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Marsh, Richard

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Motor development in six to seven year old children with identified intrinsic barriers to learning: a cross-sectional study.

Richard Marsh (301587)

A Research Report submitted to the Faculty of Science, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Science (Physiotherapy) Johannesburg, 2017.

Declaration

I, Richard Marsh, student number 301587, declare that this research report is my own work and that it has not been previously submitted to this or any other university

Signed this day……26……in……July 2017…….

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Signature …  …….....

Abstract

Background:

Research has proven that conditions such as developmental coordination disorder (DCD) and attention deficit hyperactivity disorder (ADHD) are becoming more prevalent in children of school going age and that children presenting with these conditions have intrinsic barriers to learning.

ADHD has been found in 3-5% of children. A 2001 census in South Africa showed 12% of the population had intellectual disabilities and 7% communication problems. A 2011 South African census show 3, 2% of the South African population aged five and above has mild concentration/remembering difficulties. When a child has poor performance, this can cause low self-esteem, poor social functioning, risk of obesity and vascular disease. The comorbidity between DCD and ADHD has been considered at a rate of 50%.

Aim:

The aim of this study was to determine whether children with intrinsic barriers to learning have specific motor development deficits.

Method:

There were 27 participants assessed using the Movement Assessment Battery for Children second version (M-ABC 2). The children were recruited from a private remedial school in Honeydew, South Africa and were identified as having intrinsic barriers to learning. The assessment looked at Aiming and Catching, Balance and Manual Dexterity. Each participant was assessed once. These results were analysed by looking at the prominent deficit and correlation to demographics or conditions. An ANOVA analysis was done to compare the different between conditions to Aiming and Catching, Balance and Manual Dexterity.

Results:

There were 10 females and 17 male children enrolled in the study. The mean age was seven years three months and fourteen days. The standard deviation of age was ±140.6 days. The most common diagnosis was ADHD (48%) followed by speech problems (33%).

The Manual Dexterity mean score was 7.82 (± 2.22), the Aiming and Catching mean score was 9.78 (± 3.28) and the Balance mean score was 7.59 (± 2.91). The total mean score for the M-ABC was 7.63 (± 2.84). Manual dexterity and Balance scores were both significantly lower than the Aiming and Catching scores ($p=0.02$ and $p=0.01$, respectively). The results indicated no significant difference between the Manual Dexterity and Balance scores ($p= 0.55$).

The ANOVA analysis showed that children with speech problems scored slightly higher in Manual Dexterity than children with anxiety problems and processing problems but this difference was not significant ($p=0.52$). Children with ADHD and speech problems appeared to score slightly higher in Aiming and Catching than children with anxiety problems and processing problems but this was not significantly different ($p=0.15$). Children with processing problems scored significantly higher ($p=0.03$) in Balance than children with the other conditions.

Conclusion:

Children who have intrinsic barriers to learning have been recognised to have motor deficits that fall into the diagnosis of DCD. It is important to assess these children to optimise their intervention program; not just from a cognitive aspect but from a motor aspect as well. The results of this study found that Manual Dexterity and Balance are motor components that were the most affected. Addressing these aspects may help improve the activity levels and participation of these children.

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Abbreviations

ADHD: Attention Deficit Hyperactivity Disorder

BOTMP: Bruininks-Oseretsky Test of Motor Proficiency

DAMP: Deficits of Attention and Motor Perception

DCD: Developmental Co-ordination Disorder

CNS: Central Nervous System

LD: Learning Difficulty

M-ABC: Movement-Assessment Battery for Children

M-ABC 2: Movement-Assessment Battery for Children 2nd edition

PDMS-2: Peabody Developmental Motor Scale-2nd edition

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Operational definitions:

Developmental Coordination Disorder

Developmental Coordination Disorder (DCD): "is characterized by deficits in the acquisition and execution of coordinated motor skills and is manifested by clumsiness and slowness or inaccuracy of performance of motor skills that cause interference with activities of daily living" (American Psychiatric Association 2013 page 32).

Attention Deficit Hyperactivity Deficit

Attention Deficit Hyperactivity Disorder (ADHD): "is a neurodevelopmental disorder defined by impairing levels of inattention, disorganization, and/or hyperactivity-impulsivity" (American Psychiatric Association 2013 page 32).

Deficit in Attention, Motor control and Perception

Deficit in Attention, Motor control and Perception (DAMP) "emerging international diagnostic consensus practice, DAMP has been defined as the combination of ADHD and DCD (developmental coordination disorder)." (Gillberg 2003 page 905).

Processing problems

Processing problems: The American Psychiatric association recognises the diagnosis name of Specific learning disorder. This diagnosis is defined as "when there are specific deficits in an individual's ability to perceive or process in formation efficiently and accurately" (American Psychiatric Association 2013 page 32).

Speech disorders

Speech problems: this is the production of sounds, which includes the articulation, fluency, and voice and resonance quality. If there is a deficit in language, speech and communication this will be a communication disorder (American Psychiatric Association 2013 page 41).

Learning difficulties and intrinsic barriers to learning

The terms 'Learning difficulties' and 'intrinsic barriers to learning' are used interchangeably (StatsSA 2005).

Chapter 1: Introduction

1.1 Background:

Conditions such as Developmental Coordination Disorder (DCD) and Attention deficit hyperactivity disorder (ADHD) are becoming more prevalent in children of school going age and children presenting with these conditions have intrinsic barriers to learning. The comorbidity between DCD and ADHD has been considered at a rate of 50% (Watemberg et al, 2007). A child with intrinsic barriers to learning has trouble processing information. This means their general intelligence is not diminished whereas a child with a learning disability has a level of cognitive impairment (Mohamed & Laher, 2012).

A study conducted in Hong Kong found that approximately 6% of school aged children have DCD and this can lead to a deficit in motor skills and daily activities (Hung & Pang, 2010). ADHD has been found in 3-5% of children. These children with ADHD have common comorbidities which include conduct disorders, learning disorders, anxiety disorders, autism spectrum disorders and mood disorders (Fliers et al 2007). Children can present with balance deficits, poor movement coordination and trunk weakness (Hung & Pang, 2010). When a child has poor performance, this can cause low self-esteem, poor social functioning, risk of obesity and vascular disease (Fliers et al, 2007).

Children with DCD are prone to being over-weight, avoid activity, have low self-esteem and have poor academic achievement and social competence. Children with DCD have been found to not "outgrow" their motor deficit but display more social and affective problems into adolescence (Venetsanou et al, 2007).

Poor motor control is another potential problem in children with barriers to learning but the specific motor components that are responsible for the motor deficit have not been explained. Studies have shown that 30-50% of children with ADHD can present with motor coordination deficits (Fliers et al, 2007). Researchers in Scandinavia have found that 1.2-2.0% of all seven-year-old children have Deficits of Attention and Motor Perception (DAMP). These deficits impact the child's activities of daily living negatively. It is unfortunate that the data has been inconsistent in the relation between inattention and

hyperactivity and a specific motor coordination problem (Fliers et al, 2007). A child that has intrinsic barriers to learning will have decreased cognitive achievements and their activities of daily living are interfered with (Mohamed & Laher, 2012).

Approximately 5.34% of children at public schools in South Africa have intrinsic barriers to learning. These children have been characterised with poor learning strategies, perceptual and information processing problems, mathematics and language difficulties and the inability to pay attention (StatsSA, 2005). There are also extrinsic barriers to learning for children in South Africa such as, an education system that is unable to accommodate academic diversity as well as economic and social challenges. These factors include poverty, violence, crime, substance abuse, HIV-AIDS and community attitudes (Mohamed & Laher, 2012).

Researchers found that a child that has DCD and ADHD can present with the following problems: reading difficulties, language impairments, pronunciation difficulties and phonological deficits (Watemberg et al, 2007). This includes mathematical difficulties particularly in very preterm children. There was a dominant deficit in working memory and visuospatial skills (Simms et al, 2015). Authors Flier et al (2007) showed that adults aged 22 years old had a poorer prognostic outcome with ADHD and motor coordination problems than adults with ADHD only. Poor prognostic outcome was seen to present with poor social skills and relationship building, poor school and work achievements, psychiatric problems and alcohol and drug abuse. When looking into the issue of gender, researchers found that the psychological functioning and behaviour of boys and girls were the same if a child had ADHD. Detecting a child with these conditions early on could help prevent a poor prognostic outcome (Fliers et al, 2007).

1.2 Problem statement:

Identified intrinsic barriers to learning and motor deficits have been well documented but identification of the specific motor components that may be impaired has not been researched. There is a lack of research in South Africa, investigating whether children with intrinsic barriers to learning are at a greater risk of having a specific category of motor deficit and what the relative severity of these deficits may be.

1.3 Research question:

Do children who have intrinsic barriers to learning have specific motor component deficits in their development?

1.4 Aim:

The aim of this study was to determine whether children who have intrinsic barriers to learning present with specific motor component deficits.

1.5 Objectives

The objectives of this study were:

- To describe the demographics of the population of children with intrinsic barriers to learning to attend a specific school.
- To determine the motor developmental status of children with intrinsic barriers to learning to use the Movement Assessment Battery for Children- 2 (M-ABC 2) assessment tool.
- To describe the relative severity of components of motor development deficits as assessed by the M-ABC 2 assessment tool and to indicate the severity of each motor component according to the different diagnoses.

1.6 Significance and justification for research:

If a child's motor deficit is not addressed, then this can continue into adulthood. Early detection and intervention is very important. If a child can achieve the completion of a task, it will induce feelings of joy, confidence and motivate the child to participate in activities (Hung & Pang, 2010). If this research shows that children with intrinsic barriers to learning have a specific motor deficit, then screening can be implemented and a targeted intervention program could be developed. This research can promote early childhood development and the need for early childhood intervention in our children with intrinsic barriers to learning.

Chapter 2: Literature review

In this chapter literature pertaining to the development and presentation of children with intrinsic barriers to learning will be reviewed. The influences of ADHD, DCD and intrinsic barriers to learning will be discussed. Evidence will be given to establish the validity and reliability of the assessment tool the M-ABC 2.

The search engines used were Pubmed, Scopus, PeDro and ClinicalKey. The key words used were "Developmental delay", "Gross motor", "Learning difficulties", "Intrinsic barriers to learning", "ADHD", "ADD", "DCD", "Processing disorders", "Speech disorders", "Gender" and "Age". The intention was to search for the last ten years' articles but some relevant articles that were older were used. This was because they related to recent studies. All the articles were in English.

2.1 Motor Development and contributing factors

The progression of development can be influenced by genetics or can be influenced by multiple components like social and environmental factors (Smith & Thelen, 2003). Smith and Thelen (2003) proposed the dynamical theory of child development. This considers the diverse application of self-organisation and emergence. This indicates that no single element has a priority. Development is an interaction between a number of factors and the genetic make-up of the child. These variabilities can include mother and child relationships, imitation, language, social skills, perception and action, which can lead to an atypical pattern of developmental change (Smith & Thelen, 2003).

Previous theories suggested that Central Nervous System (CNS) maturation was key for development but it has been seen that a child can have an environmental change and can improve their development. Therefore, the system looks at a multi-causality approach with humans processing complex systems and having complex environments. New skills emerge because of continuous development and maturation of a number of cooperating, dynamic systems which interact and respond to changes in the child's environment (Smith & Thelen, 2003).

Development takes time and we can intervene to improve that development. If a small change in a component of the dynamic system can be done, this could lead to reorganisation and a difference in behaviour may be seen (Smith & Thelen, 2003).

2.2 Symptoms and diagnose of ADHD and DCD

A child that has been diagnosed with ADHD has the following symptoms: overactivity, fidgeting, inability to stay seated, intruding into other people's activities and inability to wait (American Psychiatric Association, 2013: pp 32). DSM-IV has an 18 itemed ADHD checklist that is used for diagnose (Fliers et al, 2007). The first 9 items address attention and the other 9 items address hyperactivity-impulsivity. Below the age of 12 there needs to be six or more symptoms in each category to diagnose a child with ADHD (American Psychiatric Association, 2013: pp 32).

A parent or caregiver can suspect if their child has DCD is when there is an unusual clumsiness and there is persistent delay in gross or fine motor skills (Harris, Mickelson & Zwicker, 2015). Harris, Mickelson and Zwicker (2015) found there is difficulty in oral motor coordination, particularly in blowing bubbles or candles. If a child is thought to have DCD there is a screening questionnaire that can be done called the Developmental Coordination Disorder Questionnaire. The questionnaire has 15 items that are used on children aged 5-15 years old. This condition should be diagnosed by a multidisciplinary team. The team should include a physician and physiotherapist or occupational therapist. To further examine these children the DSM-IV looks at five criteria. Briefly they are: acquisition and execution of coordinated motor skills, motor skill deficit interfering with activities of daily living, onset of symptoms for motor development and to rule out any intellectual disability or neurological condition. The assessment tools used will be the M-ABC 2, Developmental Coordination Disorder Questionnaire, formal IQ testing and neurological examination (Harris, Mickelson & Zwicker, 2015).

2.3 Prevalence of ADHD and DCD

ADHD and DCD are common neurodevelopmental problems in children. A child with deficits in motor coordination can influence their academic progression and impact their activities of daily living. The rate of comorbidity has been found to be as high as 50% between the two conditions (Watemberg et al, 2007). There are 5.34% of the children in the United States at public schools that have learning difficulties (Mohamed & Laher, 2012). In Hong Kong, there are approximately 6 % of school children with Developmental Coordination Disorder (DCD) (Hung & Pang, 2010) and in the United States around 6% children aged five to eleven years old that have motor problems (American Psychiatric Association, 1994).

Calhoun, Crowell and Mayes (2000) found that 70% of children with ADHD have learning difficulties and written expression was the most common difficulty by 65% over the difficulties involving reading, maths or spelling. Children that have ADHD and Learning Difficulties (LD) have more severe disabilities when they are compared to children with just LD and no ADHD. The pattern that children with ADHD and LD also had more severe attention problems than children with just ADHD and no LD was also found. Therefore, the conclusion that the authors found was that learning difficulties and attention problems influence each other as well as coexist (Calhoun, Crowell & Mayes, 2000). A 2011 census showed that 3, 2% of South African population aged five and above had mild concentration/remembering difficulties (StatsSA, 2014).

2.4 Aetiology of intrinsic barriers to learning

Aase, Meyer and Sagvolden (2006) replicated a study looking at the influence of cultural backgrounds on children with ADHD. Children were selected from seven ethnic groups in Limpopo which included all socio-economic levels. Using a computerised game-like task, children had to figure the game out and find the sequence on their own. The results indicated that gender has no effect but children without ADHD had a higher correct score justified by improved learning of the game. This study was previously done with children from Norway. There was a striking similarity between the results from the Norwegian children with ADHD and the Limpopo children with ADHD. Therefore, the authors concluded that this study

makes the case that ADHD is more of a neurobehavioural disorder and not a cultural phenomenon. They also included that the reasoning of a wealthy or poor socio-economic country is not a factor because they included all socio-economic levels (Aase, Meyer & Sagvolden, 2006).

Flier et al (2007) used subjects from the International Multicenter ADHD Genes study. They focused on families from the Netherlands and one of the inclusion criteria was European Caucasian descent. Teachers and parents completed the relevant ADHD and motor questionnaires. The Motor questionnaires (DCD Questionnaire and Groningen Motor observation) looked at the child's fine motor skills, their gross motor movement and their ability to coordination and control their movement. Data has indicated a significant correlation between DCD and ADHD and found that high inattention scores were predictive for coordination problems. The hyperactive scores were predictive of fine motor and coordination problems. When age was investigated as a contributing factor, children with ADHD have a poor motor performance compared to children without ADHD, regardless of age. The weakness of the study was that the DCD questionnaire had not been validated in the population of ADHD children (Flier et al, 2007).

Children born preterm are found to have a higher risk of intrinsic barriers to learning (Simms et al, 2015). Structural MRIs have shown that adults have diffuse abnormalities of both grey and white matter if they were born premature and of a low birth weight (Piek & Dyck, 2004). When looking at mathematics they have developmental dyscalculia which is poor approximate number system acuity. With the use of The Wechsler Individual Achievement Test-II a Mathematic Composite score can be derived. Cognitive skills can be determined using the Raven's Coloured Progressive Matrices, Automated Working Memory Assessment, Rapid Automatized Naming test and the Developmental Neuropsychology test. These tests showed that preterm children had significant problems with mathematics: from deficits in verbal processing speed, working memory and visuospatial skills. This differs from children with developmental dyscalculia (Simms et al, 2015). Developmental dyscalculia is associated with abnormalities in the intraparietal sulci and Simms et al (2015) believe that the activation patterns are different between preterm children and children with developmental dyscalculia. Unfortunately, there was no longitudinal data to support this conclusion to see if this

difficulty was present at an earlier age. To help children that have these difficulties, regardless of whether they are preterm or not, they suggest that by decreasing the demands on the children's working memory and visuospatial skills will benefit the child. The study concluded that the associated comorbidities with mathematical difficulties are dyslexia and ADHD (Simms et al, 2015).

Sergeant, Piek and Oosterlaan (2006) investigated the relationship between ADHD and DCD. They found that 25-40% of children have a reading disability. They used the three levels of the cognitive-energetic model which looks at the hippocampus, frontal lobe, mesencephalic, reticular formation, amygdala, basal ganglia, stiatum and the cortex. It was found that ADHD children with reading difficulties had working memory deficits (Sergeant, Piek & Oosterlaan, 2006). Semrud-Clikeman et al (2000) indicated that the caudate was mainly responsible for the inhibitory control in children with ADHD. The child's cerebellum and basal ganglia are possible areas in the brain for motor dysfunction but timing problems associated with DCD is a cerebellar function. ADHD has been identified with having a reduced brain volume which includes the frontal region of the right hemisphere, corpus callosum and the cerebellum (Piek & Dyck, 2004). Piek and Dyck (2004) believe that children with a developmental disorder involves the cerebellum and the identification of children that may have DCD with comorbid ADHD is important. Poor visual-spatial organisation is involved in motor ability and social interaction (Piek & Dyck, 2004).

Children with specific language impairments have appeared to have significant movement difficulties. There has been an observation that these children are unimpaired when looking at the performance accuracy on fine motor tasks compared to their normal developing peers but there was a typical difficulty in balance. Hill (2001) believe that specific learning impairments and DCD could stem from the same aetiology but not from the same psychological mechanism. These deficits are indicators of an immature brain development, which has been seen in premature children. These delays can evolve into other cognitive delays, including prominent linguistic symptoms. Physiotherapists need to be aware that there is a risk of motor impairments when a child presents with language impairments (Hill, 2001).

2.5 Effects of ADHD, DCD and Intrinsic barriers to learning

Children with intrinsic barriers to learning can present with low self-esteem and increased risk of being bullied (Mohamed & Laher, 2012). Hill (2001) reviewed twenty-eight papers which looked at children with language impairments and their limb coordination. The studies indicated that children that present with specific language impairments have been seen to have poor visual discrimination and motor task performance which has a similarity to children with DCD. These children have shown substantial limb praxis deficits. These studies looked at the gesturing with their hands. Praxis is the skill to produce movements with a purpose which involves motor programming from the person and motor integration of complex and learnt movements. Their ability to process information is slower than normal developing peers, which influences all cognitive domains not just language function. The correlation between language impairments and motor performance can be high (Hill, 2001).

Pragmatic motor skills are weak in children with ADHD and this influences working memory performance. Studies have shown an inconsistency when looking at the relationship between inattentive and hyperactive symptoms of ADHD. This also includes motor coordination problems and whether it is correlated to age (Flier et al, 2007). Clinically, children with ADHD perform worse than typically developing children in repetitive fine motor tasks, coordination (Jucaite et al, 2003), control over movements (Eliasson, Rosblad & Forssberg, 2004), balance (Raberger & Wimmer, 2003), control of tapping tasks with timing and force (Pitcher, Piek & Barrett, 2002), the acquisition of new motor skills (Karatekin, Markiewicz & Siegal, 2003) and the time needed for central motor conduction (Ucles, Serrano & Rosa, 2000). Atypical children are more reliant on their visual feedback due to the impairment of their movement control. They can exhibit large end-point errors and duration of tasks can be prolonged, therefore motor planning can be poor and performed movements can be jerky (Eliasson, Rosblad & Forssberg, 2004).

Brown and Vickers (2004) have predicted that children with ADHD can present with problems in time estimation, time production skill and time reproduction skill. Time estimation is the verbal report of the duration of a stimulus. Time production was when a duration length was advised and the participant had to produce that specific time. Time

reproduction was when a participant had to replicate a specific duration of a stimulus after being shown the stimulus duration. There has been evidence that there is a deficit in adults with ADHD and there has been little research has been done for pre-adolescents. Time reproduction does require the most working memory and this tends to overload the children where time perception is determined by the basal ganglia and the cerebellum. Brown and Vickers (2004) has found that a child with poor motor inhibition has poor time reproduction skills. These children have shown atypical activation of the putamen in the basal ganglia but Brown and Vickers (2004) felt that the dysfunction was not exclusive to the basal ganglia. The right cerebral hemisphere is dominant for attention and believed to have dysfunction in ADHD. Imaging has shown an asymmetry in the caudate nucleus. This can explain the impairment of response inhibition which can lead to right frontal dysfunction. Another structure that is influenced by ADHD is the smaller posterior corpus callosum in the splenial area. This can interfere with the interhemispheric transfer (Brown & Vickers, 2004).

Taking this information, the investigations looked at adolescent children and found a possibility of deficit recovery through maturity. Medication seems to have no influence on the adolescents and there was equal capacity to process visual temporal information. These children even had a significant faster interhemispheric transfer times and this indicates a positive effect on arousal (Brown & Vickers, 2004). Brown and Vickers (2004) recommended that the study needed to be replicated with a larger sample size to justify these conclusions.

Raberger and Wimmer (2003) looked at children in Austria that met the criteria for ADHD and a poor reading rate. The children had their balance tested using a balance beam. They found that the children with reading disabilities only presented with poor rapid naming abilities instead of having poor balance. This study therefore hypothesised that a specific cerebellar dysfunction occurs which affects the automatisation of the visual-verbal process and another cerebellar function is responsible for the automatisation of basic sensory-motor skills like balance. This could be reason why the children with dyslexia had fair balance. The movements were performed poorly and the time required to change their direction was longer when performing a movement (Raberger & Wimmer, 2003).

Flier et al (2007) looked at 486 children with ADHD from the Netherlands and between the ages of five and nineteen years old. The questionnaires on motor coordination were done by the parents and teachers. The study established that there was no significant difference between gender but a high comorbidity between ADHD and DCD. Children with DCD and ADHD have shown to have a poor prognostic outcome in social functioning and relationships. A child that has difficulty performing tasks can presents with low self-esteem, high anxiety and poor social skills. Physically they can be at risk of obesity and vascular disease in adolescents. Clinicians should be assessing children with ADHD for any motor coordination problems (Flier et al, 2007). Sergeant, Piek and Oosterlaan (2006) used the cognitive-energetic model which identifies specific and/or overlapping mechanisms found in research of ADHD and DCD. The tapping task performance from children with DCD and ADHD showed a poorer initial reaction time and higher peak force. Children with ADHD only had no significant difference to the control group. These specific deficits can increase errors, having an increase in variability in dexterity, movement and velocity and affect their ability to modulate motor rhythm (Sergeant, Piek & Oosterlaan, 2006).

When looking at the impairments of ADHD, there is little known about the problems in learning and efficiency of executed skills. Higher-order motor problems are labelled as "clumsiness" (Karatekin, Markiewicz & Siegal, 2003). Karatekin, Markiewicz and Siegal (2003) looked at 25 children with ADHD and 27 control children; their ages were between eight to fifteen years old. The children with ADHD were more prone to incur an accidental injury and neurological exams showing poor motor control, coordination and reduced speed in fine motor tasks. The surveys conducted by the authors showed that performing motor skills was poorly done in children with ADHD. This may be because they cannot sustain their attention long enough to acquire a new skill. Skills will involve planning and complex action sequences. The child needs to learn and utilise efficient strategies. The increased cognitive load tends to exacerbate their impairment (Karatekin, Markiewicz & Siegal, 2003).

The primary sensory systems in the brain are associated with the visual, vestibular and kinaesthetic systems. These control movement but Piek and Dyck (2004) found evidence that perceptual problems are linked to visual modality and others found kinaesthetic problems in

children with coordination problems. With a closer look, children had a main deficit of visual spatial processing, kinaesthetic perception and cross-modal integration. It has been seen that children involved in an active movement increase the intramuscular receptor stimulation which improves the kinaesthetic precision but passive static movements worsen the kinaesthetic precision. The differentiation between DCD and ADHD is that children with DCD have poorer visual-spatial organisation (Piek & Dyck, 2004).

2.6 Perceptions of Intrinsic Barriers to learning, DCD and, ADHD

Mohamed and Laher (2012) investigated teachers' perceptions on learning disabilities (intrinsic barriers to learning) in South Africa. A learning disability is when the person has average to above-average intelligence. Children with learning difficulties present with reading, writing and mathematical problems. They often have poor learning strategies, poor processing and inability to pay attention. Looking at the extrinsic and intrinsic barriers help assist adapting the child's learning environment. Teachers believe that children with learning difficulties cannot cope with specific tasks and believe that they could have poor auditory and visual perception (Mohamed & Laher, 2012).

Unfortunately, high learner-teacher ratios make it difficult to address the child's individual educational needs. The preschool level is an important phase to establish an adequate base for the child's education. A solution is to look at more remedial classes with reduced numbers so teachers can continuously monitor the children and refer children on to the appropriate practitioner (Mohamed & Laher, 2012). Mohamed and Laher (2012) discussed that a clear picture of learning disability and difficulty needs to be made so the teachers can identify the children more easily and appropriately.

2.7 Rehabilitation for children with ADHD and DCD

Interventions for DCD have focused on trunk control, muscle strengthening and repetition. The intervention can increase with difficulty over time. To improve the child's motor skills they need to be focused, have self-control and practising in smaller groups will help (Watemberg et al, 2007).

Hung and Pang (2010) looked at the effects of group and individual therapy on twenty-three children aged eight years old with DCD. Children were screened using the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) and the Movement Assessment Battery for Children (M-ABC). The intervention focused on agility, balance, core stability and movement coordination. These children were challenged enough but were still able to achieve the task to instil confidence. Twelve children received the motor intervention once a week for eight consecutive weeks for the group intervention. The other eleven children received the same intervention but on an individual basis for the eight weeks. Their results showed that the group intervention was just as effective as the individual intervention. The added advantage was that in a group setting children could develop social interaction skills and be motivated better through competitiveness. There was an observation that the children's manual dexterity improved though the interventions focused on gross motor skills. Therefore, if postural control is improved then their fine motor tasks may become more efficient. Unfortunately, the sample size was small and this made the post-hoc power analysis underpowered to determine a significant difference between the interventions. So, if there were improvements with both interventions the other consideration could be to include a control group in future studies (Hung & Pang, 2010).

Watemberg et al (2007) wanted to see the effects of intensive group physical therapy program for 96 children with DCD and ADHD aged six to twelve years old. The intervention focused on perceptual motor training, sensory integration therapy, kinaesthetic training and neurodevelopmental treatment. The intervention group received four weeks of therapy twice a week for an hour each time. The tasks focused on cognitive stimulation, tasks with goals, performance of skills needed to be specific and the child needed self-control when performing the activities. These sessions were individualised for each child. The children were assessed with the M-ABC but the investigator was not blinded to which group the children were in. These children showed deficits in fine and gross motor skills. The intervention group resulted in a 50% improvement in the children's scores compared to the children in the control group. It did show that therapy needs to be individualised to the child's needs and difficulties (Watemberg et al, 2007).

2.8 Motor Assessment in Children

There are many motor outcome measures available. Many of the tests have been validated and standardised. The BOTMP and M-ABC are the most two commonly used standardised motor assessments. The BOTMP has been around the longest and is used to establish the concurrent validity of new tests, but unfortunately the standardised scores are out-dated (Croce, Horvat & McCarthy, 2001).

The M-ABC uses a checklist that a parent can fill in and a detailed scored assessment which is done by the therapist. The assessment looks at the child's temperament and asks about their medical and developmental history. The outcome measure not only gives a score but allows the assessor to see the "bigger picture". This helps to customise their intervention program for each individual child. The test can take 20 to 40 minutes to administer but this is also dependent on the child (Venetsanou et al, 2011).

The M-ABC 2 test assesses the children's Manual Dexterity, Balance and Aiming and Catching according to their relevant age band.

Each test item will be recorded as a raw score.

- A child receives an "F" if they are unable to complete the task.
- A child receives an "I" if they complete the task inappropriately.
- A child receives an "R" if they do not cooperate.

The scores of each item are recorded ranging from zero to five.

- Five is the worst performance
- Zero represents a successful completion of the task item.
- If the child receives an "F", "I", or "R" will be converted to five.
- The eight item scores are added together and can range from zero to forty (the lower the score the better the outcome).
- These scores are converted into standardised scores. The standard scores have a mean score of ten and a standard deviation of three.

The total score is interpreted with the use of the manual according to the child's age. This is represented as a percentile. A child that scores below the 5th percentile, is classified as

having a definite motor impairment. If the child scores between the 6th and 15th percentiles, they are classified "at-risk" of having a motor impairment. A child scoring above the 15th percentile is considered within the normal range of motor development. Two thirds of children have been estimated to have a standard score between seven and thirteen (Henderson, Sugden & Barnett, 2007).

During the testing procedure, the assessor may repeat an item to see exactly how the child performs the task.
If a child failed an item there are three adaptations an assessor can do:

- Test the child in a lower age band
- Adapt the test item
- Provide the child with assistance, instruction or feedback

The M-ABC assists in the identification of motor difficulties, clinical exploration, to help plan interventions, to evaluate programs and to help research (Venetsanou et al, 2011). The first version of the M-ABC was standardised using 1234 children from America, across a diversity of races and ethnic backgrounds. Children identified with motor impairments were not included in this sample. This test has been used in many studies with children with or without difficulties (Venetsanou et al, 2011).

The M-ABC 2 consists of eight tests: three for Manual Dexterity, two for Aiming and Catching and three for Balance. There are three age bands that are tested with their own tailored tests. Age band one is 3-6 years old, age band two is 7-10 years old and age band three is 11- 16 years old. Although there are three common domains, the tasks are adjusted according to age. Testing duration can be 20- 40 minutes. Manual Dexterity looks at the timing of each hand while manipulating objects, a timed bimanual task and an untimed drawing task. Aiming and Catching involves throwing an object at a target and catching an object with one or two hands. Balance assessment involves one static balance task and two dynamic balance task (Schulz et al, 2011).

Research has indication that no gold standard is available for DCD assessment but the M-ABC is used as an effective assessment tool (Flier et al, 2007). The M-ABC 2 is a standardised tool for motor assessment and the can identify three components of motor

function (Venetsanou et al, 2011). The inter-rater and intra-rater reliability of the M-ABC is excellent and the reliability coefficients is greater than 0.95 (Hung & Pang, 2010).

The M-ABC 2 test is used as the "Gold standard" in examining the validity of other new tests. Research has considered the suitability of the test with regards to cultural demands and influence, but it found results were very similar in comparison (Venetsanou et al, 2011). Using the ad hoc modification showed that each age band had a well-fitting factor model which proves the structural validity of the test. The pattern of the factor loading indicates task reliability and convergent validity (Schulz et al, 2011).

Croce, Horvat and McCarthy (2001) were able to look at the test-retest reliability of the M-ABC. Using 106 children from New Hampshire and Georgia, they were tested twice with the M-ABC and once with the Bruininks-Oseretsky test. The retest for the M-ABC was done a week later. The results showed that the test-retest reliability was excellent with 0.98 and the concurrent validity was excellent too with 0.98 (Croce, Horvat & McCarthy, 2001).

Chow and Henderson (2003) looked at the interrater and test-retest stability in the M-ABC, specifically looking at age band one. They used an equal number of boys and girls, random selection was done from the class lists at the relevant schools. Each child was assessed by both assessors but on separate occasions. These retests were done 2-3 weeks apart. An overall agreement between assessors was 0.96, which is high. The "Walking with Heels raised" was the only test that did not achieve the level of agreement and that was only for the five year olds (Chow & Henderson, 2003). Chow and Henderson (2003) did find the test-retest reliability to be low (ICC= 0.77). The study only included children with no impairments and the consideration would be to include children with a motor impairment for future studies (Chow & Henderson, 2003).

Venetsanou et al (2011) looked at articles published from 1992 to 2010 through SCOPUS, MEDLINE and SportDiscus to find evidence supporting the validity and reliability of the M-ABC tool. Nineteen articles were found and investigated the reliability and validity of the M-ABC (Venetsanou et al, 2011). Looking at the construct validity there were two studies

showing the differentiation between children with intrinsic barriers to learning and premature children. The concurrent validity between the M-ABC score and the BOTMP had a correlation of 0.53. When comparing the different cultures a study showed that the five-year-old Flemish children performed better than the standardised scores. A study indicated that American children demonstrated better in manual dexterity and static balance and the Greek children demonstrated better in their dynamic balance. The Pearson correlation ranged from 0.60 to 0.90 between the M-ABC score and the BOTMP, which is regarded as good (Venetsanou et al, 2011). One of the shortfalls of the test is that it does not evaluated handwriting. The test is also not a firm diagnosis for DCD due to its shortcomings. The M-ABC is the most efficient of the standardised test but cannot be called the "gold standard". The authors suggest that a study should be used with children with DCD to provide validity and reliability (Venetsanou et al, 2011).

To test structural validity, the confirmatory factor analysis is the common method to use (Schulz et al, 2011). Schulz et al (2011) wanted to look at the structural validity of the M-ABC 2 looking at the three age groups. A sample size of 1172 children was used which included representative proportions of demographics in the UK. The test consists of three components that assess motor control and coordination for the child to perform activities of daily living. Using some post hoc modifications this established a well-fitting factor model for the structural validity. There showed a convergent validity of the task and a modest to moderate correlation for discriminant validity. There was a higher loading in age band one but this could be from the mood or biological maturity of the child. In age band three the separation of tasks was clearer and the factor correlations were weak to modest. Meaning the three domains (factors) are becoming more differentiated and specialised and not representing a general motor ability. The model indicates that the structural validity of the M-ABC 2 is good, particularly in age band three. The children can practise and combine these skills and their movements to develop new skills (Schulz et al, 2011). Schulz et al (2011) recommend further research to investigate the structural validity of the M-ABC 2 on children with movement difficulties.

When Wagner et al (2011) looked at the factorial validity of the M-ABC-2, they used the second age band (7- 10 years old). They had a sample size of 323 children and gathered their data over six months. The eight tests looked at Manual Dexterity, Aiming and Catching and Balance. Manual dexterity was tested placing pegs into a board, threading a lace in a board and drawing along a trail. Aiming and Catching was tested two-handed catching and then throwing a bean-bag onto a mat as the target. Balance was tested by standing on one leg on a balance board; walking heel-to-toe forward along a line and hopping on mats either with one or two legs. To look at the factorial validity, they used the Mardia-Test. The results from the testing showed some doubt in the discriminant validity and the convergent validity. Unfortunately, there was no construct-close method used for comparison. With the use of the multitrait-multimethod approach research can be done to check the convergent and discriminant validity when looking at the subtests (Wagner et al, 2011). Wagner et al (2011) concluded that the M-ABC-2 should be used for therapeutic practice but not for diagnosis.

2.9 Conclusion of Literature review

This literature has shown that a child with intrinsic barriers to learning can be diagnosed with ADHD or DCD and can exhibit a multitude of motor difficulties. There has been intervention methods used to address deficits but with no specific components addressed. It has been established in the literature that a child with a learning difficulty may have motor development delay or deficits. The M-ABC 2 is an effective tool to establish if a child has any motor deficits and specific to three categories (Balance, Manual Dexterity and Aiming and Catching). This tool has been shown to be valid and reliable.

Due to the little research has been conducted to know which component of motor development is mostly affected. The M-ABC 2 will indicate which area is mostly affected in children with intrinsic barriers to learning. If a child cannot achieve physical or academic goals then this has a huge impact on their lives and we need to have an intervention that can have the best outcome.

Chapter 3: Methodology

This chapter describes the study design, study design, study setting, study population and the samples size. The hypothesis tested and independent and dependent variables have been presented. The description of the instrumentation and procedures used for the data collection has been discussed with the data reduction and analysis methods. The ethical considerations of the study have been presented at the end of this chapter.

3.1 Study design

The study is a non-experimental descriptive cross sectional study. The purpose of the study is to describe the motor developmental status of children, aged six to seven years old who present with intrinsic barriers to learning.

3.2 Study setting

Participants were selected from a private school in Honeydew, Gauteng. These children had to meet the inclusion criteria to participate in the study and consent and assent needed to be given. The school accommodated children from pre-school to Matric. There is a maximum of 15 pupils to a class and the approach to learning is assisted learning. The teachers are available after school to help the children with their homework.

The school is a private remedial school which offers educational support to all learners. Therapy support offered at the school is Educational Psychologist, Speech therapy, Occupational therapy and Physiotherapy. Pupils are drawn from the north-western suburbs of Johannesburg and are from higher socio-economic brackets.

3.3 Study population

3.3.1 Inclusion criteria

The following participants were included in this study:

- Participant has been identified with an intrinsic barrier to learning from their school file.
- Age six to seven years old.
- Participant goes to the selected school.

3.3.2 Exclusion criteria

The following participants were excluded from this study if they had:

- Congenital deformities that would affect participant's physical performance.
- Congenital condition (e.g. cerebral palsy and Down's syndrome).
- Profound visual and/or hearing impairments.

3.4 Sample size

There is a population of eighty children aged six to seven in the selected school. Based on the findings of Fliers et al (2007), the expected prevalence of motor problems will be 40%. Using the sample size formula, with a confidence level of 95% and an acceptable standard error of 15%, the minimum sample size is twenty-seven participants.

The formula used:

$$ss = \frac{Z^2 * (p) * (1-p)}{c^2}$$

- Where:
- Z = Z value (e.g. 1.96 for 95% confidence level)
  p = percentage picking a choice, expressed as decimal (.5 used for sample size needed)
  c = confidence interval, expressed as decimal (e.g., .04 = ±4)

3.5 Hypotheses

- There will be a greater deficit in the Manual Dexterity component scores in children aged six to seven years old with intrinsic barriers to learning in comparison to the Balance and Aiming and Catching component scores.
- Children with barriers to learning will present with a higher prevalence of motor deficits than expected for their age.

3.6 Data collection procedure:

Subject recruitment and allocation

Children were identified based on the inclusion and exclusion criteria at the relevant school. The participants were given an information document (Appendix 1), which was taken home and given to their parents. This form was accompanied with forms for consent (Appendix 2) by the parents allowing the child to participate in the study. If the parents gave consent the children were also asked to complete a child assent form (Appendix 3). These forms were collected from the class teacher the following week.

The participants were allocated an assessment slot where they were asked to wear their physical education uniform for the testing. The participant met with the researcher at the assessment room at the school. Each child was assessed individually in accordance with the guidelines of the M-ABC 2 manual. Once the assessment was completed the participant was shown back to their class.

Outcome measures

The M-ABC 2 test scores were recorded on an outcome measurement form (Appendix 4); this included the participant's demographic information and identified intrinsic barriers to learning from the school admission files by the researcher. Though Appendix 4 includes Medication and Medical history, this was not collected because a lot of the files were missing this information. The M-ABC 2 has been described in detail in chapter two.

3.7 Data analysis

Data was captured on Microsoft Office Excel. The software used to analyse the data was STATA 11.

Objective one: To describe the demographics of the population of children with intrinsic barriers to learning to attend a specific school.

Objective two: To determine the motor developmental status of children with intrinsic barriers to learning to use the Movement Assessment Battery for Children- 2 (M-ABC 2) assessment tool.

Objective three: To describe the relative severity of components of motor development deficits as assessed by the M-ABC 2 assessment tool and to indicate the severity of each motor component according to the different diagnoses.

For objective one: means and standard deviations or frequencies and percentages were used to summarise the demographic information as appropriate using excel software.

For objective two: Total M-ABC 2 scores and component standard scores and equivalent percentiles were calculated. The percentiles were coded into acceptable for age or at risk and these were described using frequencies and percentages.

For objective three: the three subscales (Manual Dexterity score, Aiming and Catching score, Balance score) and overall score of the test were described using means and standard deviation. The Student's T-test was used to compare these scores to each other. Significance was set at $p<0.05/p=0.05$ and an ANOVA done (with post hoc testing).

3.8 Ethical considerations

Ethical clearance was obtained from the Human Research Ethics Committee (Medical) at the University of the Witwatersrand (Appendix 6 and 7).

Permission to conduct the study was obtained from the principal following a request letter (Appendix 5). Parents of the participants were given an information leaflet and consent form for the study. In the information document, possible risks and benefits were stated as well as what was required of the participant in the study. **Consent** must be given from the participant's guardian for them to participate in the study and assent from the children. There was no payment for participating in the trial. Refusal to participate did not result in penalties or loss of benefits. Participants that wished to discontinue participation in the study could do so without any negative consequences to them. At the end of the study, the participants, their parents and the school team were informed of the results and children were referred for appropriate intervention if necessary. Participant's parents were informed that in the study their personal details will be confidential and anonymous and only group data was used for the study report, as well the identity of the school will not be revealed.

Chapter 4: Results

This chapter presents the results obtained from the study. The demographic information will be represented per the children with intrinsic barriers to learning. The children's developmental statuses are shown as overall scores, Balance, Manual Dexterity and Aiming and Catching scores. These different motor components have been compared to each other, so statistical findings can be made.

4.1. Study sample

Forty-five information and consent forms were handed out to the three grade one class at the school. Forty forms were returned and 27 children's parents consented to their child participating in the study and the children assented.

4.2 Demographic information

There were 27 children enrolled in the study. Ten of the children were female (37%) and seventeen were male (63%).

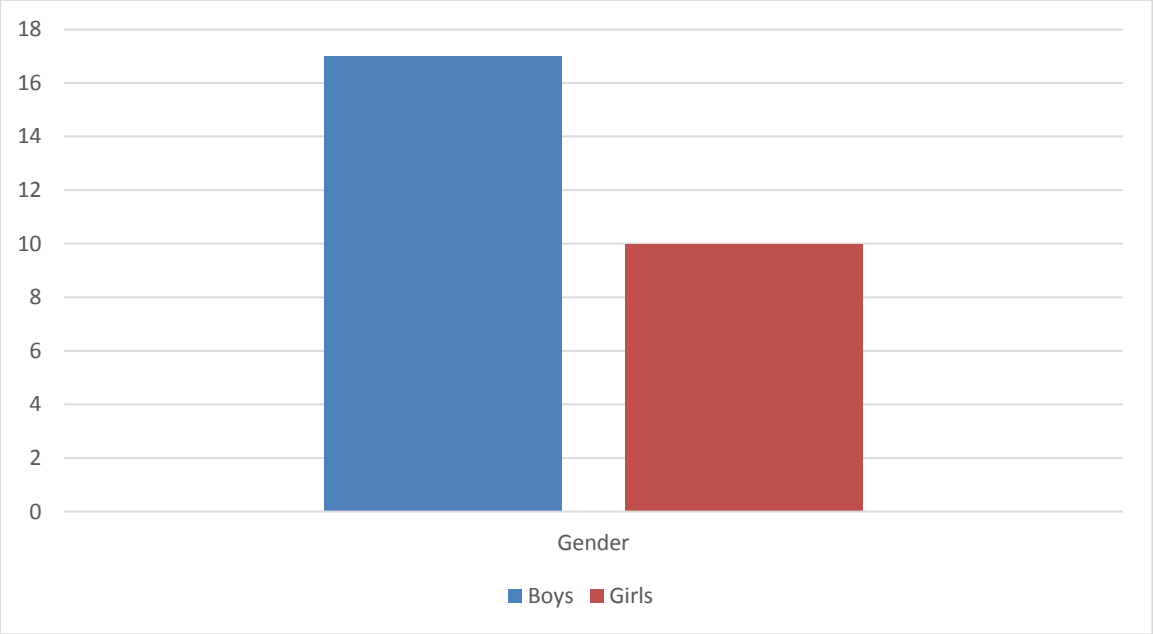


Figure 4.1 Bar graph illustrating the number of children by gender (n=27)

The mean age was seven years three months and fourteen days. The youngest child was six years nine months and three days old. The oldest was seven years eleven months and twenty days old. The standard deviation was ±140.6 days.

The children, who all had intrinsic barriers to learning, were divided into four different categories according to diagnoses that were obtained from the children's admission files, which included ADHD (13), speech problems (9), anxiety problems (2) and processing problems (3). The most common diagnosis was children with ADHD at 48%. Children with Speech problems were 33%. The remaining two conditions (anxiety problems and processing problems) made up the last 19% with the least common being anxiety problems.

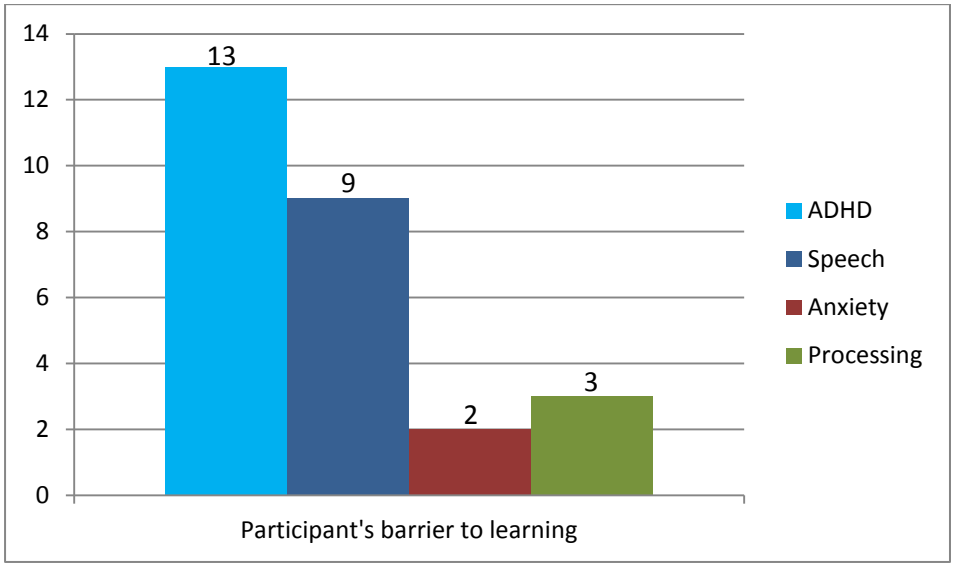


Figure 4.2 Bar graph children by diagnosis of intrinsic barriers to learning (n=27)

4.3 Motor developmental status of children with intrinsic barriers to learning using the M-ABC 2 assessment tool

The overall total scores and subscales from the M-ABC 2 assessment can be categorised. The total score is interpreted with the use of the manual according to the child's age. This is represented as a percentile. A child that scores below the 5th percentile, is classified as having a definite motor impairment (RED- high risk). If the child scores between the 6th and 15th percentiles, they are classified as having possibility (AMBER- moderate risk) of having a motor impairment. A child scoring above the 15th percentile is considered within the normal range of motor development (GREEN- no risk) (Henderson, Sugden and Barnett 2007).

Table 4.1 Overall score risk status represented by number of children (n=27)

Overall score risk status	Percentile	Risk Profile	Number of children
Red	<5	High	7
Amber	6-15	Moderate	3
Green	>15	None	17

If you combine the children that have an Amber and Red risk profile, there were ten children with a developmental risk that was 37% of the group. Seven children (26%) presented in the Red category that indicates a motor developmental delay that requires immediate intervention. The mean percentile score was 27.81(±25.57). The minimum score was 1 percentile and the maximum score was 95 percentile.

The following tables will illustrate the frequency of standardised scores for the overall scores and subscales. The mean standardised score for the M-ABC 2 is ten (Henderson, Sugden & Barnett, 2007).

4.3.1 The children's overall standardised scores

The overall standardised scores are presented in Figure 4.3

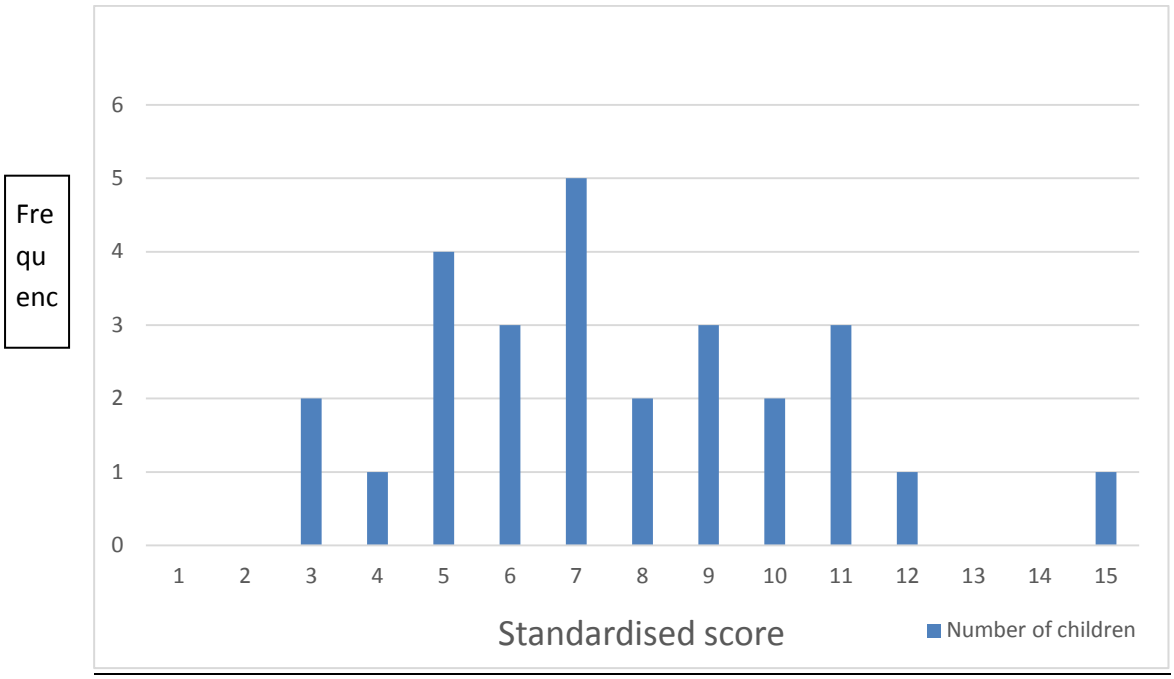


Figure 4.3 Histogram graph illustrating the frequency of standardised scores for overall standardised scores (n=27)

The mode score in the study group was seven and the mean score was 7.63 (± 2.84). The results showed 74% of the children score below the normal mean standardised score of ten. This score (ten) is the 50th percentile of the standardised tool (Henderson, Sugden & Barnett, 2007). In this group 26% of children scored ten and above. The highest standardised score was fifteen.

4.3.2 Manual Dexterity standardised scores

The standardised scores for Manual Dexterity are presented in Figure 4.4

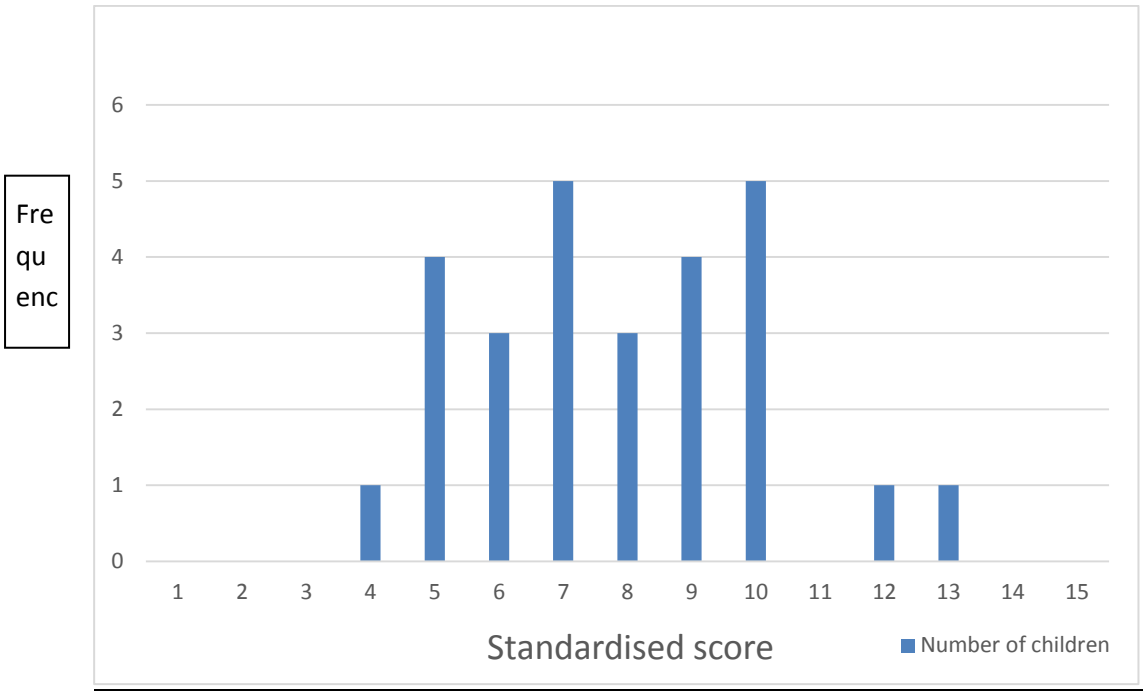


Figure 4.4 Histogram graph illustrating the frequency of standardise scores for Manual Dexterity (n=27)

The mode scores in the study group were seven and ten. The mean score was 7.82 (± 2.22). The results showed that 74% of the children score below the normal mean standardised score of ten. This score (ten) is the 50th percentile of the standardised tool. In this group, only 26% of children scored ten or above but there were no scores more than thirteen.

4.3.3 Aiming and Catching standardised scores

The standardised scores for Aiming and Catching are presented in Figure 4.5

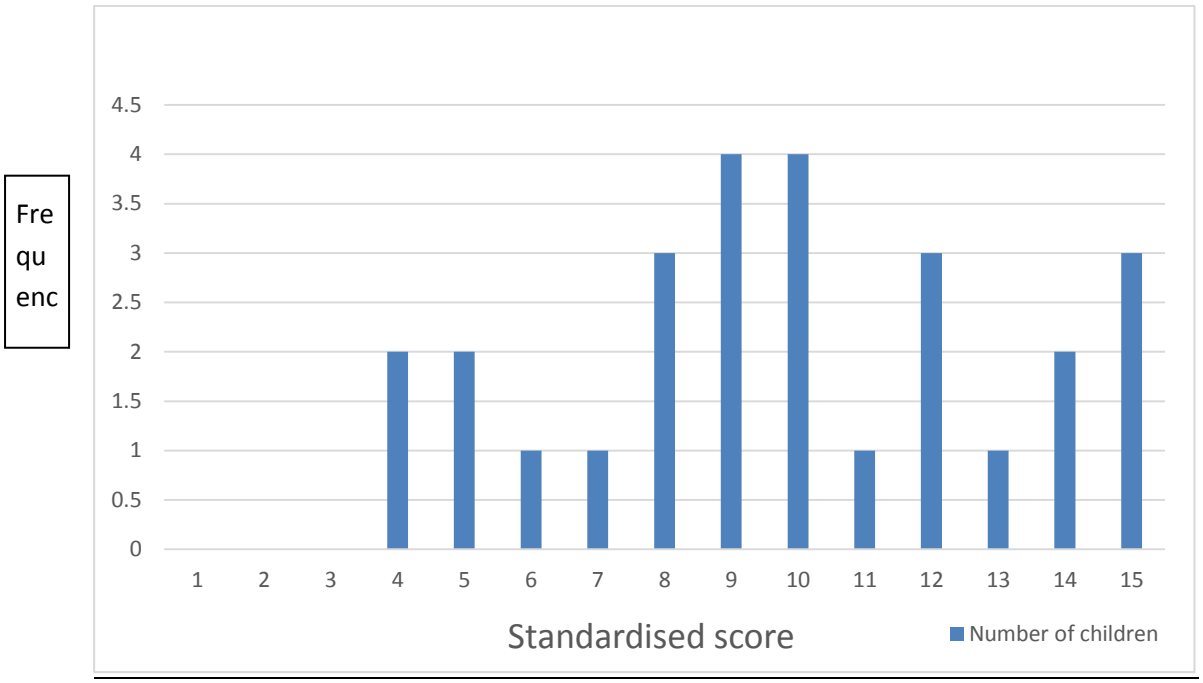


Figure 4.5 Histogram graph illustrating the frequency of standardise scores for Aiming and Catching (n=27)

The mode scores in the study group were nine and ten. The mean standardised score was 9.78 (± 3.28). The results show that 48% of the children score below the normal mean standardised score of ten. This score (ten) is the 50th percentile of the standardised tool. In this group 52% of children scored ten and above, with three children scoring fifteen.

4.3.4 Balance standardised scores

The standardised scores for Balance are presented in Figure 4.6



Figure 4.6 Histogram graph illustrating the frequency of standardise scores for Balance (n=27)

The mode score in the study group was five and the mean standardised score was 7.59 (± 2.91). The results showed 67% of the children score below the normal mean standardised score of ten. This score (ten) is the 50th percentile of the standardised tool. While in this group 33% scored ten and above. The highest score was fourteen scored by one child.

4.4 The relative severity of components (subscales) of motor development deficits as assessed by the M-ABC 2 assessment tool

The results represented in this section show the severity of deficits in motor development for the overall scores and the subscales. These results are analysed according to the intrinsic barriers to learning.

The bar graph below shows the means standardised scores of the children from each motor component and overall scores.



Figure 4.7 Bar graph illustrating the mean standardised scores for overall standardised scores and each subscale standardised score

Looking at the standardised scores for each component, Aiming and Catching scored the highest with 9.78 (± 3.28). This was very close to the 50th percentile score of ten. Manual Dexterity was 7.85 (± 2.22) and Balance was 7.59 (± 2.91) which both scored lower than the normal mean standardised score of ten. The overall standardised score was 7.63 (± 2.84) which is lower than the normal mean standardised score of ten.

These mean standardised scores were compared to each other using the Student's T-test to see if there was a significant difference.

Table 4.2 Statistical difference between the three subscales standardised scores of the test and to the overall standardised scores

	Manual Dexterity score	Aiming and Catching score
Manual Dexterity score	1	0.02*
Aiming and Catching score	0.02*	1
Balance score	0.55	0.01*

*Significant difference at $p < 0.05$

Analysis indicated that comparing Manual Dexterity to Aiming and Catching there is a significant difference (p= 0.02). The comparison with Balance to Aiming and Catching was a significant difference (0.01). There was no statistical significant difference between Manual Dexterity and Balance (p=0.55).

For each diagnosis, the mean standardised score for each subscale has been illustrated.

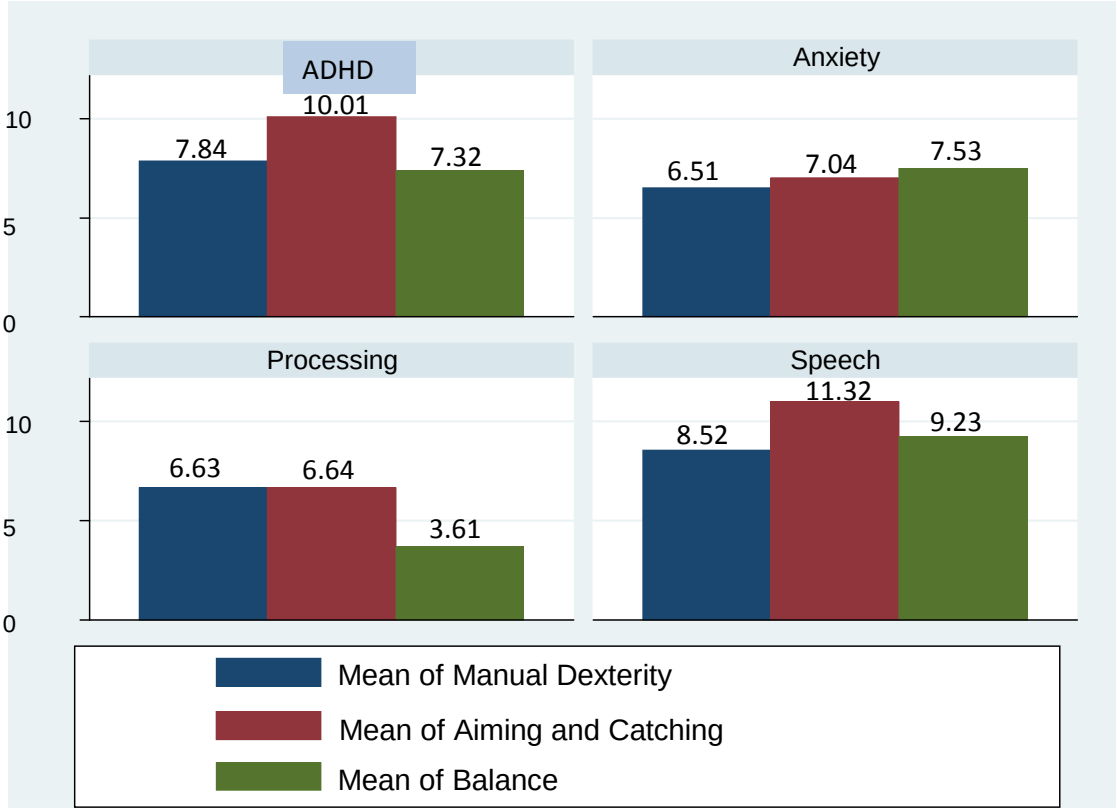


Figure 4.8 Bar graphs illustrating the mean standardise scores for each test component per each diagnosis

The scores for children with ADHD showed that Aiming and Catching was their strongest area by achieving the 50th percentile score (ten) and their weakest was Balance. The scores for children with anxiety problems showed that they are relatively below the 50th percentile (normal mean is ten) for all three subscales. The scores for the children with processing problems scored the lowest compared to the other conditions particularly with Balance scoring below five which was the lowest score. The scores for the children with speech problems scored the highest compared to the other conditions with Aiming and Catching being above ten which was the highest and Manual Dexterity being their lowest score but still a good score.

The next table represents the mean standardised scores for the subscales and overall scores for each diagnosis. The P-values have been calculated at the bottom of the table.

Table 4.3 Diagnoses represented per mean standardised scores and difference

Diagnosis	Manual Dexterity Mean (SD)	Aiming & Catching Mean (SD)	Balance Mean (SD)	Total
ADHD	7.84(±2.23)	10.01(±2.53)	7.32(±3.19)	7.44(±1.98)
Anxiety	6.51(±0.71)	7.04(±2.83)	7.53(±3.54)	6.02(±1.41)
Processing	6.63(±2.89)	6.64(±3.06)	3.61(±1.53)	4.34(±2.31)
Speech	8.52(±2.35)	11.32(±4.00)	9.23(±3.03)	9.31(±3.43)
P value	0.52	0.15	0.03*	0.04*

*Significant at a cut-off p=0.05

An ANOVA was used to test for significant difference between scores for each diagnosis. Children with speech problems appear to score on average slightly higher in Manual Dexterity than children with anxiety and processing problems but this was not significantly different in this study possibly due to the small numbers. Children with ADHD and speech problems appear to score on average slightly higher in Aiming and Catching than anxiety and processing problems but this was not significantly different in this study possibly due to the small numbers. Children with processing problems scored significantly lower in Balance than the other conditions (p= 0.03). Looking at the total test score, speech problems has the highest score compared to the rest of the conditions.

4.5 Conclusion

When looking at the demographic information there was 48% of the children with ADHD and 33% of the children had speech problems. The study results showed 37% of the study group having motor developmental delay according to their overall assessment scores. Only 26% of the study group was able to score above the 50th percentile for the overall scores.

The Manual Dexterity scores indicated that 74% of the children fell below the 50th percentile, the Aiming and Catching scores were 48% of the children below the 50th percentile and was 67% of the children were below the 50th percentile for Balance. Balance had the lowest mean score of 7.59 (± 2.91) and the highest score was Aiming and Catching of 9.78 (± 3.28). Both Manual Dexterity and Balance scores were significantly lower than Aiming and Catching scores ($p=0.02$ and 0.01 respectively). There was no significant difference between Balance and Manual Dexterity scores ($p=0.55$)

According to the ANOVA analysis children with processing problems scored significantly lower in Balance ($p=0.03$). The children with anxiety problems scored the lowest in all fields and the children with speech problems scored the highest.

Chapter 5: Discussion

The results presented in chapter four will be discussed in this chapter looking at the population of the children, their motor developmental status and the severity of each motor component in their development.

5.1 Demographic information

5.1.1 Gender

The study group consisted of 37% female and 63% male, which is not significant enough to establish a prominent gender link to motor deficits and intrinsic barriers to learning but the observation that can be made in this population sample, was there were more boys than girls with intrinsic barriers to learning. There was a study done by Aase, Meyer and Sagvolden (2006) where children in the Limpopo province with ADHD had no difference in the results when comparing the children's gender. Though girls seem as the minority when it comes to ADHD, there has been evidence to show girls are equally affected with their neuro-psychological function and their behaviour (Flier et al, 2007). Flier et al (2007) results showed that 34% boys and 29% girls presented with ADHD. Gillberg (2003) looked at the research and found a ratio of 3-5:1 in respect to male: female with DAMP. Unfortunately Gillberg (2003) feels that ADHD and DCD with girls can be missed or misdiagnosed.

5.1.2 Age

The mean age was seven years three months and fourteen days. This age range was picked for the specific population. When age was looked at as a contributing factor, children with ADHD have a poorer motor performance, regardless of age (Flier et al, 2007). Gillberg (2003) found that motor clumsiness becomes less marked with increasing age. The observation of having motor clumsiness was seen easier in children at the age of seven compared to the children aged seven years old. Another observation was that the most severe form of DAMP occurs in 1.2-2.0% of all children aged seven year olds (Gillberg, 2003). Flier et al (2007) found that the younger the children the more likely to identify a motor co-ordination problems. Therefore, the reason for choosing children at the age of six to seven years old was because the above evidence indicates that children are peaking with intrinsic barriers to learning and can be identified earlier.

5.1.3 Diagnosis

The most common diagnosis was children with ADHD with 48% of children in this study having this diagnosis. Studies have indicated that there is a rate of comorbidity of 30%-50% between children with the DCD and ADHD conditions (Watemberg et al, 2007; Sergeant, Piek & Oosterlaan, 2006; Flier et al, 2007).

One third (33%) of the children in this study had speech problems. Watemberg et al (2007) found that 37.7% of the children with ADHD and DCD had speech problems. The census done in 2005 for South African indicated that 7% of school-going children had communication difficulties (StatsSA, 2005), however this was from the general population not a population with identified barriers to learning.

The remaining two conditions (anxiety and processing problems) made up the last 19% with the least common being anxiety problems. Watemberg et al (2007) had 13% of their children with anxiety problems present with ADHD and DCD. It is important to recognise this group of children because the results in chapter four indicate that this group of children had the lowest scores compared to the other children.

5.2 Motor developmental status of children with intrinsic barriers to learning using the M-ABC 2 assessment tool

5.2.1. Developmental status

When looking at the overall total scores and subscales from the M-ABC 2 assessment, the scores can be categorised. The total score is interpreted with the use of the manual according to the child's age. This is represented as a percentile. A child that scores below the 5th percentile, is classified as having a definite motor impairment (RED- high risk). If the child scores between the 6th and 15th percentiles, they are classified to have some impairment (AMBER- moderate risk). A child scoring above the 15^{th} percentile is considered within the normal range of motor development (GREEN- no risk) (Henderson, Sugden & Barnett, 2007).

The results indicated that ten children (37%) were at risk, falling into the Amber and Red categories. Therefore 37% of the children with intrinsic barriers to learning had motor development delay. Calhoun, Crowell and Mayes (2000) found in their results that there was a comorbidity of 70% which is significantly higher. Though they looked at learning difficulties with ADHD they included written expression problems with the children which doubled their prevalence rate. Written expression is the child's ability to write (Calhoun, Crowell & Mayes, 2000). This was not included in this study. Hill (2001) found that the prevalence of DCD and language impairment in the reviewed studies ranged from 40-90%.

5.2.2. Overall standardised scores

The overall mean score was 7.63 (± 2.84) and the mode score was seven. If you consider the 50^{th} percentile as the norm according to the test the manual (Henderson, Sugden & Barnett, 2007), 74% of the children fell under the 50^{th} percentile. The study showed that 26% of the children could score ten or above but the M-ABC 2 considers the standard score that equate to 15^{th} percentile or above as adequate. Piek and Dyck (2004) reported a study that stated that up to 58% of children with ADHD have movement problems and they fell below the 15^{th} percentile of the respective standard movement assessment battery.

5.2.3 Manual Dexterity standardised scores

The mean Manual Dexterity score was 7.82 (± 2.22) and seven and ten were the mode scores. Again, 74% of the children scored below the normal mean standardised score of ten. Hill (2001) found that children with a language disorders are susceptible to substantial limb praxis deficits when looking at the gesturing with their hands. Piek and Dyck (2004) reported that two studies indicated that children with ADHD have poorer fine motor control but no difference in their kinaesthetic acuity when compared to a control group. The only fault with the study was that they did not identify the children with DCD (Piek & Dyck, 2004). Hung and Pang (2010) took children identified with DCD and after implementing an intervention program of individual and group therapy, the children's Manual Dexterity had the most significant improvement ($p= 0.034$ and $p= 0.007$). Piek and Dyck (2004) investigated a test (The Purdue peg-board), which is a fine motor skill and found that children with DCD and

ADHD had significantly poorer results than children with ADHD only. They could conclude that the DCD children presented with poor visual-spatial organisation (Piek & Dyck, 2004).

5.2.4 Aiming and Catching standardised scores

The mean score for Aiming and Catching was the highest at 9.78 (± 3.28) and nine and ten were the mode scores. The results indicated that 48% of the children score below the 50th percentile of the M-ABC 2. Piek and Dyck (2004) stated that in the studies that they analysed, none of the several studies could establish significant visual-motor deficits in children with ADHD. Piek and Dyck (2004) reported that children with ADHD did have visual-motor deficits compared to control children but it was established that the tests used accessed the children's processing speed. Therefore, this indicates that children with ADHD may have a slower processing speed; however, it has not been well researched if children with intrinsic barriers to learning have poor Aiming and Catching abilities (Piek & Dyck, 2004). Hung and Pang (2010) did find that after their interventions, the scores of the children with DCD did not change significantly (p= 0.202 and 0.476).

5.2.5 Balance standardised scores

Balance had the lowest mean score of 7.59 (± 2.91) and the lowest mode score of five. Interestingly, there were 67% of the children that scored below the 50th percentile of the M-ABC 2, as opposed to the 74% of the children for Manual Dexterity but the mean scores were lower than the Manual Dexterity scores. The results of the study are supported by the following finding in literature. Raberger and Winner (2003) found that the children with ADHD performed poorly in the balance test. While the children with reading difficulties performed well (Raberger & Winner, 2003). Hung and Pang (2010) took children that were diagnosed with DCD and established a baseline score with the M-ABC 2. After their interventions of group and individual therapy were implemented, they found that the children's balance (p= 0.040 for individual intervention) scores and manual dexterity (p= 0.007 for individual intervention) scores both improved (Hung & Pang, 2010). The results indicate that children with an intrinsic barrier to learning need an intervention focused on balance. The possibility of manual dexterity improving is good and could be investigated further.

5.3 The relative severity of components (subscales) of motor development deficits as assessed by the M-ABC 2 assessment tool

5.3.1 Subscale comparisons

Looking at the standardised scores for each component, Aiming and Catching scored the highest with 9.78 (± 3.28) and Balance scored the lowest with 7.59 (± 2.91). Manual Dexterity scored with the second lowest score of 7.82 (± 2.22). These scores did not have a statistical difference against the normal mean standardised score of ten, but the results indicate that children with intrinsic barriers to learning need there balance and manual dexterity addressed. These were their weakest areas of motor development.

Once the mean subscale scores were compared to each other there was a significant difference. Analysis indicated that comparing Manual Dexterity to Aiming and Catching there is a significant difference of 0.02 and a comparison with Balance to Aiming and Catching was a significant difference of 0.01. The only subscales that did not have a difference were Manual Dexterity and Balance (0.55). Which indicates that further investigation is needed to see which area is influencing the other. Balance is the lowest score that could indicate that this motor skill is influencing manual dexterity but there was no significant difference between the two.

5.3.2 Subscale indications per diagnosis

The children in this study with ADHD showed that their Aiming and Catching was the strongest subscale and Balance was the weakest. This is in contrast to what Sergeant, Piek and Oosterlaan (2006) found with their reviewed studies that children with ADHD had poor gross motor skills particularly with Manual Dexterity skills. This is in contrast because the children with ADHD were able to perform well in the Aiming and Catching items it was just manual dexterity and balance that they need assistance. The children in this study with anxiety problems resulted with all three subscales falling below the 50^{th} percentile, therefore they were all weak. The possibility of an intervention program that is designed to increase the child's confidence by achieving activities could improve their subscale scores. The children in this study with processing problems scored the lowest compared to the other conditions particularly with Balance being the worst. These children will need the more intensive intervention program, so all three areas can be covered and where a multi-disciplinary team

will be needed. The children in this study with speech problems scored the highest compared to the other conditions with Aiming and Catching being the highest, but studies from Hill (2001) review indicated that Balance was the typical motor deficit in children with speech problems. This indicates that further study is needed to validate this contrast in information. There is an importance in knowing a child's diagnosis because that will influence the direction of you treatment.

5.3.3 Significant difference between the diagnoses per subscales

The ANOVA analysis indicated the significant difference between the diagnoses. There was no significant difference in Manual Dexterity between diagnoses but the children with speech problems did appears to score on average slightly higher. This can indicate that when assessing a child with a speech problem to focus on their balance motor development. This is evident because the results indicated that there was no significant difference in Aiming and Catching. There was an indication though that the children with processing problems did score significantly lower in Balance than the other conditions. These children may have difficulty processing and coordinating the movement and control when asked to balance. The results did show that the children with ADHD and speech problems did score slightly higher than the children with anxiety problems and processing problems. This can support the reasoning for possible screening of children when diagnosed with anxiety and processing problems for their motor development. The only subscale with a significant p-value was Balance and with the total test score, the children with speech problems diagnosis had the highest score compared to the rest of the conditions. Children with intrinsic barriers to learning need to be screened for motor deficits in development with attention to balance and their particular condition because each condition has shown to have strengths and weaknesses.

5.4 Implications of the study

The children with ADHD scored higher in Aiming and Catching and their lowest score was Balance. The children with anxiety problems scored relatively low for all three components and they were all below ten. The children with processing problems scored the lowest compared to the other conditions with Balance scoring below five. Children with speech problems scored the highest compared to the other conditions with Aiming and Catching being above ten and Manual Dexterity being their lowest score. The common trend in three or

the four conditions that contribute to intrinsic barriers to learning is balance. The data has indicated that Manual Dexterity and Balance are two areas that need to be addressed with an intervention for children with intrinsic barriers to learning. Children with processing problems and anxiety problems are conditions that should be screened and placed in an intervention program to improve their abilities. Children with ADHD and speech problems should be monitored and if possible also placed in an intervention program.

Children are always being assessed for early intervention but to identify a specific component that the child needs attention will individualise and optimise the interventions. Early intervention will assist these children in achieving milestones and may prevent further delay. The uniqueness of this study is linking specific intrinsic barriers to learning to motor deficits.

5.5 Limitations of the study

The study did not use a control group of children with no intrinsic barriers to learning. The study was not able to compare the results to a group of children with no intrinsic barriers to learning. So the researcher cannot apply the results to children from other schools and other areas. These results can only be applied to the participants in this study and cannot be generalised.

5.6 Recommendations for further research

Increase the sample size by identifying more remedial schools in the area; this can include mainstream schools to create a control group. This will increase the validity and reliability of the study. The M-ABC 2 is a tool that is standardised and easy to use that the assessors can be blinded if they just assess the children at their relevant schools. This will increase the reliability of the test and eliminate bias.

Identifying individual components will make referrals to a multi-disciplinary team easier and optimise the child's school and lifestyle experience. Further research needs to be look at for motor deficits in specific intrinsic barriers to learning and possible intervention programmes for each condition.

Chapter 6: Conclusion

This study looked at the motor development of children with intrinsic barriers to learning. These barriers included ADHD, speech problems, anxiety problems and processing problems. The participants were from the north-western suburbs of Johannesburg and attended a private remedial school. The children aged six to seven years old, were assessed using the M-ABC 2. This test assesses the Manual Dexterity, Balance and Aiming and Catching capabilities of the children. The aim of the study was to determine whether children who have intrinsic barriers to learning present with specific motor component deficits. Children were assessed at a single time point using the M-ABC 2

When analysis of the children's demographic information was done, the only significant finding was gender. Under two thirds of the children that had intrinsic barriers to learning were male. Age was not a deciding factor because the children all presented with motor difficulties regardless of age. With regards to the children's conditions, it was found that ADHD was a more prevalent condition in the group and the results did confirm that there was a high correlation between children with ADHD and DCD.

The scores for the children was categorised for their overall score and subscales for each motor skill. The results showed that 37% of the children needed an intervention for their motor skills and 74% of the children did not reach the 50^{th} percentile score. If you had to look only at the Manual Dexterity of the children, 74% of the children did not reach the 50^{th} percentile. For Aiming and Catching 48% did not reach the 50^{th} percentile and for Balance it was 67%. These are values that indicate that all children with intrinsic barriers to learning can benefit from motor assessments and intervention.

The mean sub scale scores showed that Balance was the lowest and Aiming and Catching was the highest. Balance and Manual Dexterity scores were significantly lower than Aiming and Catching. These findings will help to guide a practitioner when assessing a child with an intrinsic barrier to learning and planning appropriate intervention.

The different diagnostic conditions in the study showed a pattern of strengths and weaknesses. Children with ADHD are good at Aiming and Catching but poor with Balance. Children with anxiety problems were weak in all three areas and need to be prioritised for assessment and treatment. Children with processing problems scored the lowest particularly with Balance. The children with speech problems scored the highest overall and Aiming and Catching was their highest score.

Early identification and early intervention may assist in the motor development of children with intrinsic barriers to learning. Educators, therapists and parents need to be made aware of the need for motor screening and possible intervention for all children with learning difficulties.

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Appendix 1: Information document for study

Title: Motor development in six to seven year old children with identified intrinsic barriers to learning: an cross-sectional study.

Dear Parent

Good day and thank you for taking the time to read this letter. My name is Richard Marsh, a qualified Physiotherapist that is doing his Master's degree at Witwatersrand University, and I am conducting a study to determine the motor development of children with intrinsic barriers to learning at the age of six to seven. In the study participants who have a barriers will have a once off assessment of gross motor function. We are only determining the level of the child's motor development and it is not a process to diagnose the child with a condition.

Invitation to participate: We would like to invite your child to participate in our research study.

What is involved in the study: Once you have read the information document, there is a form for consent that will be needed to be signed by the legal guardian. Your child should return this form to school.

You will be notified of the date of the assessment and requested that your child wears their physical education uniform for activity. Each child will enter the evaluation room where there will be an assessor that will conduct the test. The test is the Movement Activity Battery for Children. Your child will be asked to complete some fun, age appropriate activities such as throwing and catching a ball and balancing on one leg. On completion of the assessment your child will have completed the requirements for the study.

Benefits: Through the assessment your child's results will be available to you. Where if there are any shortfalls of motor development you will be aware of them and will be given the appropriate intervention needed.

.

Participation is voluntary: Refusal to participate will not result in penalties or loss of benefits. The child will continue with normal school activities. Parents or children that wish to discontinue participation in the study can do so at any time.

Convenience: There is no charge for the assessment for your child. This is an assessment involved in a study. You will not need to transport your child anywhere the assessor will conduct the assessment at school. Times will be co-ordinated so your child does not miss out on important school work.

Risks: The assessment tool involves movement which with any activity could lead to the child falling or tripping. Otherwise this is a standardised test with no future risks.

Confidentiality: Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed if personal information is needs to be disclosed by law.

Organisations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as Research Ethics Committee and the Medicines Control Council. If results are published, this may lead to the details from the study being used but no names will be disclosed.

Please do not hesitate to contact me or my supervisor should you have any questions about this project.

Kind regards

Contact details of Researchers:

Richard Marsh: 0722380602

Prof J Potterton 011 717 7218

Prof P Cleaton –Jones 011 717 1234 (Chairman of the Human Research Ethics Committee University of the Witwatersrand)

Details are for further information or reporting of study related adverse events.

These details are given to report any complaints/problems that you have.

Appendix 2: Consent form

I, _____, parent of , _____, have read the information document and understand all the relevant information given to me. I understand the risks and benefits of the study and the purpose of the study. I consent that my child will voluntarily participate in the study and I give my written consent for my child's medical information to be utilised in this study.

Participant's name: _____

Parent's name: _____

Parent's signature: _____

Witness' name: _____

Witness' signature: _____

Date: _____

Signed at: _____

Appendix 3: Children assent form

Hi my name is Richard

We are doing a study to learn about children with barriers to learning and to see how good their activity is.

If you agree to be in our study, we are going to ask you to perform some activities. We want you to try your best. The activities that you will be doing, has no right or wrong way of doing them. This will take place at your school.

You can ask questions about the study at any time. If you decide at any time that you would like to stop, you can do so.

If you sign this paper, it means that you have read this and that you want to be in the study. If you do not want to be in the study, do not sign this paper. Being in the study is up to you, and no one will be upset if you do not sign this paper or if you change your mind later.

Your printed name: _____

Your signature: _____

Printed name of person obtaining assent: _____

Signature of person obtaining assent: _____

Date _____

Appendix 4: Movement ABC assessment form

Assessor's name:	
Participant's no.:	
Date:	
Score: **Need to have record of subscale scores, total score as well as percentiles**	
Date of birth:	
Age at assessment:	
Gender:	
Medical history/learning difficulty: **Medication?**	

Item number	**Item score**	**Comments**
1		
2		
3		

4		
5		
6		
7		
8		

Signature of assessor

Appendix 5: Consent from the Principal

Title: Motor development in six to seven year old children with identified intrinsic barriers to learning: an cross-sectional study.

Dear Dr Staples

Good day and thank you for taking the time to read this letter. My name is Richard Marsh, a Witwatersrand University physiotherapy Masters student, and I am conducting a study to determine the motor development of children with intrinsic barriers tolearning at the age of six to seven. In the study participants who have an intrinsic barrier will have a once off assessment of gross motor function. We are only determining the level of the child's motor development and it is not a process to diagnose the child with a condition.

I would like to request permission to conduct this study at your school.

What is involved in the study: Parents will be given an information document explaining the study and requesting that they give consent for their child to participate in this study. The assessments will take place at school at a time suitable to the class teacher. Once the data has been collected, the results will be made available to the parents.

Risks: The assessment tool is for motor function assessment therefore the only risk will be the risk of injury while doing the activity. The Movement Activity Battery for Children assessment is a standardised assessment tool and will not cause future harm to the child.

Benefits: Through the assessment the child's results will be available to the parents.

Participation is voluntary: Refusal to participate will not result in penalties or loss of benefits. The child will continue with their normal school activities. Parents or children that wish to discontinue participation in the study can do so at any time.

Confidentiality: Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed if personal information is needed to be disclosed by law.

Organisations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as Research Ethics Committee and the Medicines Control Council. If results are published, this may lead to individual/ cohort identification.

Please do not hesitate to contact me or my supervisor should you have any questions about this project.

Kind regards

Contact details of Researchers:

Richard Marsh: 0722380602

Prof J Potterton 011 717 7218

Prof P Cleaton –Jones 011 717 1234 (Chairman of the Human Research Ethics Committee University of the Witwatersrand)

Details are for further information or reporting of study related adverse events.

These details are given to report any complaints/problems that you have.

_____ _____

Signature of Researcher Date

I, _____, principal of Newton House School. Give permission for Richard Marsh to conducted his study.

_____ _____

Signature of Principal Date

Appendix 6: Ethical clearance certificate

R14/49 Mr Richard Marsh

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160412

NAME: (Principal Investigator)	Mr Richard Marsh
DEPARTMENT:	Physiotherapy Newton School, Honeydew
PROJECT TITLE:	Motor Development in Six to Seven Year Old Chldren with Learning Difficulties: A Cohort Study
DATE CONSIDERED:	06/05/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Joanne Potterton
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	01/06/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004,10th floor, Senate House/2nd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated,from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review in April and will therefore be due in the month of April each year.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 7: Change of title approval

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

29 June 2016
Person No: 301587
PAG

Mr R Marsh
5
David Street
Florida
1709
South Africa

Dear Mr Marsh

Master of Science in Physiotherapy: Approval of Title

We have pleasure in advising that your proposal entitled *Motor development in six to seven year old children with identified intrinsic barriers to learning* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 8: Plagiarism report

Research report

ORIGINALITY REPORT

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