	100,0

Table 1. Psychomotor profile of children clinically diagnosed with ADHD.

The psychomotor profile of 422 children was 79.6% eupraxic, it maens normal, while 17.3% was dispraxic or performed with difficulty.

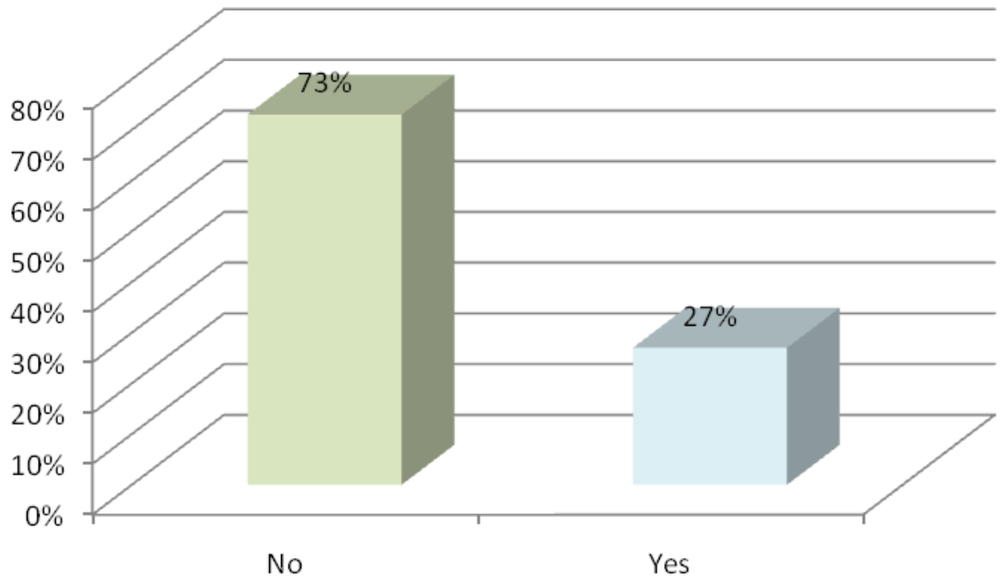

Fig. 1. Results obtained in the participant sample by taking medications (methylphenidate)

It is remarkable how 100% of the sample participating in the study only 27% use methylphenidate.

Psyichomotor profile	Use medication		No use medication	
	Fcia	%	Fcia	%
Apraxic (weak)	1	,9	0	0
Dispraxic(Satisfactory)	18	15,8	55	17,9
Eupraxic (Good)	89	78,1	247	80,2
Hiperpraxic (Excellent)	6	5,3	6	1,9
Total	114	100,0	308	100,0

Table 2. Results of psychomotor profile in children who use medication compared with those who do not use it.

In this study was found that from 114 children taking medication, 83.3% (95) are male and 16.7% (19) female. Depending on the level of schooling, the largest proportion was located in the third grade of school (28 boys), 26 in the first grade and 22 in fourth grade and according to the age of children medicated, the greater proportion was 7 and 10 years (21 children) and 8-9 and 11 years (14 children).

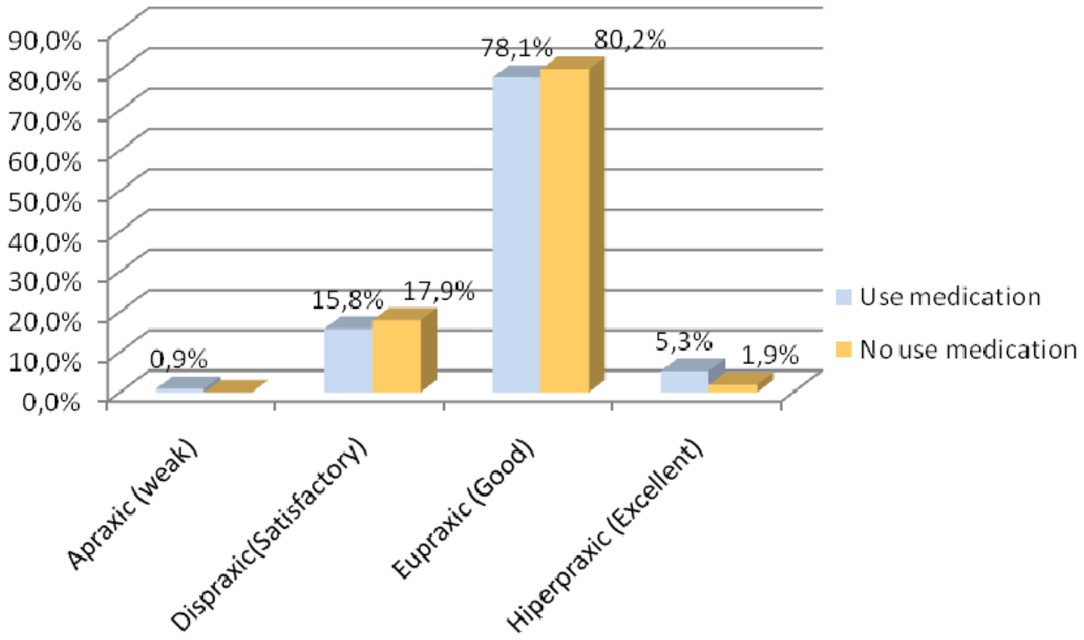

Fig. 2. Psychomotor profile results in children who use medication compared with those who do not use it.

Notice although the mean difference for each of the motor skills factors assessed in clinically diagnosed children is higher in children who use medication compared to those who do not use it when comparing these differences, it was found that their differences are not statistically significant.

Variable	X children who use medication	X children who do not use medication	U	Sig. Bilat.
Tone	3,06	3,00	16834,000	,490
Balance	2,96	2,83	16000,500	,124
Laterality	1,22	1,21	17411,000	, 854
Body notion	2,70	2,56	15791,000	,079
Estructuration espacial	1,96	1,86	16339,500	,235
Global Praxia	1,89	1,78	16221,500	,189
Fine Praxia	2,50	2,42	16308,500	,218

Table 3. Comparison between groups of children with ADHD from obtained results in factors of psychomotor profile

Variable	X children who use medication	X children who do not use medication	U	Sig. Bilat.
Tone	3,02	3,00	486,000	,903
Balance	2.91	2,78	452,000	,547
Laterality	1,24	1,17	460,500	,538
Body notion	2,60	2,56	473,000	,756
Estructuration espacial	1,89	1,78	464,000	,756
Global Praxia	1,91	1,61	403,000	,203
Fine Praxia	2,45	2,50	476,000	,792

Table 4. Comparison between groups of children with ADHD predominantly hyperactive from results obtained in the factors of psychomotor profile

Comparing the motor skill factors among children diagnosed with ADHD predominantly hyperactive differences in the means are not statistically significant. It was found from the psychomotor profile 55 children use methylphenidate of which 69.1% have a normal profile (Eupraxic), 5.5% hyperpraxic and 23.6% dispraxic.

Variable	X children who use medication	X children who do not use medication	U	Sig. Bilat.
Tone	3,20	3,09	2358,500	,346
Balance	3,06	2,84	2189,000	,102
Laterality	1,20	1,19	2593,500	,943
Body notion	2,74	2,62	2462,000	,566
Estructuration espacial	2,00	1,85	2351,500	,320
Global Praxia	1,94	1,83	2365,500	,341
Fine Praxia	2,49	2,43	2472,500	,599

Table 5. Comparison between groups of children with ADHD predominantly inattention of the obtained results of the psychomotor profile factors

Comparing the motor skill factors among children diagnosed with ADHD and predominantly inattention, the differences in the means are not statistically significant. It is noteworthy that in relation to the psychomotor profile, it did not occur in these apraxic profile children and a higher proportion of children with predominantly inattentive profile were normal.

Variable	X children who use medication	X children who do not use medication	U	Sig. Bilat.
Tone	3,00	2,91	1338,000	,651
Balance	2,91	2,78	1287,000	,443
Laterality	1,23	1,24	1400,500	,895
Body Notion	2,91	2,46	918,000	,004
Estructuration. Espacial	2,09	1,84	1142,000	,117
Global Praxia	1,77	1,77	1396,000	,895
Fine Praxia	2,56	2,36	1148,500	,117

Table 6. Comparison between groups of children with ADHD predominantly combined of the obtained results of the factors of psychomotor profile.

Comparing the motor skill factors among children diagnosed with ADHD predominantly combined, the mean differences were not statistically significant in the body notion variable. It is important to highlight in these children the apraxic profile and in a higher proportion the children with combined prevalence obtained an excellent or hiperpraxic profile.

Pharmachological Treatment	Type of TDAH			Total
	Inattention	Hyperactivity	Combined	
YES	57	35	22	114
NO	30	149	129	308

	Value	gl	Sig. asintotic (bilateral)
Chi-square of Pearson	83.237[a]	2	.000
Reason of verosimilitude	75.874	2	.000
Lineal per lineal association	60.599	1	.000
N of valid cases	422		

Table 7. Relation between consumption of medication and subtype of ADHD

The table above shows that there seems to be a relationship between the consumption of medication and subtype of ADHD ($p < 0.00$).

The data above show differences in mean scores achieved in the development of motor skills developed by children clinically diagnosed with ADHD who use medication in relation to the ones who do not, but these differences were statistically significant only for children with Combined ADHD predominant factor in the notion of body ($p < 0.004$), the other factors and each of the subtypes were not found differences statistically significant.

(Pelham et al., 1990) examined the effectiveness of methylphenidate to improve the performance of hyperactive children in the game of baseball. Although medication did not enhance skills for the game, it produced significant effects on attention, so that involvement in the activity was higher. In short, while psychostimulant medication did not make children more skilled players, their teammates thought that they showed a better disposition towards the game.

These results have a positive nature because, as suggested by Pelham et al (Pelham et al., 1990), peers are more benevolent in judging a child who strives and makes mistakes for his

clumsiness, than when a fellow is judged by errors made due to his uninterest for the game. Papers published in recent years by the Multimodal Treatment Study of Children with Attention Deficit / Hyperactivity Disorder (MTA Cooperative Group, 1999 confirm the efficacy of psychostimulants in the treatment of ADHD.

In fact, a number of reports have shown that methylphenidate decreases in children with ADHD their disobedience, their verbal aggression and their antisocial behaviors (Hinshaw et al., 1993; Klein et al., 1997), it facilitates the standardization of their behavior in class (Rapport et al., 1994) and it favors social interactions with classmates (Whalen y Henker, 1991). Similarly, other research has found improvements in the performance of children with ADHD / C on homework such as math problems, word reading (Smith et al., 1998) and quality of writing (Tucha y Klaus, 2001) the administration of methylphenidate.

4. Conclusion

In attempting to solve the objective of the study, it can be concluded that the psychomotor profile of children diagnosed with ADHD is eupraxic and it is classified in the same category as children who consume and don´t consume medication, and they are located in the same profile for eupraxic healthy children, although their score is lower and the performance levels of each factor are worse. Exceptionally, there were no differences in the psychomotor profile of different factors, but in this case, it is also deficient in healthy children. (Vidarte et al., 2009).

In general, studies of motor skills in children with ADHD are overly simplistic and marred by methodological shortcomings. This makes it difficult to know precisely: motor behavior of children with ADHD, the most appropriate type of exercise in improving such symptoms, neurological and biochemical pathways through which explain the improvements made and its effectiveness compared to other traditional treatments traditional, or as part of a multimodal treatment.

It is therefore recommended to initiate a systematic process that allows the collection of information on an ongoing basis and thereby make permanent monitoring to processes conducted with multimodal intervention in children diagnosed with ADHD. The inclusion of this condition in the policy of early childhood at national level, given its high prevalence and the possibility of effective management in the beginning of school age.

5. Study limitations

The study limitations were: the absence of stratified sampling by sex and the low participation of children studying in private institutions, this variable would have enable to identify possible differences by socioeconomic status.

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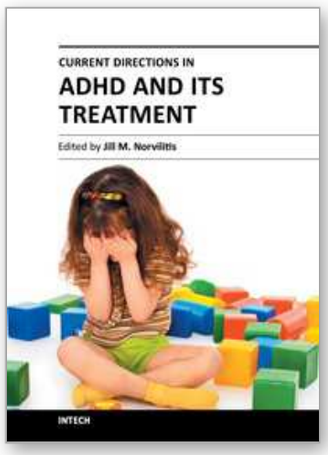

Current Directions in ADHD and Its Treatment

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The treatment of Attention Deficit Hyperactivity Disorder is a matter of ongoing research and debate, with considerable data supporting both psychopharmacological and behavioral approaches. Researchers continue to search for new interventions to be used in conjunction with or in place of the more traditional approaches. These interventions run the gamut from social skills training to cognitive behavioral interventions to meditation to neuropsychologically-based techniques. The goal of this volume is to explore the state-of-the-art in considerations in the treatment of ADHD around the world. This broad survey covers issues related to comorbidity that affect the treatment choices that are made, the effects of psychopharmacology, and non-medication treatments, with a special section devoted to the controversial new treatment, neurofeedback. There is something in this volume for everyone interested in the treatment of ADHD, from students examining the topic for the first time to researchers and practitioners looking for inspiration for new research questions or potential interventions.

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