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## Authors(s)
Morton, Caitriona

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THE EFFECT OF A GROUP MOTOR SKILLS PROGRAMME ON THE PARTICIPATION AND MOVEMENT ABILITY OF CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER

Caitríona Morton, B. Sc. Physio

UCD Student Number: 12255678

The thesis is submitted to University College Dublin in fulfilment of the requirements for the degree of Research Masters

School of Public Health, Physiotherapy and Population Science,
University College Dublin

Head of School: Professor Cecily Kelleher

Head of Subject: Professor Brian Caulfield

Principal Supervisor: Dr. Tara Cusack

Research Masters Panel: Dr. Amanda Connell & Dr. Brona Fullen

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ABSTRACT

Purpose: This study aimed to investigate the levels of change in participation and movement ability in children with Developmental Coordination Disorder (DCD) following attendance at a community-based group motor skills intervention programme.

Relevance: Children with DCD participate and enjoy active hobbies less than their peers (Jarus et al., 2011), and are at risk of overweight and obesity (Rivillis et al., 2011). DCD presents in 6% of school-aged children (American Psychiatric Association, 2000), who are frequently treated in community-based groups (Hung & Pang 2010). The effects of group motor skills interventions on participation are unknown.

Participants: Thirty children aged 7-10 years with DCD, without other physical or intellectual impairment, suitable for group therapy, were recruited from the Health Service Executive (HSE) Dublin South West community area and the Adelaide and Meath Hospital, Tallaght. Ethical permission to undertake this study was gained from University College Dublin (UCD) and the Adelaide and Meath Hospital, Tallaght.

Methods: Participants were randomly allocated into intervention (n=15) or control (n=15) groups and were assessed using the Children’s Assessment of Participation and Enjoyment (CAPE) and the Movement Assessment Battery for Children (MABC). Intervention was a physiotherapist-led group motor skills programme, one hour weekly for 10 weeks.

Analysis: SPSS was used to perform nonparametric testing for between-group (Mann-Whitney U) and within-group analysis (Wilcoxon-signed rank) following intervention. The study was sufficiently powered, with 26 children being required to demonstrate treatment effect.

Results: Following intervention participation intensity improved significantly between groups (p=0.01), and remained significantly improved from baseline at 8 months post intervention (p=0.01) in the intervention group. Motor performance improved significantly between groups (p=0.01) and also remained significantly improved from baseline at 8 months post intervention in the intervention group (p=0.005).

Conclusion: A specific 10 week group motor skills intervention improved participation and motor performance in children with DCD, with results maintained at 8 months.
THESIS CORRECTIONS SIGN OFF FORM

Candidate: Cailtorna Morton
Student No: 12255678
Thesis Title: The Effect of a Group Motor Skills Programme on the Participation and Movement Ability of Children with Developmental Co-ordination Disorder

Degree: Master of Science (MSc)
College: Health Sciences
School: Public Health, Physiotherapy and Population Science

The above candidate has now completed all necessary corrections to his/her thesis and a hardbound copy of the thesis is to be submitted to Assessment, Tierney Building.

Print Name: Catherine Blake

Signed: [Signature]
(Examiner nominated to oversee corrections)

Date: 20th February 2015
STATEMENT OF ORIGINAL AUTHORSHIP

I hereby certify that the submitted work is my own work, was completed while registered as a candidate for the degree stated on the Title Page, and I have not obtained a degree elsewhere on the basis of the research presented in this submitted work.

Signed: ________________________________

Date: ________________________________
1. INTRODUCTION

1.1 Introduction

Developmental Coordination Disorder (DCD) is a disability that affects approximately 6% of school age-children worldwide, according to international estimates (American Psychiatric Association, 1994; Kadesjo & Gillberg 1999). DCD is described in the Diagnostic and Statistical Manual, Fifth Edition (DSM-V) as a motor skill disorder which is characterised by a marked impairment in motor coordination abilities and significantly impacts activities of daily living or academic achievement. While clumsiness in children is not a new phenomenon, the condition of DCD was poorly defined and rarely recognised until the 1990s. DCD is now considered to be one of the major health problems among school-age children worldwide (Magalhães et al., 2011; Cairney et al., 2005; Green et al., 2005; Henderson & Henderson 2002; Polatajko & Cantin 2006).

There are no current prevalence figures for DCD in the Irish population. In Ireland, any parent who believes their child to have a disability is entitled to a multidisciplinary assessment of their child under the Disability Act (2005). This assessment is often required to gain access to services for children such as special needs assistance or therapies. While no data regarding the rate of diagnosis is available in Ireland to date, the Assessment of Need process is likely to have lead to an increase in diagnosis of the condition, due to more parents requesting assessments on behalf of their children. This has likely led to an increase in the number of children with DCD on the caseload of community physiotherapists, as children with DCD are most likely to access therapy in community care services as opposed to acute hospitals. Community care services are public health services provided in the local community by either the Health Service Executive (HSE) or voluntary organisations on behalf of the HSE.

This study was primarily concerned with the participation of children with DCD, as defined by the World Health Organisation (WHO) as the “involvement in life situations” (International Classification of Functioning, Disability, and Health; WHO 2001). This study examined specifically how participation might be increased through the use of a group motor skills intervention programme in the community care setting. This thesis will focus on examining the effects of a group intervention programme on
the participation levels and motor skills (manual dexterity, aiming and catching, and balance) of children with DCD.

In this chapter, an overview of DCD and its diagnostic criteria will be presented. The prevalence and aetiology of the condition will be outlined. The impact of DCD on participation, body composition, and physical activity will be explored. The current evidence in relation to intervention and group treatment in DCD will be summarised.

1.2 Terminology

Many children fail to perform certain developmental motor milestones in comparison to their peers. Tasks such as dressing, tying shoelaces, handwriting, cycling, hopping, skipping, and catching balls become noticeably difficult as a result (Miyahara & Register 2000). The significance of movement difficulty and its implications were first identified in 1937 by Orton, and became apparent in the literature in the 1960s. Between then and the 1990s, many terms were used both clinically and in literature to describe movement difficulty, or clumsiness. While “Developmental Coordination Disorder” is now widely accepted and used to describe movement difficulty under specific circumstances, the lack of consensus with regard to terminology makes research and clinical management of the condition complex.

Some of the historical definitions used to describe the presentation of a child who fails to perform motor tasks at the expected level, are as follows:

- Apraxia (Orton 1937)
- Developmental apraxia and agnosia (Gubbay et al., 1965)
- Sensory integrative dysfunction (Ayres et al., 1972)
- Developmental dyspraxia (Adams 1983)
- Clumsy child syndrome (Adams 1983)
- Perceptual motor dysfunction (Laszlo et al., 1988)
- Developmental coordination disorder (Polatajko et al. 1995)
- Disorder of attention and motor perception (DAMP) (Kadesjo 1999)
- Physical awkwardness (Miyahara & Register 2000)
- Minimal brain dysfunction (Gibbs et al. 2006)
An international consensus meeting was held in Ontario in 1994 in order to work towards improving communication between clinicians and researchers working with children who present with these difficulties. The terminology used to describe these children was also discussed and determined, and a consensus was reached that the term “Developmental Coordination Disorder” (DCD) was acceptable. Diagnostic criteria for DCD was subsequently added to the 3rd edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-III) (American Psychiatric Association, 1994) and remains in the most current edition. However, another major medical classification system does not agree with this terminology. The 10th edition of the International Classification of Diseases (ICD-10) (World Health Organisation 1992) uses the term “specific developmental disorder of motor function”.

According to a systematic review of the terminology used in research reports of DCD by Magalhães et al., (2006), the term DCD is gaining acceptance and is used in over half of all published articles on this topic. In addition, the 1994 London consensus was reaffirmed with the publication of the Leeds Consensus Statement (Sugdon, 2006), which highlighted the agreement of international researchers and clinicians to retain the term DCD as a distinct disorder. The usage still varies between countries, as the term “clumsy child syndrome” is still in general usage in the USA (Krutz 2003) and the acronym DAMP (disorder of attention and motor perception) is used in Scandinavian counties to identify children with attention and motor control deficits (Gilberg et al., 2003).

An added difficulty with terminology also arises within different groups. A number of studies have highlighted the varying perceptions and usages of the terms discussed above in groups of parents, health professionals, and teachers. In the 1990s, parents of children with physical difficulty became empowered as recognition of the disorder became more common. In 1994 the “Dyspraxia Forum” was launched in the UK in order to provide links between families. Today more than 40 local groups exist throughout the UK, Ireland, and Australia. All of these parent groups use the term “dyspraxia” to name the condition of their children (Miyahara et al., 2000). The parent lobby group in the UK, the Dyspraxia Foundation, provides their own broad definition of the term: “An impairment or immaturity of the organisation of movement;
associated with this there may be problems of language, perception and thought” (Dyspraxia Foundation, 1997).

Peters et al., (2000) conducted a survey of 234 adults, 57% of whom were health professionals, where participants were asked to define the terms “Clumsy”, “Dyspraxia”, and “Developmental Coordination Disorder”. The results indicated that the terms dyspraxia and DCD were less familiar to all respondents than “clumsy”. The use of the term “clumsy” however was regarded by respondents as the least acceptable term. The divergence of understanding and differences between professionals in relation to terminology was emphasised. A similar finding was documented in a study by Miyahara & Register (2000), where 125 health professionals, parents, and teachers completed a semantic differential ratings scale for 3 terms: “Developmental Dyspraxia”, “Developmental Coordination Disorder”, and “Clumsy Child Syndrome”. The latter term was regarded as the least favourable and most insensitive term, but overall most respondents perceived the 3 terms very differently. Gibbs et al., (2006) argues that the definition of DCD is very similar to that of dyspraxia, and regards the two as synonymous. The two terms are often used interchangeably, however Baxter (2012) argues that motor dyspraxia is a symptom and that DCD is only one of many possible causes.

In 2012 the European Academy for Childhood Disability (EACD) published recommendations on definition, diagnosis, and management of motor clumsiness (Blank et al., 2012). The definition of DCD was subject to extensive international research and consensus by an expert panel. The group stated that the DSM-IV criteria of the condition are better defined than those of the ICD-10, and therefore are the most suitable set of diagnostic criteria that are currently available to clinicians. The DSM is also designed to be neutral with respect to causality and has hence gained acceptance amongst both researchers and clinicians (Wilson, 2005). The authors state that the term developmental coordination disorder (DCD) should be used to refer to children with developmental motor problems in countries which adhere to the DSM-IV-TR classification. In countries where ICD-10 has legal status, the term specific developmental disorder of motor functions (SDDMF) (F82, ICD-10) should be used.
In summary, it is clear that the terminology in this field presents a challenge both clinically and academically. Despite the use of DCD by most clinicians, many terms are still used interchangeably by parents, teachers, and health professionals to describe physical or movement difficulty. Based on the wide acceptance of the term clinically and in the literature, in addition to the recommendations of the research of the EACD (Blank et al., 2012), the term “Developmental Coordination Disorder” (DCD) was adopted for use in this study.

1.3 Diagnostic Criteria for DCD & Presentation

DCD according to the 5th edition of the Diagnostic and Statistical Manual (2013) is defined by the following four criteria:

A. The acquisition and execution of coordinated motor skills is substantially below that expected given the individual’s chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness (e.g., dropping or bumping into objects) as well as slowness and inaccuracy of performance of motor skills (e.g., catching an object, using scissors or cutlery, handwriting, riding a bike, or participating in sports).

B. The motor skills deficit in Criterion A significantly and persistently interferes with activities of daily living appropriate to chronological age (e.g., self-care and self-maintenance) and impacts academic/school productivity, prevocational and vocational activities, leisure, and play.

C. Onset of symptoms is in the early developmental period.

D. The motor skills deficits are not better explained by intellectual disability (intellectual developmental disorder) or visual impairment and are not attributable to a neurological condition affecting movement (e.g., cerebral palsy, muscular dystrophy, degenerative disorder).
This study is concerned with children who according to the above criteria have a lower than expected motor performance that interferes with daily life. The motor difficulty is not due to a medical or neurological condition, as is stated in criterion D. Children with DCD will often initially manifest motor deficits in virtually every motor domain (Summers et al., 2008) and tend to work at a slower pace than their typically developing peers (Missiuna & Pollack, 1995; Schoemaker et al., 2001). The types of difficulties experienced by children with DCD have been well documented (Summers et al., 2008; Mandich et al., 2003; Missiuna et al., 2007; Rosenblum, 2006), and often include many self care challenges such as dressing, fastening button or zips, tying shoelaces, using utensils, and toileting. School-related tasks that often present difficulty include handwriting or drawing, copying, painting, using scissors, organising, and finishing work on time (Zwicker et al., 2012). Often depending on age, gender, and culture, difficulties may present in elements of physical education or play, with tasks such as running, hopping, jumping, throwing, catching, or playing sports often presenting challenges. Riding a bike or scooter often presents a challenge. Despite having an average or above intelligence, children with DCD have poorer school outcomes than their peers (Cantell et al., 1994; Cantell et al., 2003).

In addition to the above motor and functional difficulties, children with DCD are also at greater risk for being bullied, and have been found to suffer from higher levels of depression than typically developing peers (Campbell & Missiuna 2012). A population based study has demonstrated that children with DCD are at an increased risk of social and psychological distress (Campbell & Missiuna 2012). Before the completion of longitudinal studies of children with DCD, it was previously thought that children simply grew out of their motor difficulties (Fox et al., 1996; Sellers et al., 1995). It is now known however that motor problems can exist into adolescence (Cantel et al., 2003) and adulthood (Cousins et al., 2003), and also that the presentation in adulthood extends beyond motor difficulty. Secondary mental health, emotional, and behavioural issues are reportedly present in the longer-term (Missiuna et al., 2009; Missiuna et al., 2007; Green et al., 2006). The effect of DCD on physical activity, participation, and body composition will be outlined further in this chapter.
It has been suggested that the labelling of a child with DCD constitutes “inappropriate medicalisation” (Gibbs et al., 2006), and that while an agreed diagnosis could lead to services and treatments, a label on developing children could affect self-perception and the expectation of parents and teachers (Miyahara & Register, 2000). The issue of labelling physical awkwardness is often debated in the literature (Gibbs et al., 2006), but many parents anecdotally report the greater access to services following diagnosis. While the DSM-IV criteria exist for DCD, the assessment process often varies, and can be undertaken by a number of professionals.

Under the criteria in the DSM-V, the issue of what constitutes a “motor skills deficit” is uncertain, as no cut-off criterion is defined. To this end, the EACD guidelines (Blank et al., 2012) recommend that motor performance must be assessed using a motor test, and that diagnosis should be made by a professional qualified to examine specific criteria. The 2nd edition of the Movement Assessment Battery for Children (MABC) is frequently used to assess the motor skills of children, as the level of evidence for the quality and suitability of this measure to diagnose DCD is moderate to good (Blank et al., 2012).

The complete assessment should also reflect culturally relevant developmental norms. DCD would not typically be diagnosed before the age of 5 (Blank et al., 2012), as problems exist with assessing children of this age. The rate of acquisition of activities of daily living is also variable for children of this age, and the cooperation and motivation of young children during motor assessments can be variable.

In summary, the impaired motor skills of children with DCD as outlined above have an impact on daily life (Summers et al., 2003), and can persist into adulthood. The potential impact on social and psychological domains also has an impact on the life of children with DCD (Campbell & Missiuna 2012). This study, while primarily concerned with participation patterns of children with DCD, also sought to examine the effects of a group motor skills intervention programme on the motor ability of the children.

1.4 Prevalence of DCD

The prevalence of DCD varies within populations, as reported in the literature. There are currently no prevalence figures available for the Irish population. Estimates in
different populations can range from 1.4-19% (Lingam et al., 2009; Wright & Sugden, 1996; Tsiotra et al., 2006). It is widely recognised that the large variance in this figure is due to the difficulties with terminology as discussed previously, and also due to varying assessment and diagnostic criteria (Zwicker et al., 2012). The most commonly reported prevalence is 5-6% of school age children (American Psychiatric Association, 2000). High prevalence has been reported in Greece, at 19% (Tsiotra, 2006), but this may be due to poor application of all 4 diagnostic criteria, which may either misidentify normal children as having DCD, or misidentify other physical disabilities as being DCD. Conversely, the true prevalence of DCD may be underrepresented due to lack of awareness of the disorder. Awareness of the condition amongst physicians in Canada was demonstrated to be as low as 9% (Gaines et al., 2008), which could lead to under-diagnosis of the condition.

DCD has been found to have a higher prevalence amongst boys, with a male to female ratio of between 2:1 and 7:1 (DSM-V, 2013). Children born prematurely or with low birth weights are also at an increased risk of developing DCD (Bowens, 1999; Holsti et al., 2002). Between 12.5-50% of preterm infants reportedly have motor impairments consistent with DCD (Davis et al., 2007). DCD also frequently co-occurs with other disorders, such as attention deficit hyperactivity disorder (ADHD), learning disabilities, and speech and language impairments. Studies have also shown that more than 50% of children with dyslexia showed definite motor coordination difficulties (Iversen et al., 2005).

1.5 Aetiology

The aetiology of DCD is largely unknown, and many theories exist as to the exact underlying mechanism. The patterns of symptoms, progress, and co-morbidities vary, which makes defining aetiology difficult. It has been documented that DCD is related to central nervous system pathology (American Psychiatric Association, 2000). It has been suggested that due to the overlapping nature of DCD with other developmental disorders, diffuse areas of the brain may be involved (Kaplan et al., 1998), with disruption of brain development causing the disorders.

Two possible mechanisms underlying the disorder have been hypothesised (Zwicker et al., 2012). The automatisation deficit hypothesis suggested that children with DCD have difficulty making motor skills automatic (Fawcett, 1992), suggesting the
involvement of the cerebellum. The internal modelling deficit hypothesis also suggests cerebellar involvement (Kageger et al., 2004). Successful motor control is thought to result from an internal model that accurately predicts the sensory consequences of motor command (Krakauer & Shadmehr, 2007), with motor difficulty resulting from a mismatch in cerebellar motor signals. While the exact mechanism underlying DCD is unknown, many theories have implicated some level of cerebellar involvement (Canten et al., 2007; Zwicker et al., 2009). Zwicker et al., (2012) compared the integrity of motor, sensory and cerebellar pathways in the brains of children with DCD to children without DCD. It was found that children with DCD exhibited significantly lower mean diffusivity of the posterior corticospinal tract and posterior thalamic radiation when compared to controls. The authors concluded that altered microstructural development of sensory and motor pathways may be implicated in DCD.

1.6 Participation of Children with DCD

The International Classification of Functioning, Disability, and Health introduced by the World Health Organization (WHO) in 2001 provides a framework for classification at three levels: body function and structure (impairment), activity (activity limitations), and participation (participation restrictions). The model is based on the idea that impairments at the level of body structure or function influence a person’s ability to carry out activities and participate in everyday life. Participation is defined as “involvement in life situations” (International Classification of Functioning, Disability, and Health; WHO 2001), and is integral to normal childhood development. The WHO (2001) makes a distinction between participation and activity; activity simply being the execution of tasks. Participation plays an important role in the development of children’s social relationships and skills, and has an influence over long-term physical and mental health (Law et al., 2004). Participation enables children to explore their social, intellectual, emotional, and physical potential, and it is also an important predictor or future life satisfaction (Kinney et al., 1992). Several factors influence the participation of children, including their abilities, physical and social environments.

Children with disabilities are known to participate less than their peers (Bult et al., 2011). Previous research has found that in childhood disability, there is less variation in activities, with fewer social activities, and more time spent alone or on informal
activities (Law et al., 2006). It is also well documented that children with movement difficulty or DCD specifically, participate in fewer activities than typically their developing peers (Fong et al., 2011; Jarus et al., 2011).

Jarus et al., (2011) compared 25 children aged 5-7 with DCD to 25 children without DCD, and reported the DCD group participated in fewer physical, skill-based, informal, and total activities. Fong et al., (2011) reported a significant association between motor impairment and participation diversity deficit. The authors found that participation intensity in children with DCD was lower than typically developing peers. This indicates that while all children have access to the same range of activities, children with DCD will have lower participation intensity in all types of activity. It has been hypothesised that children with less efficient movement patterns expend more energy during activities, and may fatigue faster (Wrotniak et al., 2006).

Both Jarus et al., (2011) and Fong et al., (2011) concluded that there is a significant relationship between movement ability and participation, but it must also be considered that many other factors influence participation. Fong et al., (2011) reported a significant relationship between weight status and participation, and concluded that being overweight or obese may make it more difficult for children with DCD to participate in activities, due to reduced physical fitness and the social stigma associated with obesity (Puhl & Latner, 2007). Children with DCD typically have a more sedentary pattern than their peers (Mandich et al., 2003). Soref et al., (2011) confirmed that socio-economic status influenced the diversity of child participation, and it is important to take the age of the child with DCD into account when considering participation. At a young age, children depend on their parents in setting their daily routine, and thus their diversity and frequency of participation (Liberman et al., 2012).

In summary, it is clear that participation is vital for overall development, and must be a consideration in management of the child with DCD. It has been demonstrated that parents, children and professionals consider enhanced participation in leisure activities to be one of the most important outcomes of intervention in children with disabilities (Vargus-Adams & Martin, 2010). Limited participation from a young age may be associated with emotional or psychological problems (Liberman et al., 2012), and it has been suggested that treatment of children with DCD should focus on the
level of participation or the child, rather than focused on remediating impairment (Mandich et al., 2003). As little is currently known about how best to impact participation levels in this client group, this study sought to evaluate the effectiveness of a specific intervention programme on participation levels in children with DCD.

1.7 Physical Activity, Fitness, and Body Composition in Children with DCD

In addition to low overall participation, children with DCD are less likely than their peers to take part in vigorous, active play (Rivillis et al., 2011). Being less physically active than others (Bouffard et al., 1996), causes children with DCD to have poor health related fitness in general (Faught et al., 2005). In one popular model, this relation is characterized as a negative feedback loop: poor motor functioning leads to decreased activity, which leads to a failure to develop motor skills and to poor fitness, both of which may further discourage physical activity (Hands et al., 2002). As children with DCD grow to adulthood, they are at greater risk of developing cardiovascular disease, when compared to normally developing peers (Beutum et al., 2013).

A systematic review of physical activity and fitness in children with DCD carried out by Rivillis et al., (2011) demonstrated that motor competence plays an important part in fitness and physical activity outcomes. The literature available (Cairney et al., 2007; Faught et al., 2005; Schott et al., 2007) demonstrates that body composition, cardio respiratory fitness, muscle strength and endurance, anaerobic capacity, power, and physical activity have all been negatively associated, to various degrees, with poor motor proficiency. Performance levels in fitness components are significantly lower in children with DCD (Hands et al., 2006). Schott et al., (2007) reported 37% of children with DCD to be overweight or obese. It is debatable whether it is more important to measure children’s participation in physical activity or their level of physical fitness (Angilley & Haggas, 2009); however it is clear that management of this client group is made more challenging by existing low levels of aerobic fitness.

1.8 Evidence for Treatment Approaches in DCD

Due to the fact that little is known about the exact aetiology of DCD, treatments have been driven by competing theories of motor development and motor skill acquisition
A systematic review of intervention for children with DCD by Mandich et al. (2001) concluded that there is sufficient evidence of good quality to confirm that intervention in general is better than nothing in children with DCD. Interventions in DCD broadly fall into two categories: deficit-orientated or task-orientated approaches.

Deficit-orientated approaches were developed in the ‘60s and ‘70s, and are rooted in the mechanistic thinking of that time (Polatajko et al., 2005). This approach aims to target the underlying deficits of the child, thus resulting in improved task performance. Examples of deficit-orientated approaches include sensory integration therapy, sensorimotor-orientated treatment, and process-orientated treatment (Zwicker et al., 2012). This theory assumes that motor difficulties are a result of faults in underlying sensory, motor, or sensory integration systems, and the goal of this approach is to repair “impaired” systems, often through the practise of primitive skills that the child may not have developed to the expected level. These approaches are reported to be outdated and have inconclusive evidence for effectiveness (Zwicker et al., 2012). All require very intensive and long-term treatment (Polatajko et al., 2005).

Task-orientated approaches, on the other hand, are grounded in theories of motor control and motor learning, and focus on the teaching of functional skills (Schmidt 2005). Intervention is focused on task performance, with the interaction between the person, task, and environment being paramount (Mulder, 1991; Schmidt, 1988). Examples include task-specific intervention (Revie et al., 1993), neuromotor task training (Schoemaker et al., 2003; Niemeijer et al., 2007), and Cognitive Orientation to daily Occupational Performance (CO-OP) training (Miller et al., 2001; Polatajko et al., 2001). A task-orientated approach could be, for example, the repetitive practise of a specific task or game, such as throwing and catching a tennis ball, or pedalling a bike. The evidence for task-orientated interventions is more promising (Sugdon, 2007; Missiuna et al., 2006), but no single approach has been fully validated in the literature.

A small number of published reviews, summarised in Table 1.1, examine the evidence for intervention approaches in DCD. Sugdon (2007) published a review of intervention approaches in children with DCD, and highlighted the dearth of high quality research in this area compared to other disabilities. The author concluded that
there is no definitive evidence for intervention in DCD, but suggested principles and guidelines to support functional intervention based on the available evidence:

- The child must be active in choosing interventions and their own treatment goals, as there can be differences between child goals and parent goals (Dunford, 2005).
- The priority of treatment should be on functional activities that are relevant to daily living.
- Activities should be taught as specific skills and with a view to generalization, for example, teaching riding a bike in component parts as well as introducing problem-solving activities and encouraging the child to search for similarities in other situations (Henderson & Sugdon 1992).
- When teaching children with DCD, the amount and type of instructions and demonstrations and the different types of practices and the nature of the feedback can all be varied according to where the child is in the learning process.
- Intervention should be accommodated within the family routine.
- Parents, teachers, and other health professionals should be included where possible.

Wilson (2005) argued in a review of assessment and treatment approaches in children with DCD that examining brain activity using a cognitive neuroscientific approach might help to improve understanding of motor learning in children with DCD. Considering the principles of neuroplasticity, it is possible that children with DCD can demonstrate improved motor skill and permanent change in association with motor learning training (Schmidt, 2005; Kleim et al. 2008). It is currently unknown what type and frequency of training is required to induce a change in neuroplasticity. It has been proposed that functional MRI and diffusion tensor imaging (DTI) can further the evidence base in managing this client group.
A survey of Canadian therapists (Mandich et al., 1999) suggested that a combination of the two previously outlined approaches is used, and that therapists choose approaches based on the child’s needs. DCD is a heterogeneous condition, and no single approach works for all children (Mandich et al., 2001). It is widely accepted that functional or task-specific training has more evidence than a bottom-up approach of intervention, and since the 1990s has appeared more in the literature. While a combination of approaches is often used, task-orientated training is likely more popular, and is the least time consuming of the two approaches (Polatajko et al., 2005). The key findings of 3 reviews in this area are summarised in Table 1.1.

In summary, while there is a dearth of high quality research in the area of intervention in DCD, the evidence for functional, task-specific training is most promising. The recommendations made by Sugdon (2007) as outlined above were taken into consideration during the design of this study’s intervention, which was functional and relevant to activities of daily living.
## Table 1.1 Reviews of intervention approaches in DCD and summary of their key findings

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Key Findings</th>
</tr>
</thead>
</table>
2. Data for sensory integrative therapy and perceptual-motor therapy suggests they have little impact compared to other interventions |
| Sugdon (2007) | “Current Approaches to Intervention in Children with Developmental Coordination Disorder” | 1. There is a dearth of high quality, independently conducted evaluations of interventions in DCD compared to the literature in other areas of disability  
2. Limited evidence exists for sensory integrative therapy  
3. There is insufficient evidence for a comprehensive guide to intervention in DCD |
2. Perceptual-motor therapy and sensory integration therapy were most frequently investigated and demonstrated some positive effects, but were poorly defined in the literature and cannot be recommended over task-based training. |
1.9 Evidence for Group Treatment in DCD

A meta-analysis conducted by Pless & Carlsson (2000) reported that one to one intervention in DCD was most commonly reported in the literature, but yielded the lowest effects when compared to intervention in a small group or to a home programme. The authors reported sufficient evidence to support motor skill training for children with DCD in a group setting. With increased financial pressures on services along with growing waiting lists, group-based training may be an appealing approach (Hung & Pang, 2010). Lengthy waiting lists have grown as a result of increased awareness of the problem, and due to the medical treatment model of many therapies that provides 1:1 therapy as opposed to group intervention to patients (Peters & Wright 1999). Group based therapy has been demonstrated to be effective and more favourable than individual therapy in other areas of disability, for example in cerebral palsy (Bumin et al., 2001) and in obesity (deMello et al., 2004). These studies have demonstrated that the group setting may provide additional social benefits and improved interaction for children.

In DCD, there are few randomized controlled trials that have examined the effects of group based motor skill training (Pless et al., 2000; Peens et al., 2007; Hung & Pang, 2010). A systematic review on the effects of group treatment on motor skills and participation was conducted as part of this study and will be discussed in Chapter 2. An early pilot study by Peters & Wright in 1999 described the development of a specific group intervention for children with DCD. Fourteen subjects age 7-8 were recruited and completed a 10 week programme of motor skills intervention. Improvement in motor ability was achieved in 12 of the 14 participants following the programme, and group dynamics were reported as being successful in facilitating the children's motivation to succeed. The authors observed that group therapy provided a range of psychosocial benefits for the children and their families. A weakness of this pilot study however was the small number of participants and the absence of a control group.

In a younger group of children with DCD, Pless et al., (2000) demonstrated that children in a group motor skills programme improved more than a control group. Seventeen children aged 5-6 with DCD were compared to 20 children with DCD in a no-intervention control group. The intervention was conducted once a week for 10
weeks and both groups improved their motor abilities. The authors added that the group programme was more suited to children with mild motor deficits, but not those with severe motor problems, as it was observed that those with milder deficits demonstrated a more significant improvement.

A third study by Peens et al., (2008) added to the body of evidence for group motor skill intervention, demonstrating that children aged 7-9 with DCD improved motor ability when compared to a control group after attending an 8 week programme (twice weekly) that combined task-specific and sensory integration treatment approaches. The self-concept of children with DCD improved following a combined psycho-motor intervention.

Finally, the most recent study, conducted by Hung & Pang (2010), demonstrated that motor training in a group setting had the same efficacy as individual therapy, in a randomized controlled trial involving 23 children with DCD. The motor training was a multi-dimensional exercise programme, delivered over 8 weeks, with one session each week. There was an improvement in motor performance in both groups, with no statistically significant difference between them. However, similarly to Peters & Wright (1999), the authors noted additional benefits to group therapy. The group setting was found to provide more opportunity for social interaction, motivated children to compete with each other, and contribute to a stronger sense of competence from successful performance in front of peers.

The available evidence from the current literature suggests that group motor skill training is a promising treatment option for many children with DCD; producing similar gains in motor performance compared to individual therapy, as well as added social benefit. Another benefit of group therapy is the associated cost and time saving (Hung & Pang 2010). The evidence in this area is further examined in a systematic review conducted as part of this study, which is outlined in Chapter 2.

1.10 Conclusion

Children with DCD represent approximately 5-6% of school age children (American Psychiatric Association, 2000), and have lower than average motor skills which impacts upon daily life (Summer et al., 2008). Children with DCD also demonstrate psychological distress as a result of their motor difficulties (Campbell & Missiuna
Children with DCD participate less than their typically developing peers (Fong et al., 2011; Jarus et al., 2011; Magalhães et al., 2011; Bart et al., 2011), are more likely to suffer from poor aerobic fitness (Rivillis et al., 2011), and are more likely to be overweight or obese than their peers (Schott et al., 2007). These difficulties are known to potentially continue into adulthood (Cousins et al., 2003), and together comprise the risk factors for potentially developing cardiovascular disease in adulthood (Beutum et al., 2013).

There is favourable evidence for the use of group motor skills training in the management of children with DCD, with physical gains often seen as a result (Peters & Wright, 1999; Hung & Pang 2010). This will be explored further in Chapter 2. Few interventions however examine the change in participation following intervention (Magalhães et al., 2011). Improved understanding of the participation of children with DCD in everyday activities, and how it might be improved by intervention is essential (Magalhães et al., 2011). Interventions early in life that effectively promote participation could provide considerable lifetime gains for children and their families, and, through preventing ill health, could bring cost savings to the health service and society more broadly (Kohlemeinen et al., 2011). With the popularity of group based physiotherapy group intervention in the community growing; there is a need for further evidence in this area. A trial examining the effects of group therapy on participation is necessary to guide the practise and intervention in this patient group.
2. SYSTEMATIC REVIEW & META-ANALYSIS

“The evidence for group motor skill intervention on the participation and movement ability of children with Developmental Coordination Disorder”

2.1 Introduction

A systematic review and meta-analysis of the effects of group motor skill interventions in Developmental Coordination Disorder (DCD) were conducted as part of this study and will be presented in this chapter. The aim of the review will be stated. The methods, search strategy, and article review procedure will be outlined. The results of the review will be presented in both flow chart and table format. The statistical analysis used in the meta-analysis will be described and results will be presented in table format. The results and implications of the findings will be discussed.

2.2 Aim of Systematic Review & Meta-Analysis

As outlined in chapter one, there are a small number of published review articles that have examined the evidence for intervention in children with DCD (Hillier, 2007; Wilson, 2005; Sugdon, 2007). To date, there has been no systematic review or meta-analysis specifically examining the effects of group motor skills intervention in children with DCD. The aim of this review and meta-analysis was to systematically identify all group-based motor skills intervention research and to identify the quality of evidence for their effectiveness with respect to both movement ability and participation.

2.3 Methods of Systematic Review

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) standardized reporting guidelines were followed to standardize this review (Moher et al., 2009).

2.3.1 Inclusion Criteria

All study types were included, and no limit was set on date of publication. The inclusion criteria for articles were based on the PICO (population, intervention, comparison, and outcome) design (Richardson et al., 1995).
• Population: children (age 0 to 12) with developmental coordination disorder (or allied terms)

• Intervention: group motor skill training or group exercise therapy

• Comparison: studies comparing two or more arms, with one focused on motor skills groups or exercise groups’ impact on participation levels and/or motor ability

• Outcome: participation and/or movement ability

2.3.2 Exclusion Criteria

Articles were excluded if they did not involve some element of motor skill training that was delivered in group format. Articles not published in English were excluded.

2.3.3 Search Strategy

A systematic literature search was conducted using the following 7 online databases: PsycINFO, CINAHL, Biosis, PEDro, Embase, PubMed, and the Cochrane Collaboration. The search was conducted as per the requirements of each database using terms commonly used in research reports concerning children with DCD. The following keywords were used:

(motor skills OR training OR exercise OR exercises OR exercising OR physiotherapy OR therapy) AND (group OR groups OR class OR classes) AND (participation OR participating OR participated OR participate) AND (children OR youth) AND (developmental coordination disorder OR dyspraxia OR clumsy OR clumsiness OR incoordination OR motor impairment OR motor skills disorder OR minimal brain dysfunction OR motor delay OR minor neurological dysfunction OR perceptual motor difficulties OR movement disorder OR sensory integration OR sensory integrative disorder OR sensorimotor difficulties OR physically awkward) AND (movement ability OR movement skills OR motor impairment OR movement difficulty).

In addition to the online search, the reference lists of all retrieved articles were also searched for further studies to identify additional relevant articles and to minimise search bias.
2.3.4 Study Selection & Methodological Quality Assessment

The initial search yielded titles and abstracts of articles. Titles were screened and articles that did not meet the inclusion criteria based on their title were excluded. The remaining abstracts were read by two reviewers and those that appeared to meet the criteria were included. These articles were read in full by one reviewer, and those that did not meet the inclusion criteria were excluded. For articles that involved a clinical trial, methodological quality was evaluated by one reviewer using the Cochrane Risk of Bias tool (Higgins et al., 2011). A study was considered to have a low risk of bias if all of the criteria in the tool were met. The internal and external validity of studies was assessed using the Physiotherapy Evidence Database (PEDro) Scale. The PEDro scale includes 11 items, which are scored 0 or 1, resulting in a maximum total score of 11. This tool is valid and reliable (Maher et al., 2003), and studies scoring 7 or more are considered to be of moderate to high methodological quality.

2.4 Results of Systematic Review

2.4.1 Article Selection

The search yielded 488 article titles. Three hundred and four were excluded based on title, leaving 86 remaining abstracts. Twenty-three studies remained after reading abstracts, and 13 articles remained after reading the full texts. The result of the searches is displayed in the PRISMA flow diagram (Moher et al., 2009) in Figure 2.1.
Figure 2.1: PRISMA flow diagram displaying the result of literature search and screening for eligibility

- Records identified through database searching (n = 483)
- Additional records identified through other sources (n = 5)
- Records after duplicates removed (n = 390)
  - Titles screened (n = 390)
    - Eliminated based on title (n = 304)
    - Abstracts read by 2 reviewers (n = 86)
      - Eliminated based on abstract (n = 63)
      - Full text read (n = 23)
        - Articles excluded and reasons
          - Reporting results from same population (n = 1)
          - Not group intervention (n = 4)
          - Intervention did not meet inclusion criteria (n = 5)
- Articles included for review (n = 13)
2.4.2 Study Characteristics

The study characteristics are summarised in Table 2.1. Of the 13 articles included in the review, 9 were randomized or quasi-randomized controlled trials, and are presented in Table 2.2. One article (Kane et al., 2011) involved a series of case studies of children who attended a group core exercise programme. Three articles (Dunford et al., 2011; Peters & Wright 1999; Klein et al., 2008) involved “repeated measures” study designs, with no control group. All 13 studies included populations of children with DCD, with ages ranging from 6 to 12 years. The number of participants in the studies ranged from 3 to 58.

2.4.3 Methodological Quality

The PEDro scale scores and Cochrane Risk of Bias scores of the 9 clinical trials included in the review are displayed in Table 2.2. According to the Cochrane Risk of Bias tool, only one study (Fong et al., 2012) was low risk. The PEDro scale scores ranged from 6-10, with 8 of the articles scoring above 7 points on the scale, thus considered to be of moderate to high methodological quality (Jelsma et al., 2014; Fong et al., 2012; Tsai et al., 2009; Tsai et al., 2012; Hung & Pang 2010; Hillier et al., 2010; Sugdon & Chambers 2000; Pless et al., 2000). The 4 non-clinical trials were of variable methodological quality. Kane et al., (2011) used standardised outcome measures and the authors give a detailed description of the group intervention and home programme used. However, the 3 children in the study each attended only 50% of the group programme and had poor compliance with the home programme described. While Dunford et al., (2011) used standardised outcome measures to evaluate the group programme, the sample size of 8 children meant that the study was underpowered and therefore the results of this study were difficult to compare to others. Similarly, Klein et al., 2008 had only 6 subjects in their study which involved only a 2 week intervention of typing skills. Standardised outcome measures were not used in this study and no statistical analysis was conducted. Peters & Wright (1999) was a study of good methodological quality, using standardised outcome measures, and a well described intervention. The only limitation of this study was the lack of a control group which the authors acknowledge as a barrier to the application of the study results.
<table>
<thead>
<tr>
<th>Author, Year &amp; Study Type</th>
<th>No. &amp; Age Range of Subjects</th>
<th>Intervention Type</th>
<th>Duration &amp; Frequency</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jelsma et al 2014 RCT</td>
<td>28 (6-12y)</td>
<td>Group Wii training</td>
<td>6 weeks, 30min sessions x 3 a week</td>
<td>MABC, BOT2, WBB, Enjoyment Scale</td>
<td>Significant improvement in MABC, BOT2, WBB compared to control. Enjoyment was reported.</td>
</tr>
<tr>
<td>Fong et al 2012 RCT</td>
<td>44 (6-9y)</td>
<td>Taekwondo classes</td>
<td>12 weeks, 12 x 1 hour sessions</td>
<td>SOT, UST</td>
<td>Significant improvement in SOT and UST compared to control group.</td>
</tr>
<tr>
<td>Tsai et al 2012 RCT</td>
<td>51 (9-10y)</td>
<td>Group soccer training</td>
<td>10 weeks, 50mins x 5 times a week</td>
<td>MABC, Visuospatial test</td>
<td>Significant improvement in MABC compared to control. Significant improvement in visuospatial test compared to control.</td>
</tr>
<tr>
<td>Dunford 2011 Repeated Measures Design</td>
<td>8 (7-11y)</td>
<td>Group practise of functional skills</td>
<td>2 weeks, 8 x 50min sessions</td>
<td>MABC, COPM, Harter’s Scale</td>
<td>Significant improvement in COPM and MABC. No control group.</td>
</tr>
<tr>
<td>Kane et al 2011 Repeated Measures Design</td>
<td>3 (9-13y)</td>
<td>Group core exercise</td>
<td>6 weeks, 2 hours a week</td>
<td>DCDQ, BOTMP-SF, CSAPPA</td>
<td>Case Studies only.</td>
</tr>
<tr>
<td>Hung &amp; Pang 2010 RCT</td>
<td>23 (6-10y)</td>
<td>Group gross motor skills</td>
<td>8 weeks, 8 x 45min sessions</td>
<td>MABC, Parental Satisfaction Questionnaire</td>
<td>Significant within-group improvement in MABC. No change compared to control</td>
</tr>
<tr>
<td>Hillier et al 2010 Quasi RCT</td>
<td>13 (5-8y)</td>
<td>Aquatic therapy group</td>
<td>6 weeks, 6 x 30min sessions</td>
<td>MABC Questionnaire</td>
<td>No significant changes in measures.</td>
</tr>
<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Intervention</td>
<td>Duration</td>
<td>Outcomes</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
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</tr>
</tbody>
</table>
| Tsai et al 2009 RCT   | 43 (9-10y)  | Table tennis classes              | 10 weeks, 3 hours a week | MABC Visuospatial test  
|                       |             |                                   |                     | Significant improvement in MABC compared to control.  
|                       |             |                                   |                     | Significant improvement in visuospatial test compared to control. |
| Peens et al 2008 RCT  | 58 (7-9y)   | Group gross and fine motor skills | 8 weeks, 8 x 30min sessions | TSCS-CF CAS MABC  
|                       |             |                                   |                     | Significant improvement in MABC compared to controls. |
| Klein et al 2008      | 6 (7-10y)   | Group computer skills             | 2 weeks, 10 x 1 hour sessions | Touch Keyboarding Speed  
| Repeated Measures     |             |                                   |                     | No statistical analysis. |
| Design                |             |                                   |                     |                                               |
| Sugdon & Chambers 2003 RCT | 31 (7-9y) | Group functional skill practise   | 40 weeks, 20min sessions x 3 a week | MABC  
|                       |             |                                   |                     | Significant improvement in MABC compared to control. |
| Pless et al 2000 RCT  | 37 (5-6y)   | Group gross motor skills          | 10 weeks, 10 x 1 hour sessions | MABC  
|                       |             |                                   |                     | No significant change in MABC compared to control group. |
| Peters & Wright 1999  | 14 (7-8y)   | Group programme of skills         | 10 weeks, 10 x 1 hour sessions | MABC Perceived Competence Scale FVC  
| Repeated Measures     |             |                                   |                     | Significant within-group improvement in MABC and FVC.  
| Design                |             |                                   |                     | No control group. |
### Table 2.1b: List of abbreviations from articles reviewed

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MABC</td>
<td>Movement Assessment Battery for Children</td>
</tr>
<tr>
<td>TSCS-CF</td>
<td>The Tennessee Self-Concept Scale -Child Form</td>
</tr>
<tr>
<td>CAS</td>
<td>Child Anxiety Scale</td>
</tr>
<tr>
<td>FVC</td>
<td>Forced Vital Capacity</td>
</tr>
<tr>
<td>COPM</td>
<td>Canadian Occupational Therapy Measure</td>
</tr>
<tr>
<td>SOT</td>
<td>Sensory Organisation Test</td>
</tr>
<tr>
<td>UST</td>
<td>Unilateral Stance Test</td>
</tr>
<tr>
<td>PSPCSA</td>
<td>Pictorial Scale of Perceived Competence and Social Acceptance</td>
</tr>
<tr>
<td>DCD-Q</td>
<td>Developmental Coordination Disorder Questionnaire</td>
</tr>
<tr>
<td>BOTMP-SF</td>
<td>Bruininks-Oseretsky Test of Motor Proficiency – Short Form</td>
</tr>
<tr>
<td>CSAPPA</td>
<td>Children’s Self-Perceptions of Adequacy in and Predilection for Physical Activity</td>
</tr>
<tr>
<td>BOT2</td>
<td>Bruininks-Oseretsky Test of Motor Proficiency Second Edition</td>
</tr>
<tr>
<td>WBB</td>
<td>Wii Balance Board</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Selection</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Jelsma et al 2014</td>
<td>Unclear</td>
</tr>
<tr>
<td>Fong et al 2012</td>
<td>Low Risk</td>
</tr>
<tr>
<td>Tsai et al 2012</td>
<td>High Risk</td>
</tr>
<tr>
<td>Hung &amp; Pang 2010</td>
<td>Low Risk</td>
</tr>
<tr>
<td>Hillier et al 2010</td>
<td>Low Risk</td>
</tr>
<tr>
<td>Tsai et al 2009</td>
<td>High Risk</td>
</tr>
<tr>
<td>Peens et al 2008</td>
<td>High Risk</td>
</tr>
<tr>
<td>Sugdon &amp; Chambers 2003</td>
<td>High Risk</td>
</tr>
<tr>
<td>Pless et al 2000</td>
<td>Low Risk</td>
</tr>
</tbody>
</table>
2.4.4 Outcome Measures

The outcome measures used in the studies reviewed are summarised in Table 2.1. All 13 studies measured some component of motor ability following group intervention. The Movement Assessment Battery for Children (MABC) was used in 10 of the 13 studies as a measure of motor ability. The first edition of the MABC was used in 9 studies, with only one (Jelsma et al., 2014) using the second edition of the measure. The Bruininks-Oseretsky Test of Motor Proficiency (BOT-MP) was used in 2 of the studies. Both the MABC and the BOT-MP are standardised outcome measures with strong psychometric properties (Henderson & Sugdon 2007; Bruininks & Bruininks 2005). Sensory organisation and balance control was measured in one study using a computerised dynamic posturography (CDP) machine, which is a reliable and valid tool (Di Fabio & Foudriot, 1996). Only one study, Klein et al., (2008), did not use a standardised outcome measure to evaluate the effects of intervention. This study measured touch keyboarding speed and typing accuracy, which was not standardised.

A number of questionnaires measuring constructs such as perceived competence, anxiety, and self-perception were used in addition to measures of motor ability in some of the studies. No standardised measure of participation or enjoyment was used in any of the studies reviewed. One study (Hillier et al., 2010) measured participation following group intervention. This was measured using a questionnaire designed by the researchers, which was not a standardised measure. One study (Jelsma et al., 2014) measured enjoyment following group intervention, using a series of smiling faces devised by the researcher.

In summary, this review demonstrates the large number of outcome measures available for measuring movement ability in children with DCD. The MABC appeared most frequently in the literature reviewed, and this measure provided the basis for the meta-analysis which is described in section 2.5. While a number of standardised questionnaires were used in the studies reviewed, no study used a standardised outcome measure for the evaluation of changes to participation or enjoyment.
2.4.5 Group Intervention Design

All 13 studies involved some form of group intervention, with each study having a different intervention design. Three studies (Hung & Pang, 2010; Peens et al., 2008, Pless et al., 2000) involved group gross motor training. Three studies (Dunford et al., 2011; Peters & Wright 1999; Sugdon & Chambers 2003) involved group practise of functional skills, or activities of daily living (ADLs). The remaining 7 studies each had a different type of intervention, which were Taekwondo, soccer training, core exercise, computer skills, table tennis, aquatic therapy, and Wii training. Both the length of the group programmes and the duration and frequency of sessions throughout the programmes varied amongst the studies. The length of group programmes ranged from 2 weeks to 12 weeks. The duration of sessions ranged from 30 minutes to 3 hours, with frequency of sessions ranging from 1 session to 5 sessions per week.

2.4.6 Study Results

Two studies (Kane et al., 2011; Klein et al., 2008) did not use statistical analysis in the reporting of results. Kane et al., (2011) involved case studies, and Klein et al., (2008) did not compare pre- and post-test measures. One study (Pless et al., 2000) reported no significant change in MABC scores between intervention and control groups, however when children with borderline difficulties were compared to those with severe difficulties, the borderline group had a significant improvement following the group intervention.

The remaining studies all demonstrated a significant difference in at least one measure following group intervention. Dunford et al., (2011) and Peters & Wright (1999) both demonstrated significant change following group intervention, however analysis was limited to within-group analysis as there were no control groups used in these studies. Hung & Pang (2010) found no difference between intervention and control groups, but did report a significant within-group improvement in children who undertook group intervention. Six studies (Fong et al., 2012, Peens et al., 2008; Tsai et al., 2009; Tsai et al., 2012; Sugdon & Chambers, 2003; Jelsma et al., 2014) reported a significant improvement in measures of movement ability following group intervention compared to controls. No significant change in participation or enjoyment
was demonstrated in either Hillier et al., (2008) or Jelsma et al., (2014), however as previously discussed, the measures used in these studies were not standardised.

In summary, 6 of the 13 studies reported a significant improvement in movement ability compared to controls, which provides promising evidence for group motor skill intervention programmes. This improvement was further analysed in the meta-analysis.

2.5 Meta-analysis

Of the nine studies that used the first edition of the MABC, four (Hung & Pang, 2010; Hillier et al., 2010; Peens et al., 2008; Pless et al., 2000) were suitable for inclusion in a meta-analysis. Both Dunford et al., (2011) and Peters & Wright (1999) were not suitable as no control group was used in either study. Tsai et al., (2009), Tsai et al., (2012), and Sugdon & Chambers (2003) did not publish details of mean MABC scores before and after intervention and therefore could also not be included in the meta-analysis.

2.5.1 Data Extraction

Data extraction was completed independently by the principal investigator and included the mean and standard deviation for the MABC for both intervention and control groups at baseline and following intervention. This was reviewed by a second author.

2.5.2 Statistical Analysis

The statistical analysis was conducted using Review Manager 5 [Version 5.1.7 Cochrane Collaboration 2012]. For the purposes of this review, the terms ‘usual care’ was defined in the context of each individual intervention. The mean difference (MD) in outcomes between the control and the ‘group exercise’ group post-intervention was used as the mode of analysis. The impact of sample size was addressed by estimating a weighting factor for each study, and assigning larger effect-weights in studies with larger samples. Statistical heterogeneity was measured using the $I^2$ statistic. In the current study, an $I^2$ statistic of $\leq 50\%$ was the cut-off point for acceptable heterogeneity and the fixed-effects model was applied below this point.
2.5.3 Results

Four randomised controlled trials examined the effect of group exercise when compared to either no treatment (Hillier et al., 2010; Peens et al., 2008; Pless et al., 2000) or individual treatment (Hung & Pang, 2010) in children with DCD, using the MABC. There was no significant difference between the group exercise (n=55) and control group (n=54) with respect to levels of daily activities post-intervention [MD=-2.11 (95% CI -4.48, 0.27), p=0.08, \( I^2=0\% \)]. Figure 2.2 displays these findings.

Figure 2.2: Mean difference between the exercise group and the control group on the MABC post intervention

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Group exercise</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>IV, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillier 2010</td>
<td>15.5 4.1</td>
<td>20.8 6.5</td>
<td>5.30</td>
<td>0.06</td>
<td>-11.45, 0.66</td>
</tr>
<tr>
<td>Hung &amp; Pang 2010</td>
<td>10.4 3.8</td>
<td>10.6 6.9</td>
<td>0.40</td>
<td>0.75</td>
<td>-3.35, 4.75</td>
</tr>
<tr>
<td>Peens 2008</td>
<td>10.25 5.61</td>
<td>12.5 8.43</td>
<td>2.25</td>
<td>0.25</td>
<td>-6.58, 2.45</td>
</tr>
<tr>
<td>Pless 2000</td>
<td>11.1 5.3</td>
<td>14.6 6.6</td>
<td>2.80</td>
<td>0.30</td>
<td>-7.27, 1.47</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td></td>
<td></td>
<td>-2.11</td>
<td>1.47</td>
<td>-4.48, 0.27</td>
</tr>
</tbody>
</table>

Heterogeneity: Chisq = 2.44, df = 3 (P = 0.49), I² = 0%
Test for overall effect Z = 1.74 (P = 0.08)

2.6 Discussion

This systematic review yielded a small number of articles, with very few involving randomized controlled trials of high quality. Little is known about optimal intervention in children with DCD, and this review has demonstrated the lack of evidence of adequate quality available in the specific area of group intervention. Two studies examined the impact of groups on participation, however the quality of the outcome measurement was poor, and therefore the value of the results is limited.

Only four studies were suitable for inclusion in meta-analysis, which demonstrated no significant difference between group intervention and control. The four studies included in meta-analysis however had either a moderate or high risk of bias, and involved a large variability in duration and frequency of interventions. While the same outcome measure was used in these four studies, the differences in subjects and intervention approaches used make comparison difficult. Three of the 4 trials in the meta-analysis showed positive albeit non significant change in favour of the experimental. Overall, the mean change also favoured the experimental but this was not statistically significant. The total numbers included in this analysis were small,
with only 55 subjects in the exercise group compared to 54 in the control group. Further trials are required to add to the value of this meta-analysis.

Each of the studies used the widely accepted term “Developmental Coordination Disorder” and based inclusion criteria on the Diagnostic and Statistical Manual 4\textsuperscript{th} Edition (DSM-IV) diagnostic criteria for DCD. It is clear that there is some evidence to support the use of group motor skills intervention groups in improving movement ability in DCD with respect to movement ability. The effect of group motor skills on participation remains unknown.

The limitations of this systematic review and meta-analysis are the small number articles yielded in the search, and the low number of randomised controlled trials of sufficient quality. Four of the 13 articles in the review were of poor methodological quality and did not contribute significantly to the quality of the review. Only 4 of the 13 articles were included in the meta-analysis which found no significant difference between group intervention and controls. The use of outcome measures varied in the articles, which made comparison of results difficult. Neither participation nor enjoyment was included as outcome measures in the studies reviewed. The finding of this systematic review indicates the need for further high quality research in this area. The review also highlights the variability in group treatment which exists in the management of children with DCD. Many of the studies describe promising group intervention strategies which could be replicated in clinical practice.

2.7 Conclusion

The aim of this systematic review and meta-analysis was to examine the extent and quality of the evidence available for the use of group motor skills training in children with DCD. Following an extensive search of the available literature, 13 studies were identified. While the meta-analysis conducted on only 4 studies found no significant difference between group intervention and controls, 6 of the 13 studies which were of high methodological quality did report a significant improvement in movement ability compared to controls. As outlined in Chapter 1, it is known that participation levels in children with DCD are low, and that group gross motor skill training has a positive effect on motor skills. However, the effects of such intervention on participation in children with DCD are unknown. This systematic review and analysis highlights the large gap in the current knowledge in this area. There is a clear need to include
strategies aimed at improving participation in treatment of children with DCD, but the effectiveness of this is unknown. The need for an appropriate measure of participation is highlighted by this review. The aim of the current study was to examine the effect of a group motor skills programme on participation and movement ability in children aged 7-10 with Developmental Coordination Disorder (DCD).
3. METHODS

3.1 Hypothesis

Children with movement difficulty caused by DCD who attend a 10 week group motor skills programme in the community will demonstrate an increase in participation levels, and an improvement in movement ability compared to those who do not attend the intervention.

3.2 Study Design & Setting

The study took place in the community physiotherapy department in the Health Service Executive (HSE) Dublin South West area. All testing and intervention took place in the community physiotherapy department gym located in Chamber House in Tallaght. Tallaght is a large suburb of the greater Dublin area, located 13km southwest of Dublin city centre. Parts of the suburb have high concentrations of social deprivation, with West Tallaght experiencing high levels of economic, social, and environmental disadvantage (MacLaren et al., 2007). Recruitment was conducted through the HSE and the Adelaide and Meath Hospital, Tallaght.

3.3 Ethics

Ethical approval was initially sought from the Health Service Executive (HSE) however there is no ethical committee for Primary, Continuing, and Community Care in the HSE covering the Dublin Mid Leinster area. Therefore, ethical approval was sought and granted by University College Dublin Human Research Ethics Committee. Ethical approval was also sought and granted by the Ethics Board of the Adelaide and Meath Hospital, Tallaght. Letters of approval from both committees are located in Appendices 1 and 2.

3.4 Recruitment

In order to recruit participants for the study, an information leaflet for health professionals, which is located in Appendix 3, was posted directly to 45 GP practices in the Dublin South West catchment area. The list of current General Practitioners in Dublin South West was accessed through the HSE website. GPs were also provided with information leaflets about the study for parents and for children, which are located in Appendices 4 and 5. The GPs were asked to give parents of children with
Developmental Coordination Disorder (DCD) the parent and child-specific leaflets about the study and display the information in their practices. All GPs were given the contact information of the researcher and were asked to make contact if they had identified any possible clients for the study. The researcher then followed up by phone with the parents of these possible clients. Parents of possible clients could also phone the researcher directly.

The same information leaflets for both health professionals and parents were also posted to all paediatric primary care staff working in the HSE in Dublin South West. The staff included 4 occupational therapists, 1 physiotherapist, 2 speech therapists, and 2 psychologists. These health professionals were asked to inform parents about the study and to refer potential clients for the study to the researcher. Information leaflets about the study were displayed in paediatric waiting areas in Dublin South West.

The study information leaflets were also sent to 3 community health paediatricians in Tallaght Hospital. Two paediatric physiotherapists in Tallaght Hospital were also provided with the same information and asked to refer suitable clients to the researcher. The study information was provided to parents attending the Developmental Coordination Clinic in Tallaght Hospital with their children. At the time of the study, this clinic ran every 3 months.

Children were also directly recruited by the researcher from the HSE Dublin South West physiotherapy waiting list and from clients who were attending the service at that time. The parents of any clients deemed eligible, either from the existing caseload in physiotherapy, or those referred to the study by a third party, were contacted directly by the researcher.

Parents of potential participants were contacted initially by the researcher by phone and the study was explained to them. Parents, who indicated an interest in reading about the study and who had not already received the information leaflets, were subsequently posted the parent information leaflet and the age appropriate leaflet for their child to read. They were then contacted again by phone by the researcher after 2 weeks and asked to indicate their interest in enrolling their child in the study. This gave the parents an opportunity to ask any questions about the research. Those who wished to take part were then invited to an assessment session. The parent signed a
consent form and the child signed an assent form (Appendix 4) in the presence of the researcher at the initial assessment session.

Children were recruited between December 2012 and September 2013, in groups of 10. Block randomisation was used. For every 10 children who were recruited and assessed, they were randomised into either control or intervention groups, with 5 children in each group. Each child’s name was placed in a sealed envelope and the groups were chosen at random by an independent health professional in the HSE.

3.5 Inclusion Criteria

Community dwelling children of both genders aged 7-10 (inclusive) with a movement difficulty as indicated by the Movement Assessment Battery for Children (MABC) were included. This age bracket was chosen to correspond with the MABC 7-10 year assessment. Children with a total test score at or below the 15th percentile were included in the study. A score below the 15th percentile on the MABC indicates a movement difficulty.

3.6 Exclusion Criteria

Children with underlying illnesses or syndromes were excluded from study. Children with physical or intellectual disability causing movement difficulty were excluded. Children with behavioural or significant attention difficulty were excluded from the study as this would have rendered them unsuitable for group therapy. Children with a total score above the 15th percentile on the MABC were excluded.
Figure 3.1: Recruitment, randomisation, and assessment schedule

Children Referred

Charts/Referrals Screened

Parents Given Leaflets

Parents Contacted after 2 weeks

Parents Declined

Children Included

Obtained Consent

G1 Randomised

Intervention Assessed at baseline, 4, 8 & 12 m
Control Assessed at baseline & 4 months

G2 Randomised

Intervention Assessed at baseline, 4 & 8 m
Control Assessed at baseline & 4 months

G3 Randomised

Intervention Assessed at baseline & 4 months
Control Assessed at baseline & 4 months
3.7 Sample Size Calculation

Sample size calculations were based on changes in the Movement Assessment Battery for Children (MABC). This measure was chosen as it has strong psychometric properties (Henderson & Sugden 1992). While the primary outcome measure for this study was the Children’s Assessment of Participation and Enjoyment (CAPE), this measure was not chosen to calculate sample size as values for standard deviation and clinically significant change could not be found in the literature. The number of children required in each group to produce a statistically meaningful change in movement difficulty was calculated using the comparison of means in two independent groups (Daly and Bourke, 2000).

The formula used for the calculation of the number of clients required, involved the prediction of a standard deviation (σ) for the MABC test and an anticipated significant clinical change (Δ). The value for the standard deviation (σ), 4.5 was obtained from a study conducted by Piek et al., (2000). The clinically significant change in the MABC of five points was obtained from a study by Niemeijer (2007). The sample size calculations are presented in Figure 3.2.

The value of the constant value ‘K’, 7.8, was dictated by the significance level chosen for the study, in this case a two-sided significance level of 5% with an 80% chance of detecting a treatment effect. From the calculation demonstrated in Figure 3.2, 26 participants were required to sufficiently power the study. Due to the process of block randomisation in groups of 10, a target sample size of 30 participants was set.
3.8 Assessment

Once recruited, participants were invited to an assessment appointment in the community physiotherapy department in Chamber House, Tallaght. An appointment was made with the parents by phone and a reminder was sent by text 24 hours before the appointment. A standardised assessment was then conducted by the researcher. Appointments lasted approximately 90 minutes each.

The primary outcome measures used were:

- Children’s Assessment of Participation and Enjoyment (CAPE)
- Preferences for Activities of Children (PAC)
The secondary outcome measures used were:

- Height
- Weight
- Body Mass Index (BMI) percentile
- Movement Assessment Battery for Children (MABC)
- Paediatric Balance Scale (PBS)
- Parent Questionnaire

3.9 Primary Outcome Measures

The two primary outcome measures used in this study, the Children’s Assessment of Participation and Enjoyment (CAPE) and the Preferences for Activities of Children (PAC) will be described in this section. The CAPE and PAC outcome measures are subject to copyright by Pearson PLC. While permission was received from Pearson PLC to use the measures in this study, the measures could not be included in the appendices of this thesis. The permission and details of purchase and copyright from Pearson PLC can be viewed in Appendix 6.

3.9.1 Children’s Assessment of Participation and Enjoyment (CAPE)

The Children’s Assessment of Participation and Enjoyment (CAPE), (King et al., 2001), is a questionnaire that was used in this study to measure participation levels of the children with DCD. The CAPE questionnaire has been demonstrated to have sufficient internal consistency, test-retest reliability, content validity, and construct validity (King et al., 2007).

The CAPE questionnaire is used to document how children participate in everyday activities outside of the school environment. It can be used with individuals between 5 and 21 years of age, and measures a number of dimensions of participation in 55 different activities. Seated with a parent, each child was shown a series of 55 pictures on cue cards and asked to identify whether they had done the activity in the past 4 months. For all activities that the child participated in, they were further asked to indicate, with the help of their parent:
• where they did the activity
• how often they did the activity
• with whom they did the activity
• how much they enjoyed the activity

In order to demonstrate the enjoyment of an activity, the child was provided with a picture of 5 faces, ranging from sad to happy. The child was asked to point to the face which most corresponded to their enjoyment of each activity, which in turn corresponds to a score.

From testing the child using the questionnaire in this manner, the CAPE examines participation in 5 dimensions:

1. Diversity
2. Intensity
3. With Whom
4. Where
5. Enjoyment

The scores derived from the CAPE are not standard scores, but can be used to examine the pattern of a child's participation, and can also be used to monitor changes over time. Each of the 5 dimensions above can be analysed with 3 different levels of scoring:

1. Overall Score: provides a global view of the child's participation
2. Domain Score: quantifies the formal and informal activities in which the child participates
3. Activity Type Score: describes the child’s participation in 5 types of activity: recreational, physical, social, skill-based, and self improvement activities.

Overall scores were calculated in each of the 5 dimensions for each child. The ranges of these overall scores are as follows:
1. “Diversity” – Range: 0-55. This score is the sum of the total number of activities in the questionnaire. There are 55 activities in total. One point is given for each activity that the child has completed in the past 4 months. A higher total score indicates diverse participation.

2. “Intensity” - Range: 0.0 -7.0. The intensity score reflects the amount of time that the child spends participating in the activities reported in the diversity section. A higher intensity score reflects a greater amount of time participating. A child may indicate a large volume of activities in the diversity section, but report a small amount of time participating. The maximum score for intensity is 7.

3. “With Whom” – Range: 1.0 - 5.0. This score represents the people with whom the child participates. Lower scores indicate time spent on individual or solitary conditions, whereas a high score indicates a greater level of social engagement. The maximum score is 5.

4. “Where”- Range: 1.0 – 6.0. The where score indicates the environment in which the child takes part in their activities. A low score indicates more home-based activities, whereas a higher score represents community-based activities. The maximum score is 6.

5. “Enjoyment” – Range: 1.0 – 5.0. The enjoyment score reflects the average enjoyment rating for all of the items the child participates in. A higher rating of enjoyment is indicated by a higher score. Enjoyment can influence the child’s motivation to continue with an activity. The maximum score is 5.

Domain scores were also calculated for each child, in the 3 dimensions of participation most likely to be affected by the intervention; diversity, intensity, and enjoyment. The meaning and ranges of these scores are as follows:

- Diversity: There are 40 informal items on the questionnaire, and 15 informal items, therefore the diversity domain score ranges from 0-40 for informal activities, and from 0-15 for formal activities. This score provides an insight into the categories of activities in which a child participates.
• Intensity: The domain score for intensity provides an insight into how frequently a child participates in formal versus informal activities. This score is calculated by dividing the overall intensity score for either informal or formal items by the total number of activities in each section. The intensity domain score ranges from 0-7.

• Enjoyment: The domain score for enjoyment reflects the level of enjoyment a child reports in either formal or informal activities. The maximum enjoyment score for either domain is 5.

Finally, activity type scores were calculated for the same 3 dimensions of participation: diversity, intensity, and enjoyment. There are 5 activity types included in the CAPE:

• Recreational: There are 12 activities in this category, which include things such as playing with toys, watching television, playing computer games, or playing with board games, cards, or pets.

• Physical Activities: There are 13 activities in this category, which include things such as team or individual sports, gardening, or exercise.

• Social: There are 10 activities in this category, which include things such as visiting friends or family, going to parties, or to the cinema.

• Skill Based: There are 10 activities in this category also, which include things such as swimming, dancing, playing music, and taking art lessons.

• Self Improvement: There are 10 activities in this category, which include things such as reading, doing chores, doing homework, and religious activity.

3.9.2 Preferences for Activities of Children (PAC)

A related tool, the Preferences for Activities of Children (PAC) questionnaire (King et al., 2001) was used to calculate each child's preference for out of school activities, based on the CAPE cue cards. Reliability and validity of this measure has been demonstrated (King et al., 2007).
Seated with their parent, each child was asked to sort the 55 activity cards into 3 piles:

(1) Prefer to do

(2) Sort of prefer to do

(3) Prefer not to do

The preference score is simply calculated by adding the preference ratings and dividing by the total number of activities. Preference scores are averages that range from 1.0 – 3.0. A higher rating score refers to greater preference for activities overall.

3.10 Secondary Outcome Measures

3.10.1 Height

Height was measured in centimetres using a standard Leicester height measure (Seca). Children were instructed to remove their shoes and stand with their back to the measure. They were then asked to look straight ahead, take a deep breath in and out. The height reading was then taken. Three measures of height were taken and the average result of 3 measures was recorded.

3.10.2 Weight

Weight was measured in kilograms using a standard SECA (Seca) scales. Children were instructed to remove shoes and jackets. Light clothing remained. Three measures of weight were taken and the average result of 3 measures was recorded.

3.10.3 Body Mass Index (BMI) Percentile

Body Mass Index (BMI) was calculated for each child using the standard formula of dividing the weight by the height squared. A BMI percentile was calculated for each child using BMI reference curves (Cole et al., 1995) which took into account age and gender. The BMI percentile was plotted on a growth chart for each child. BMI percentiles were analysed using the NHS National Obesity Observatory guidelines on BMI percentiles (2006). The population monitoring thresholds were used, which state that a BMI between the 85th and 94th percentile represents overweight, and a BMI above the 95th percentile represents obesity.
3.10.4 Movement Assessment Battery for Children (MABC)

The Movement Assessment Battery for Children 2nd Edition (MABC) was used to evaluate motor performance of each child. The MABC is subject to copyright by Pearson PLC and thus could not be included in the appendices of this thesis. Correspondence from Pearson PLC in relation to permission and copyright of this measure can be viewed in Appendix 7. The MABC is an individually-administered standardised test for children with motor impairment. The MABC has good reliability and concurrent validity (Henderson & Sugden 2007; Leemrijse et al., 1999; Smits-Engelsman et al., 2008) and is frequently used to identify children with DCD (Geuze et al., 2001). The MABC has been proven to be both a valid and reliable tool for measuring motor performance in children aged between 3 and 16 (Henderson & Sugdon 1992) and has also been shown to be stable for a 12 week period (Schoemaker et al., 1994). The test takes approximately 30 minutes to complete. The test contains 8 subtests across three domains: manual dexterity, aiming and catching, and balance.

The manual dexterity subtest involves 3 separate tasks. The first task involves the child drawing a line within a printed pattern, where they must keep inside the lines. The numbers of errors are counted. Secondly, the child completes a peg placing test at speed and the better of two attempts is recorded for hand. Finally, the child completes a threading task using a piece of string and a plastic board with holes. The fastest time of two attempts is recorded. A raw score is then calculated from the tests and can be used to produce a percentile score for manual dexterity using the MABC handbook.

The aiming and catching subtest involves 2 separate tasks. The aiming task involves the child standing 2 meters from a target mat and attempting to throw a beanbag into a defined red mark on the mat. The number of correctly executed throws is recorded out of 10. For the catching task, the child stands 2 meters from a wall and throws a tennis ball against the wall. They must catch the ball without trapping it in their two hands. The number of correct catches out of 10 is recorded. The raw score from this subtest is used to calculate the child’s percentile score for throwing and catching.

The balance subtest involves 3 tasks. In the first, the child must hop on one leg across 5 mats. The number of hops on each leg is recorded. The second task
involves the child standing on a balance board. The duration in seconds is recorded for each leg. In the third task, the child must walk heel to toe along a 2m line on the floor, which is marked with yellow tape. The number of steps up to 15 is recorded. Similar to the other subtests, the raw score is used to calculate the child’s balance percentile.

The raw scores from each domain are transformed into standard scores and added to ascertain the total test score, which ranges from 0 to 40. Normal values are available for each age (Henderson & Sugdon 2007). The total test score is then used to calculate the overall movement difficulty percentile. Children who score below the 5th percentile are deemed to have a definite movement difficulty. Children who score below the 15th percentile are deemed to be at risk of movement difficulty. Those above the 15th percentile are considered to be within normal limits (Henderson & Sugdon 1992).

3.10.5 Paediatric Balance Scale (PBS)

The Paediatric Balance Scale (PBS) was used to measure balance, in addition to the balance subtests in the MABC. This scale is a modified version of the Berg Balance Scale, which was developed as a measure for school-age children with mild to moderate motor impairment. The PBS has been demonstrated to have good interrater and test-retest reliability in school age children (Franjoine et al., 2003).

The measure involves 14 functional balance tasks and has a maximum score of 56. The 14 tasks assess some of the functional activities a child must perform to independently function. Some of the items tested include sitting and standing balance, sit to stand/stand to sit, transfers, stepping, reaching forward, reaching to the floor, turning, and stepping on and off of an elevated surface.

3.10.6 Parent Questionnaire

The views of parents were recorded by the researcher using a standard schedule of questions. The full schedule of questions can be found in Appendix 8. In the development stage of the study, it had been proposed that parent interviews would be recorded by the researcher and transcribed. However, it became apparent during initial assessment appointments that some children and parents became uncomfortable with these sensitive questions in their presence. This presented an
ethical dilemma and the emotional responses of the children were respected. It was not always possible for the child to wait out of earshot, and it was not practical to ask the parents to attend a separate appointment with their child. Where possible, the parents were interviewed in person when the child was not present, however many of the interviews were subsequently conducted over the phone and it was not possible to record them. Responses were instead recorded in writing by the researcher and summarised.

Parents were asked to give their own opinion of their child’s activity levels, abilities, willingness to take part in new activities and groups, and were also asked whether they felt their child was aware of their limitations. Six questions were asked, to which parents were asked to respond “yes”, “no”, or “unsure”.

3.11 Order of Testing

Testing was done in a standardised manner, using the same equipment each time. Testing began with the MABC, PBS, and measures of height and weight. The CAPE and PAC questionnaires were then completed with the child and the parent. The parents were then asked the schedule of questions when possible in person, or they were asked over the phone over the following days. Parents were present for the entirety of testing. The assessment form used during testing is included in Appendix 9.

3.12 Intervention

Following initial assessment and randomization, the 5 children in the intervention group began a 10 week exercise programme. The children in the control group did not take part in any further intervention. Once the children in the control group had completed their follow up assessment at 4 months they were offered to opportunity to participate in the intervention independently of the study. A 10 week programme was chosen to maximise attendance and subsequent effects of the intervention. One session a week was offered as it was considered that attendance would be optimal with this format. Previous studies on group intervention in children with DCD either involved an 8 week (Peens et al., 2007; Hung & Pang 2010) or 10 week duration (Peters & Wright, 1999; Pless et al., 2000). These interventions involved one session a week, with the exception of Peens et al., (2007), where 2 sessions a week were
provided. Improvements in motor ability were successfully achieved with these
durations, and therefore a similar approach was adopted for this study. It was
considered that a programme of a shorter duration would theoretically be less likely
to produce results of significance.

The intervention consisted of a structured 10 week exercise programme run by the
researcher in the physiotherapy gym in Chamber House, in Tallaght, Dublin 24. The
programme ran for one hour each week, for 10 weeks. The dates and times were
provided to parents in writing at least 2 weeks before the commencement of the
group. Parents were urged to ensure full attendance in order to obtain benefit from
the group. A text reminder was sent by the researcher to each parent at least 24
hours prior to each group session.

At the beginning of the programme, each child and their parents were provided with
an exercise log book. The log book, a copy of which can be found in Appendix 10
was printed in colour and given to the participants' parents in an A4 plastic project
folder. An instruction note was included on the first page of the logbook, requesting
that parents complete the logbook with their child every day, apart from group day.
The log book consisted of a 10 week exercise diary which detailed one exercise for
each week. Participants and their families were asked to keep the book safe in their
homes and informed that it would be collected by the researcher on the last day.

The exercise classes consisted of a warm up, practise of the home exercise for that
week, and a review of the exercise from the previous week. The focus of the group
each week was dictated by the home exercise. This is detailed in Table 3.1. Balance
activities included balance beam walking, throwing and catching while on balance
cushions, obstacle courses, and balancing on rocking boards. Co-ordination activities
included tipping target practise, basketball, racket games, tennis ball aiming and
catching. Core strengthening exercises included sit-ups on gym balls, trunk curling,
and activities in 4-point kneeling. Attendance was recorded by the researcher.
<table>
<thead>
<tr>
<th>Week</th>
<th>Home Exercise Description</th>
<th>Focus of Exercise &amp; Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Wheelbarrows:</strong> The child places their hands on the floor and has a partner hold onto their feet. The child must complete as many steps as possible walking on their hands.</td>
<td>Shoulder Stability, Core Strength</td>
</tr>
<tr>
<td>2</td>
<td><strong>Target Practise:</strong> The child must stand 2 meters from a target and practise accurate throwing to that target.</td>
<td>Hand – Eye Coordination</td>
</tr>
<tr>
<td>3</td>
<td><strong>Crabwalk:</strong> The child sits on the floor. Both hands and feet are placed on the floor and the child lifts their body off the floor, trying to complete as many steps as possible.</td>
<td>Shoulder Stability, Core Stability</td>
</tr>
<tr>
<td>4</td>
<td><strong>Hopping:</strong> The child must practise hopping up and down their hallway on each leg, counting the amount of hops</td>
<td>Pelvic Stability, Balance</td>
</tr>
<tr>
<td>5</td>
<td><strong>Superman:</strong> The child lies on their stomach and lifts up their head, arms, and legs, extending their trunk. They must hold this position for as long as possible.</td>
<td>Core extensor strength</td>
</tr>
<tr>
<td>6</td>
<td><strong>Tennis Ball:</strong> The child must stand 2m from a wall and throw a tennis ball against it and catch it upon return.</td>
<td>Hand – Eye Coordination</td>
</tr>
<tr>
<td>7</td>
<td><strong>Lunge and Throw:</strong> The child stands in a lunge position opposite a partner and must throw and catch a ball to each other.</td>
<td>Balance, Hand – Eye Coordination, Core Strength</td>
</tr>
<tr>
<td>8</td>
<td><strong>Ball Rolling:</strong> The child rolls a large gym ball up and down a wall using only their hands, without using any other part of their body.</td>
<td>Shoulder Stability, Endurance</td>
</tr>
<tr>
<td>9</td>
<td><strong>Line Walking:</strong> The child tandem walks along a line, trying to keep their balance</td>
<td>Balance</td>
</tr>
<tr>
<td>10</td>
<td><strong>Hedgehogs:</strong> The child lies supine and must curl up into a ball by flexing their hips and cervical spine.</td>
<td>Core flexor strength</td>
</tr>
</tbody>
</table>
3.13 Retesting

Following the 10 week programme of intervention, all 10 children from both the intervention and the control groups were invited back for reassessment. Retesting was conducted in an identical manner to the initial assessment as previously described. The schedule of parent questions was not repeated, however feedback was sought from parents of children who attended the intervention as to whether they though their child enjoyed coming to the exercise classes. There were approximately four months in between the baseline and second assessments for each child. Parents of the children in the intervention group were asked to return the log books on the last day of class. For those who failed to do so, they were reminded to bring the log books to the reassessment. Parents who did not return the log books were reminded by phone and given the option to return them by post.

The first group of 5 children randomized into the intervention group were invited for retesting on three occasions; 4 months, 8 months, and 12 months post their baseline assessment. The second intervention group were invited for retesting on two occasions; at 4 months and 8 months post baseline assessment. The final intervention group were retested only once at 4 months post baseline assessment. It was not possible to retest all 15 children in the intervention groups at 8 and 12 months post baseline assessment due to the time constraints of the study. The 15 children in the control group were tested on only 2 occasions; at baseline and at 4 months post baseline, as it would have been unethical to withhold treatment from the control group for 12 months. There was no further follow up of the control group once they had completed their assessments. The recruitment and retesting schedule can be viewed in Appendix 11.

3.14 Analysis of Data

Data analysis was conducted using the International Business Machines (IBM) Statistical Package for Social Sciences (SPSS 20). Descriptive statistics were used to summarise baseline demographics, and all data was assessed for its normality of distribution using the Shapiro-Wilks test.

The mean difference from baseline to follow-up (4 months) was calculated for the CAPE, the PAC, the MABC, and the PBS. Mean differences and standard deviations
were calculated for all outcomes. Between-group differences, comparing the mean
difference of the intervention to the control group, were calculated. The Mann
Whitney U test was used to calculate between-group differences, for non-parametric,
non-normally distributed data. The independent samples t-test was used to calculate
between-group differences for parametric, normally distributed data. A significance
level of 0.05 was set for any inferential statistics conducted.

Within-group differences, comparing the intervention group at baseline with their 4, 8,
and 12 month findings were also calculated, as a secondary analysis to the main aim
of the study. The Wilcoxon signed rank test was used to calculate within-group
differences for non-parametric, non-normally distributed data, and the paired samples
t-test was used for the same calculation in parametric, normally distributed data. A
significance level of 0.05 was set for any inferential statistics conducted. The risk of
type 1 statistical error with repeated testing is acknowledged, however in this
secondary analysis no adjustments to critical value for statistical significance were
made (e.g.: Bonferroni correction).

The data obtained from the parent interviews at baseline was treated as quantitative.
The number of responses to either yes/no/unsure were recorded and presented as
percentages.

3.15 Summary

This study employed a quantitative methodology to examine the effects of a group
motor skills intervention programme on the participation and motor skills in children
with DCD. Recruitment was dictated by the sample size calculation that was
performed, and block randomisation was used to allocate the children into either
intervention or control groups. Standardised outcome measures with strong
psychometric properties were used in all baseline assessments and for retesting. The
10 week intervention described was designed based on previous literature in this
area.
4. RESULTS

4.1 Introduction

The results of the study will be presented in this chapter. The recruitment section details the number of participants recruited from the different sources, and describes the results of block randomisation. The baseline demographics section will detail information collected for each child upon recruitment to the study, relating to age, gender, co-existing medical conditions, and involvement of other health professionals with each child.

The results of the parent interviews at baseline will be presented. The parent interviews examined parents’ perceptions of their child’s participation and enjoyment of activities. The attendance to exercise classes and the children’s compliance to the home programme as indicated by the completed exercise log books is detailed in the exercise class section. A summary of parents’ feedback to the programme will be detailed.

The findings from both the intervention and control groups at baseline and post intervention in each outcome measure will be presented and compared. Between-group analysis at the 4 month time point will be presented. Comparison of change in outcomes, from baseline to 4 months in the intervention group versus the control group will be presented.

While the main focus of the study was the between-group analysis, the results of within-group analysis in the intervention group from each outcome measure at 4 months, 8 months, and 12 months will also be presented.

4.2 Recruitment

The recruitment and group allocation processes are outlined in Figure 4.1. Thirty-seven children were referred to the study, and 30 of these children were recruited. Sixteen children were referred to the study by third parties. Physiotherapists in Tallaght Hospital referred 9 children, all of whom were eligible and were subsequently included in the study. Occupational therapists in the HSE referred 7 children to the study, 4 of whom were unsuitable and were subsequently excluded. One child had a diagnosis of Albright Syndrome, one had a club hand, one had
Marfan syndrome, and one had Attention Deficit Hyperactivity Disorder which would have prevented the child's ability to take part in an exercise class. One child was referred by his parents who were made aware of the study by the Irish Society of Chartered Physiotherapists.

Twenty families were approached by the researcher. Of these 20 families, 1 declined to take part, 1 failed to respond, and 1 child had suffered a spinal fracture and was therefore unable to take part in an exercise class.

All 30 children who were recruited remained enrolled in the study for its duration. Each child was followed up successfully with the exception of one participant in the first intervention group, who was unable to attend for 12 month retesting due to a family member becoming ill.
Figure 4.1: Recruitment of subjects: number of participants at each point in the study

Children Referred $n=17$ → Charts/Referrals Screened $n=37$ → Parents Given Leaflets $n=32$ → Parents Contacted after 2 weeks $n=32$ → Parents Declined $n=2$ → Children Included $n=30$ → Obtained Consent $n=30$ → Randomised

- G1 $n=10$ → Randomised
  - Intervention $n=5$ → Assessed at baseline, 4 & 8 months
  - Control $n=5$ → Assessed at baseline & 4 months
- G2 $n=10$ → Randomised
  - Intervention $n=5$ → Assessed at baseline & 4 months
  - Control $n=5$ → Assessed at Baseline, 4 & 8 months
- G3 $n=10$ → Randomised
  - Intervention $n=5$ → Assessed at baseline & 4 months
  - Control $n=5$ → Assessed at baseline & 4 months

One child unavailable at 12 months
4.3 Baseline Demographics

Table 4.1 presents the baseline demographics of the 30 children recruited to the study and the co-existing conditions of the 30 children. The majority of the study participants were male (67%; n=20), with a mean age of 7 years and 10 months. Just over half (53%; n=16) of the children were general medical card holders. Overall, the majority (63%; n=19) of the children were normal weight, with 30% (n=9) being obese and 7% (n=2) overweight (NHS National Obesity Observatory guidelines on BMI percentiles, 2006). There were no statistically significant differences between the intervention and control groups at baseline.

The co-existing medical conditions of participants are presented in Table 4.2. A number of children had a diagnosis of Asperger’s Syndrome (n=4) and Autism Spectrum Disorder (ASD) (n=7). Less than half (n=12) had speech impairment. Two children had a mild learning difficulty that did not impact their ability to participate in group physiotherapy. A number of the children (n=12) were attending speech therapy and the majority (n=28) were attending occupational therapy. Eighteen of the children were attending a paediatrician in relation to their DCD.

4.4 Distribution of Data

Data was assessed for its normality of distribution using the Shapiro-Wilk normality test. The majority of data was not normally distributed. The variables that were normally distributed were the Paediatric Balance Scale (PBS) (p=0.6), height (p=0.1), the overall “diversity” score of the Children’s Assessment of Participation and Enjoyment (CAPE) (p=0.29), the overall “with whom” score of the CAPE (p=0.2), and the overall “enjoyment” score of the CAPE (p=0.06). Parametric testing was used in the analysis of the PBS. Non-parametric testing was used elsewhere.
Table 4.1: Baseline demographics of study participants (n=30)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Mean Age (SD) in years and months</th>
<th>Mean BMI Percentile (SD) kg/m²</th>
<th>Normal Weight</th>
<th>*Overweight (n = 10)</th>
<th>*Obese (n = 3)</th>
<th>GMS Holder</th>
<th>Attending OT for DCD</th>
<th>Attending Paediatrician for DCD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention</strong></td>
<td>13</td>
<td>2</td>
<td>8y2m (1y2m)</td>
<td>54 (33)</td>
<td>67%</td>
<td>13%</td>
<td>20%</td>
<td>7</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
<td></td>
<td></td>
<td>(n = 10)</td>
<td></td>
<td>(n = 2)</td>
<td>(n = 3)</td>
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</tr>
<tr>
<td><strong>Control</strong></td>
<td>7</td>
<td>8</td>
<td>7y10m (1y3m)</td>
<td>71 (27)</td>
<td>60%</td>
<td>0%</td>
<td>40%</td>
<td>9</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
<td></td>
<td></td>
<td>(n = 9)</td>
<td></td>
<td>(n = 0)</td>
<td>(n = 6)</td>
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</tbody>
</table>


Table 4.2: Co-existing conditions of study participants (n=30)*

<table>
<thead>
<tr>
<th></th>
<th>Asperger’s Syndrome</th>
<th>ASD</th>
<th>Speech Impairment</th>
<th>Epilepsy</th>
<th>ADD</th>
<th>Dyslexia</th>
<th>Learning Difficulty</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention</strong></td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
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</tr>
</tbody>
</table>

* Some children in the study had more than one co-existing condition
4.5 Exercise Classes

The average attendance of the intervention group at the 10 classes was 8.5 classes. Of the 15 children involved in the intervention portion of the study, 6 children attended every class, 6 children missed only one session, one child missed 3 sessions, one child missed 5 sessions, and one child missed 8. This represents 22 missed sessions out of a total of 150 sessions. Reasons given for 22 non-attendances were participant sickness (n=8), inclement weather (n=1), parent unable to drop the participant to the class (n=5), and prior commitments such as hospital appointments, holidays, or formal activities (n=8).

4.6 Exercise Log Books

Of the 15 intervention participants, 13 returned the completed logbook. The two children who did not return the logbook were unable to locate it in their homes, but said they had completed it each week. Analysis of the logbook is summarised in Figure 4.2. For each exercise, the number of days indicated by parents as completed, was counted and presented in a percentage. The average of the 13 children for each exercise is presented here. Participants recorded high compliance to daily exercise practise for the first 5 weeks of the programme. The compliance ranges from 83% - 94% in the first 5 weeks. The highest compliance was recorded in week 2, when the exercise was target practise. Reported compliance was reduced in the latter half of the 10 week programme. Reported compliance ranged from 15% to 78%.
Figure 4.2: Results in percentages from week 1 to 10 of exercise log book compliance of the intervention group during attendance at the 10 week programme.

| Week 1: Wheelbarrows | 87% |
| Week 2: Target Practise | 94% |
| Week 3: Crabwalking | 85% |
| Week 4: Hopping | 90% |
| Week 5: Superman | 83% |
| Week 6: Tennis Ball | 67% |
| Week 7: Lunge & Throw | 78% |
| Week 8: Ball Rolling | 50% |
| Week 9: Line Walking | 64% |
| Week 10: Hedgehog | 15% |

4.7 Primary Outcome Measures: Children's Assessment of Participation and Enjoyment (CAPE) and Preferences for Activities of Children (PAC)

The results of the Children's Assessment of Participation and Enjoyment (CAPE) questionnaire and Preferences for Activities of Children (PAC) questionnaire will be presented in this section.

As previously outlined, the CAPE questionnaire examines participation in 5 dimensions:

1. Diversity
2. Intensity
3. With Whom
4. Where
5. Enjoyment

Three levels of scoring are available for each dimension:

- Overall Score: provides a global view of the child's participation
• Domain Score: quantifies the formal and informal activities in which the child participates

• Activity Type Score: describes the child’s participation in 5 types of activity: recreational, physical, social, skill-based, and self improvement activities.

Firstly, the results of the between-group analysis with respect to the overall CAPE and PAC scores in the 5 dimensions of participation will be presented. Secondly, the results of the between-group analysis with respect to the CAPE domain scores and activity-type scores in 3 chosen dimensions of participation (diversity, intensity, and enjoyment) will be presented. Finally, the results of within-group analysis of the overall CAPE and PAC scores at baseline, 4 months, 8 months, and 12 months in the intervention group will be presented.

4.7.1 Between-Group Analysis: CAPE and PAC Overall Scores

The values for these outcome measures recorded at baseline and at follow-up (4 months) are outlined in this section. The results are presented in table format in Table 4.3. Mean scores, standard deviations, and mean differences between Time 1 (baseline) and Time 2 (follow up at 4 months) are presented for all data.

Changes in the intervention group were compared to changes in the control group at the 4 month follow up point. As the data was not normally distributed, non parametric testing was used. The Mann Whitney U test was used to compare the difference in means between the intervention group and the control group for statistical significance.

The between-group change in the Intensity score of the CAPE was statistically significant (p = 0.01). There was no statistically significant between-group change in the Diversity, With Whom, Where, or Enjoyment scores of the CAPE. The between-group change in the PAC score was not statistically significant.
<table>
<thead>
<tr>
<th></th>
<th>Intervention Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 1</td>
<td>Time 2</td>
</tr>
<tr>
<td>Diversity (SD)</td>
<td>25.2 (5.0)</td>
<td>27.1 (5.8)</td>
</tr>
<tr>
<td>Intensity (SD)</td>
<td>2.00 (0.4)</td>
<td>2.40 (0.6)</td>
</tr>
<tr>
<td>With Whom (SD)</td>
<td>2.20 (0.3)</td>
<td>2.10 (0.2)</td>
</tr>
<tr>
<td>Where (SD)</td>
<td>2.20 (0.5)</td>
<td>2.40 (0.4)</td>
</tr>
<tr>
<td>Enjoyment (SD)</td>
<td>3.40 (0.5)</td>
<td>3.90 (0.4)</td>
</tr>
<tr>
<td>PAC Score (SD)</td>
<td>1.60 (0.4)</td>
<td>2.00 (0.3)</td>
</tr>
</tbody>
</table>

* Significant change of the intervention group compared to the control group was calculated using Mann Whitney U test

*Significant change p ≤ 0.05

↑ represents an improvement, ↓ represents a disimprovement, and ↔ represents no change

Potential CAPE Score Ranges: Diversity = 0-55; Intensity = 0-7; With Whom = 1-5; Where = 1-6; Enjoyment = 1-5

Potential PAC Score Range: 1-3
Table 4.4: Between-Group Analysis: Children’s Assessment of Participation and Enjoyment (CAPE) domain and activity-type scores for intervention and control groups, with respect to diversity, intensity, and enjoyment.

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Control</th>
<th>Significant Change (p=)</th>
<th>Time 1</th>
<th>Time 2</th>
<th>Mean Change</th>
<th>Time 1</th>
<th>Time 2</th>
<th>Mean Change</th>
<th>Time 1</th>
<th>Time 2</th>
<th>Mean Change</th>
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<tr>
<td></td>
<td>Time 1</td>
<td>Time 2</td>
<td>Mean Change</td>
<td>Time 1</td>
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<td><strong>Formal</strong></td>
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<tr>
<td>Diversity</td>
<td>3.0 (1.5)</td>
<td>2.9 (2.3)</td>
<td>-0.1</td>
<td>2.8 (1.7)</td>
<td>2.8 (2.4)</td>
<td>0.0</td>
<td>0.48</td>
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<tr>
<td>Intensity</td>
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<td>1.3 (0.5)</td>
<td>0.1</td>
<td>0.9 (0.5)</td>
<td>2.5 (0.3)</td>
<td>1.6</td>
<td>0.05*</td>
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<td>Enjoyment</td>
<td>3.6 (1.4)</td>
<td>4.9 (2.5)</td>
<td>1.1</td>
<td>3.3 (1.6)</td>
<td>3.5 (1.3)</td>
<td>0.2</td>
<td>0.01*</td>
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<td><strong>Informal</strong></td>
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<td>Diversity</td>
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<td>23.8 (4.2)</td>
<td>1.7</td>
<td>22.2 (5)</td>
<td>22.4 (3.4)</td>
<td>0.2</td>
<td>0.41</td>
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<td>0.53</td>
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<td><strong>Recreational</strong></td>
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<td>0.04*</td>
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<td>4.2 (0.4)</td>
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<td>0.02*</td>
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<td>0.8</td>
<td>4.3 (2.2)</td>
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<td>-0.4</td>
<td>0.01*</td>
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<tr>
<td>Intensity</td>
<td>1.0 (0.6)</td>
<td>1.5 (0.4)</td>
<td>0.5</td>
<td>0.7 (0.4)</td>
<td>2.9 (1.0)</td>
<td>2.2</td>
<td>0.66</td>
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<td></td>
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</tr>
<tr>
<td>Enjoyment</td>
<td>2.6 (2.1)</td>
<td>3.5 (2.6)</td>
<td>0.9</td>
<td>2.3 (2.6)</td>
<td>2.3 (2.0)</td>
<td>0.0</td>
<td>0.49</td>
<td></td>
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<tr>
<td><strong>Skill Based</strong></td>
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</tr>
<tr>
<td>Diversity</td>
<td>2.1 (1.1)</td>
<td>2.0 (1.2)</td>
<td>-0.1</td>
<td>2.5 (1.4)</td>
<td>2.2 (1.2)</td>
<td>-0.3</td>
<td>0.14</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Intensity</td>
<td>2.0 (1.2)</td>
<td>1.3 (0.5)</td>
<td>-0.7</td>
<td>1.3 (1.5)</td>
<td>1.2 (0.6)</td>
<td>-0.1</td>
<td>0.01*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.8 (1.9)</td>
<td>3.6 (2.0)</td>
<td>-0.2</td>
<td>3.1 (2.0)</td>
<td>2.5 (1.6)</td>
<td>-0.6</td>
<td>0.23</td>
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<td><strong>Social</strong></td>
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<td></td>
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</tr>
<tr>
<td>Diversity</td>
<td>6.6 (1.5)</td>
<td>6.3 (1.7)</td>
<td>-0.3</td>
<td>6.0 (1.7)</td>
<td>5.7 (1.7)</td>
<td>-0.3</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Intensity</td>
<td>2.4 (0.6)</td>
<td>2.5 (0.7)</td>
<td>0.1</td>
<td>2.5 (0.5)</td>
<td>2.0 (0.4)</td>
<td>-0.5</td>
<td>0.12</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.6 (0.8)</td>
<td>6.9 (3.5)</td>
<td>3.3</td>
<td>3.8 (1.3)</td>
<td>4.0 (1.0)</td>
<td>0.2</td>
<td>0.02*</td>
<td></td>
<td></td>
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<tr>
<td><strong>Self Improvement</strong></td>
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<td></td>
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</tr>
<tr>
<td>Diversity</td>
<td>7.6 (7.1)</td>
<td>5.5 (1.8)</td>
<td>-2.1</td>
<td>4.2 (2.8)</td>
<td>5.8 (2.2)</td>
<td>1.6</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>2.7 (0.4)</td>
<td>4.9 (7.4)</td>
<td>2.2</td>
<td>2.9 (0.6)</td>
<td>3.3 (1.0)</td>
<td>0.4</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.5 (1.2)</td>
<td>5.5 (1.9)</td>
<td>2.0</td>
<td>2.9 (1.6)</td>
<td>2.8 (1.8)</td>
<td>-0.1</td>
<td>0.01*</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

* significant change, p≤0.05
† Significant change calculated using Mann Whitney U test

**Potential Score Ranges**: Diversity = 0-55; Intensity = 0-7; Enjoyment = 1-5
4.7.2 Between-Group Analysis: CAPE Domain and Activity-Type Scores

In addition to the overall CAPE scores, domain scores and activity type scores were also calculated for each child. Domain scores describe the number of activities that are formal or informal. Activity type scores describe the nature of activities, which can be recreational, physically active, social, skill-based, or self-improvement in nature. While domain scores and activity type scores can be calculated for the 5 dimensions of participation (diversity, intensity, with whom, where, and enjoyment), this study analysed only the 3 dimensions which it was believed would be influenced by the intervention: diversity, intensity, and enjoyment.

Table 4.4 presents the mean domain scores and activity type scores for these 3 dimensions in both the intervention and the control group. The scores at baseline (Time 1) and post intervention, at 4 months post baseline (Time 2) are presented. The mean change in each group following the testing period is presented. This mean change of the intervention group was compared to the mean change in the control group using non parametric analysis with the Mann-Whitney U test.

At baseline, out of 55 activities listed on the CAPE, the 30 children reported choosing more informal (22.2) than formal (2.9) activities. Recreational activities represented the highest score for both diversity and intensity at baseline. Recreational activities are ad-hoc and include things like playing with toys or pets, watching television, or calling to friends. Of 55 available activities, 8.5 was the average reported diversity score at baseline for recreational activities. Of a maximum intensity score of 7, the reported mean intensity for recreational activities was 3.9 at baseline.

In contrast, the activities that were performed least frequently at baseline were skill-based and physical activities. The lowest mean diversity score at baseline, out of total score of 55, was in skill-based activities (2.3). The lowest mean intensity score at baseline was in physical activities, with a reported mean of 0.85 out of a maximum intensity of 7. The highest enjoyment scores at baseline were reported for social and recreational activities, with a mean of 3.7 and 3.3 respectively, out of a maximum enjoyment score of 5.

Following intervention, changes in domain scores and activity type scores were analysed, providing further insight into changes in the overall scores of participation.
The results of this further analysis demonstrated that the children in the intervention group experienced a significant improvement in their enjoyment (p=0.001) and intensity (p=0.05) scores during formal activities when compared with the control group. Formal activities are structured and organised, and include activities such as music or dance lessons, classes, or team based sports. Informal activities are less organised, and more ad-hoc in nature. This may include activities such as free play, reading, or calling into friends. There were no significant differences between the groups in any dimension of participation with respect to informal activities following retesting.

There was a significant change in the mean diversity (p=0.04), intensity (p=0.002), and enjoyment (p=0.02) scores of the intervention group with respect to recreational activity compared to the control group. It must be noted however, that with respect to diversity and intensity, this significant change was not due to an increase in the intervention group scores, but rather a decrease in the control group scores.

With respect to physical activities, which would include sports or general exercise, there was no significant change in the reported intensity or enjoyment in the intervention group compared with the control group, however the diversity score was significantly increased (p=0.01). This indicates that the children in the intervention group chose a greater number of physically active hobbies following physiotherapy intervention.

The mean intensity of skill-based activities was also significantly increased (p=0.01) in the intervention group following retesting, however enjoyment levels did not significantly increase in the intervention group compared to the control group. Mean enjoyment levels were significantly increased in both social (p=0.02) and self-improvement activities (p=0.001) in the intervention group compared to the control group following re-testing.

In summary, the physiotherapy intervention significantly changed the enjoyment of the children with DCD in terms of recreational, social, and skill-based type activities. As outlined in section 4.7.1, the overall intensity of the intervention group increased significantly (p = 0.01) following intervention. From the analysis in Table 4.5, it is evident that this significant change was observed in formal, recreational, and skill-based activities specifically.
4.7.3 Within-Group Analysis: Children’s Assessment of Participation and Enjoyment (CAPE) and Preferences for Activities for Children (PAC) Overall Scores

The 15 children in the intervention group completed the CAPE and PAC questionnaires at baseline, 4 months, 8 months, and 12 months. As previously described, when undertaking the CAPE questionnaire, the children were asked at each stage to report their participation for the previous 4 months. Therefore testing intervals of 4 months were chosen.

The results for each interval are presented in Table 4.5. The means, standard deviations, and mean change from baseline are presented for each interval. The direction of change is indicated. Within-group changes from baseline to 4 months, 8 months, and 12 months were compared. Data was not normally distributed; therefore non-parametric testing was used for analysis. Each score was compared to baseline using a paired samples Wilcoxon signed rank test.

At 4 months, the Intensity (p=0.06), Where (p=0.05), and Enjoyment (p=0.02) scores of the CAPE increased significantly. Diversity and With Whom scores of the CAPE were not statistically significant. At 4 months, the PAC score increased significantly (p=0.02).

At 8 months, the same within-group changes remained significantly improved compared to baseline. The Intensity (p=0.007), Where (p=0.01), and Enjoyment (p=0.01) scores of the CAPE were also significantly improved compared to baseline. The within-group change in the PAC score at 8 months from baseline was also statistically significant (p=0.01).

At 12 months, none of the within-group changes from baseline were statistically significant.
Table 4.5: Within-Group Analysis: CAPE and PAC Overall Scores are illustrated for the intervention group at baseline, 4 months, 8 months, and 12 months post baseline.

<table>
<thead>
<tr>
<th></th>
<th>4 Months (n=15)</th>
<th></th>
<th>8 Months (n=10)</th>
<th></th>
<th>12 Months (n=4)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Mean</td>
<td>Change from Baseline Direction</td>
<td>Mean Change</td>
<td>Significant Change (p=)</td>
<td>Mean Change</td>
<td>Significant Change (p=)</td>
</tr>
<tr>
<td>Diversity (SD)</td>
<td>25.2 (5)</td>
<td>27.1 (5.8)</td>
<td>1.9 ↑</td>
<td>0.16</td>
<td>27.8 (6.8)</td>
<td>2.6 ↑</td>
</tr>
<tr>
<td>Intensity (SD)</td>
<td>2.0 (0.4)</td>
<td>2.4 (0.6)</td>
<td>0.4 ↑</td>
<td>0.02*</td>
<td>2.5 (0.6)</td>
<td>0.5 ↑</td>
</tr>
<tr>
<td>With Whom (SD)</td>
<td>2.2 (0.3)</td>
<td>2.1 (0.2)</td>
<td>-0.1 ↓</td>
<td>0.86</td>
<td>2.4 (0.3)</td>
<td>0.2 ↑</td>
</tr>
<tr>
<td>Where (SD)</td>
<td>2.2 (0.5)</td>
<td>2.4 (0.4)</td>
<td>0.2 ↑</td>
<td>0.05*</td>
<td>2.7 (0.5)</td>
<td>0.5 ↑</td>
</tr>
<tr>
<td>Enjoyment (SD)</td>
<td>3.4 (0.5)</td>
<td>3.9 (0.4)</td>
<td>0.5 ↑</td>
<td>0.02*</td>
<td>4.3 (0.4)</td>
<td>0.9 ↑</td>
</tr>
<tr>
<td>PAC Score (SD)</td>
<td>1.6 (0.4)</td>
<td>2.0 (0.3)</td>
<td>0.4 ↑</td>
<td>0.02*</td>
<td>2.2 (0.2)</td>
<td>0.6 ↑</td>
</tr>
</tbody>
</table>

*† Significant change from baseline to 4 months, 8 months, and 12 months post baseline was calculated using Wilcoxon signed rank test.

*Significant change p ≤ 0.05

† represents an improvement, ↓ represents a disimprovement, and ↔ represents no change

Potential CAPE Score Ranges: Diversity = 0-55; Intensity = 0-7; With Whom = 1-5; Where = 1-6; Enjoyment = 1-5

Potential PAC Score Range: 1-3
4.8 Secondary Outcome Measure: Movement Assessment Battery for Children (MABC)

The results of the Movement Assessment Battery for Children (MABC) outcome measure will be presented in this section. Firstly, the results of the between-group analysis with respect to the MABC scores will be presented. Secondly, the results of within-group analysis of the MABC scores at baseline, 4 months, 8 months, and 12 months in the intervention group will be presented.

4.8.1 Between-Group Analysis: Movement Assessment Battery for Children (MABC)

All 30 children completed the MABC at baseline. The intervention group undertook the 10 week exercise class, and following this, all participants were re-assessed using the same outcome measure. This assessment took place at 4 months post baseline. The values for this measure recorded at Time 1 (baseline) and at Time 2 (follow up at 4 months) are outlined in this section. The results are presented in table format in Table 4.6. Mean scores, standard deviations, and mean differences are presented for all data.

Changes in the intervention group are compared to changes in the control group at 4 months. As the data was not normally distributed, non parametric testing was used. The Mann Whitney U test was used to compare the difference in means between the intervention group and the control group for statistical significance.

The between-group change in the total MABC score was statistically significant ($p = 0.001$). Two of the 3 subscales of MABC also demonstrated a significant between-group change. The between-group change in the Aiming & Catching subsection was statistically significant ($p=0.001$), as was the between-group change in the Balance subsection ($p=0.001$). The between group change in the Manual Dexterity subsection was not statistically significant.
Table 4.6: Between-Group Analysis: Percentile Scores of the Movement Assessment Battery for Children (MABC) for intervention and control groups, at Time 1 (baseline) and Time 2 (post intervention: 4 months post baseline).

<table>
<thead>
<tr>
<th></th>
<th>Intervention Group (n=15)</th>
<th>Control Group (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 1</td>
<td>Time 2</td>
</tr>
<tr>
<td></td>
<td>Time Difference</td>
<td>of Change</td>
</tr>
<tr>
<td>Total Score</td>
<td>1.90 (1.70)</td>
<td>21.2 (22.5)</td>
</tr>
<tr>
<td>Manual Dexterity</td>
<td>7.50 (10.0)</td>
<td>20.5 (27.2)</td>
</tr>
<tr>
<td>Aiming &amp; Catching</td>
<td>12.1 (11.7)</td>
<td>45.6 (24.4)</td>
</tr>
<tr>
<td>Balance</td>
<td>4.20 (4.10)</td>
<td>26.9 (14.7)</td>
</tr>
</tbody>
</table>

* Significant change between intervention group and control groups was calculated using Mann Whitney U test

† represents an improvement, ↓ represents a disimprovement, and ↔ represents no change

Scores displayed are in percentiles
4.8.2 Within-Group Analysis: Movement Assessment Battery for Children (MABC)

Fifteen children in the intervention group completed the MABC measure at baseline, 4 months, 8 months, and 12 months. The results at each time point are presented in Table 4.7. The means, standard deviations, and mean change from baseline are presented for each interval. The direction of change is indicated. Within-group changes from baseline to 4 months, 8 months, and 12 months were compared. As data was not normally distributed, non parametric testing was used. Each score was compared to baseline using a paired samples Wilcoxon signed rank test.

At 4 months, the within-group total score (p=0.001), Aiming & Catching score (p=0.002), and Balance (p=0.002) scores of the MABC increased significantly when compared to baseline measurements. The within-group change in the Manual Dexterity score was not statistically significant at 4 months.

At 8 months, this significant improvement was maintained. The within-group total score (p=0.01), Aiming & Catching score (p=0.01), and Balance (p=0.01) score maintained their significant improvement when compared to baseline. The within-group change in the Manual Dexterity score at 8 months from baseline was not statistically significant.

At 12 months, none of the within-group changes from baseline were statistically significant.
Table 4.7: Within-Group Analysis: Percentile Scores in the Movement Assessment Battery for Children (MABC) in the intervention group at baseline, 4 months, 8 months, and 12 months post baseline. Mean change from baseline and significance are demonstrated.

<table>
<thead>
<tr>
<th></th>
<th>4 Months (n=15)</th>
<th>8 Months (n=10)</th>
<th>12 Months (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Baseline Score</td>
<td>Mean Score</td>
<td>Mean Change</td>
</tr>
<tr>
<td>MABC Total (SD)</td>
<td>1.90 (1.70)</td>
<td>21.2 (22.5)</td>
<td>19.3*</td>
</tr>
<tr>
<td>Manual Dexterity (SD)</td>
<td>7.50 (10.0)</td>
<td>20.5 (27.2)</td>
<td>13.0</td>
</tr>
<tr>
<td>Aim &amp; Catching (SD)</td>
<td>12.1 (11.7)</td>
<td>45.6 (24.4)</td>
<td>33.5*</td>
</tr>
<tr>
<td>Balance (SD)</td>
<td>4.20 (4.10)</td>
<td>26.9 (14.7)</td>
<td>22.7*</td>
</tr>
</tbody>
</table>

‡ Significant change from baseline to 4 months, 8 months, and 12 months post intervention was calculated using Wilcoxon signed rank test

*Significant change p ≤ 0.05

↑ represents an improvement, ↓ represents a disimprovement, and ↔ represents no change

Scores displayed are in percentiles
4.9 Secondary Outcome Measure: Paediatric Balance Scale (PBS)

The results of the Paediatric Balance Scale (PBS) will be reported in this section. Firstly, the results of the between-group analysis with respect to the PBS scores will be presented. Secondly, the results of within-group analysis of the PBS scores at baseline, 4 months, 8 months, and 12 months in the intervention group will be presented.

4.9.1 Between-Group Analysis: Paediatric Balance Scale (PBS)

All 30 children completed the PBS at baseline. As with the other measures, the PBS was repeated at 4 months post baseline. The values for this measure recorded at Time 1 (baseline) and at Time 2 (follow up at 4 months) are outlined in this section. The results are presented in table format in Table 4.8. Mean scores, standard deviations, and mean differences are presented for all data.

Changes in the intervention group are compared to changes in the control group at 4 months. As the data was normally distributed, parametric testing was used. An independent samples t-test was used to compare the difference in means between the intervention group and the control group for statistical significance.

The between-group change in PBS score was statistically significant ($p = 0.01$).
Table 4.8: Between-Group Analysis: Scores and mean changes in the Paediatric Balance Scale (PBS) for the intervention and control groups at Time 1 (baseline) and Time 2 (post Intervention: 4 months post baseline)

<table>
<thead>
<tr>
<th></th>
<th>Intervention Group (n=15)</th>
<th>Control Group (n=15)</th>
<th>Time 1</th>
<th>Time2</th>
<th>Mean Change</th>
<th>Direction</th>
<th>Time 1</th>
<th>Time2</th>
<th>Mean Change</th>
<th>Direction</th>
<th>Significant Change ± (p=)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBS (SD)</td>
<td>51.2 (2.3)</td>
<td>55 (1)</td>
<td></td>
<td></td>
<td>3.8*</td>
<td>↑</td>
<td>49.7 (1.9)</td>
<td>50.4 (1.6)</td>
<td>0.7</td>
<td>↑</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

± Significant change between intervention and control groups was calculated using the independent samples t-test

* Significant change p≤ 0.05

↑ indicates improvement, ↓ indicates disimprovement, and ↔ indicates no change

Score Range: 0-56 points
4.9.2 Within-Group Analysis: Paediatric Balance Scale (PBS)

The 15 children in the intervention group completed the PBS measure at baseline, 4 months, 8 months, and 12 months. The results for each interval are presented in Table 4.9. The means, standard deviations, and mean change from baseline are presented for each interval. The direction of change is indicated. Within-group changes from baseline to 4 months, 8 months, and 12 months were compared. As data was normally distributed, parametric testing was used. Each score was compared to baseline using a paired samples t-test.

At 4 months, the within-group PBS score increased compared to baseline measurements with statistical significance (p=0.001). At 8 months, the same within-group changes remained significantly improved compared to baseline. The within-group PBS score at 8 months increased compared to the baseline score with statistical significance (p=0.001).

The within-group change in the PBS at 12 months was not statistically significant.
Table 4.9: Within-group Analysis: Scores in the Paediatric Balance Scale (PBS) in the intervention group at baseline, 4 months, 8 months, and 12 months post baseline, and analysis of significant change between time points

ǂ Paired samples t-test was used to compare the score at baseline to scores at 4 months, 8 months, and 12 months

* Significant change p ≤ 0.05

↑ represents an increase, ↓ represents a decrease, and ↔ represents no change

Score Range: 0-56 points

<table>
<thead>
<tr>
<th></th>
<th>4 Months (n=15)</th>
<th>8 Months (n=10)</th>
<th>12 Months (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBS</td>
<td>Mean Score (SD)</td>
<td>Mean Score (SD)</td>
<td>Mean Score (SD)</td>
</tr>
<tr>
<td></td>
<td>Baseline</td>
<td>Change from Baseline</td>
<td>Change from Baseline</td>
</tr>
<tr>
<td>Mean</td>
<td>51.2 (2.3)</td>
<td>55 (1)</td>
<td>55.5(0.7)</td>
</tr>
<tr>
<td>SD</td>
<td>3.8*</td>
<td>↑</td>
<td>4.3*</td>
</tr>
<tr>
<td>Significant Change (p=)</td>
<td>0.001*</td>
<td>↑</td>
<td>0.001*</td>
</tr>
<tr>
<td>Sig. Change (p=)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.10 Parent Interviews

The parents of the 30 children in the study were asked a series of 6 questions at baseline assessment. Some of the parents answered the questions in person, and some answered the questions over the phone. An answer of “Yes”, “No”, or “Unsure” was recorded for each question. The questions and responses at baseline are displayed in Table 4.10.

Table 4.10: Responses to parent interview questions during interviews conducted at baseline

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think your child enjoys playing sports? <em>(n=30)</em></td>
<td>13</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Do you think your child enjoys taking part in group activities? <em>(n=30)</em></td>
<td>22</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Do you think your child is aware of their physical limitations? <em>(n=30)</em></td>
<td>25</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Do you think your child is self conscious about their physical abilities? <em>(n=30)</em></td>
<td>18</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Does your child enjoy taking part in new activities? <em>(n=30)</em></td>
<td>15</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Has your child expressed a sense of failure? <em>(n=30)</em></td>
<td>14</td>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

Parents were also asked to describe their child’s level of participation in physical activity. The majority of parents *(n=20)* reported that their child needed encouragement to take part in physical activity. A number of parents used the words “sedentary” or “lazy” to describe their child. A number of parents described their child’s outdoor physical activity as being dependent upon the weather.

The 15 children who took part in the intervention were reassessed at 4 months. At this assessment, the children’s parents were asked three questions regarding their perception of their child’s enjoyment of the group exercise and the home programme. Responses were recorded by the researcher in a similar manner. The questions and responses are displayed in Table 4.11.
Table 4.11: Results of parent interviews carried out following intervention

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Unsure/Sometimes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think your child enjoyed attending the Physiotherapy classes?</td>
<td>11</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Did your child need a lot of encouragement from you to attend the Physiotherapy classes?</td>
<td>9</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Do you think your child enjoyed doing the home exercises?</td>
<td>9</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

4.11 Summary

In summary, the 30 children recruited to the study were comparable at baseline, and remained enrolled in the study for the entire duration. The majority of data variables were not normally distributed, and thus guided the choice of tests used in data analysis. Attendance at classes and compliance to the logbooks was reasonably good.

The primary outcome measure was found to have improved significantly in the intervention group compared to the control group. A significant improvement in the intensity dimension of the CAPE in the intervention group was noted. Following intervention, children demonstrated significant increases in some diversity, intensity, and enjoyment levels. A significant improvement in motor skills was also demonstrated in the MABC measure in the intervention group. Improvements in both participation and motor skills were maintained at 8 months.
5. DISCUSSION

5.1 Introduction

This study examined the effects of a community based group motor skills intervention programme on the participation and movement ability in children with Developmental Coordination Disorder (DCD). It was found that attendance at a 10 week group motor skills intervention programme improved some dimensions of participation in this client group. The study also demonstrated a significant reduction in the movement difficulty of children who attended a group motor skills intervention programme compared to a control group. The hypothesis of the study was therefore supported. The statistically significant improvements in outcomes were maintained over an 8 month period in children who attended the intervention group. The results of this study would indicate that the use of group based motor skills intervention programmes in the community to improve participation and movement ability in children with DCD is feasible, and provides a basis for further research in this area.

5.2 Baseline Demographics of the Study Population

The intervention and control groups in this study were similar in terms of baseline demographics, and were comparable with other studies concerned with group intervention in DCD (Hung & Pang 2010; Peens et al., 2008; Peters & Wright, 1999). There were 20 males and 10 females included in the study. This proportion of boys to girls reflects the higher prevalence of DCD amongst boys (Diagnostic and Statistical Manual, 5th Edition, 2013). Each child in the study met the diagnostic criteria for DCD as outlined in Chapter 1. The number of co-existing conditions of the clients in this study is consistent with the general finding that DCD frequently overlaps with other disorders (Kaplan et al., 1998).

Thirty-seven percent (n= 11) of the study population were overweight or obese, which was evaluated using the NHS National Obesity Observatory guidelines on BMI percentiles (2011). This figure is well above the national average of 26% of 9 year olds who are overweight or obese (Layte & McCrory 2011). Specifically, 7% (n=2) of the study population were overweight, and 30% (n=9) were obese. This is consistent with the study by Schott et al., (2007) where it was reported that approximately 37% of German children with DCD are overweight or obese. It is also consistent with the
finding of a systematic review of overweight and obesity in DCD by Hendrix et al., (2014) where it was documented that children with DCD between the ages of 4 and 14 had higher body mass indexes, waist circumferences, and greater percentages of body fat compared with controls without DCD.

The participation patterns of the children in this study at baseline were typical for a population with DCD, being comparable to previous studies (Fong et al., 2011; Jarus et al., 2011). Out of 55 available activities in the CAPE questionnaire, the majority of activities undertaken by the 30 children in this study were informal rather than formal. This is typical of a DCD population, where formal activities include things such as team sports, lessons, or classes. While this pattern is similar to that recorded in Jarus et al., (2011), it must be considered that over half of the children in the current study were medical card holders, and that their families may not have the means to fund formal activities. The impact of socioeconomic status on participation has been documented (Soref et al., 2011), and was reflected in the current study.

At baseline, the children in the current study chose mostly recreational activities in their spare time, choosing both a higher number of these activities and performing them more regularly than other activities. This pattern is identical to that found by Jarus et al., (2011). Skill-based and physical active hobbies were the lowest scoring activity types at baseline, which is also typical of the DCD population. Jarus et al., (2011) reported that in a non-DCD group, active physical and skill-based activities scored higher than in a DCD group. Of note, the children in both studies had low movement ability, with all scoring below the 5th percentile on the Movement Assessment Battery for Children (MABC). Jarus et al., (2011) reported a correlation between motor impairment and participation scores.

The movement ability at baseline of the children who took part in this study was quite low. Despite this study’s inclusion criteria which would have allowed children at or below the 15th percentile, each child recruited to this study was at or below the 5th percentile in the total score on the MABC. A score below the 5th percentile indicates a definite movement difficulty, whereas a score between the 5th and 15th percentiles indicates a probable movement difficulty. The mean percentile score for the intervention and control groups were 1.9 and 1.7 respectively. These average total scores are much lower than those in a similar study by Hung & Pang, (2010) where
in a study with 23 participants, only 13 scored lower than the 5\textsuperscript{th} percentile on the MABC. All of the children in this study were within a close range of scores, and were therefore comparable at baseline.

In summary, 30 children were recruited for the current study, and at baseline, satisfactorily represented the documented norms with respect to gender, body composition, movement ability, and participation patterns for children with DCD. The 30 children recruited, being between 7-10 years old, also represented a population that frequently attend physiotherapy for DCD. The similarity at baseline of the 30 children in this study provided a good basis for analysis of intervention effectiveness.

5.3 Change in the Children’s Assessment of Participation and Enjoyment (CAPE) and Preference for Activities of Children (PAC) questionnaire scores

Attendance at the 10 week group motor skills intervention programme in this study resulted in increased participation in the intervention group. Four of the 5 dimensions of participation (diversity, intensity, with whom, where, and enjoyment), as measured by the CAPE questionnaire’s overall scores, improved in the intervention group following the intervention programme, with the intensity dimension demonstrating significance. In comparison, the scores in the control group either decreased or stayed the same. The secondary within-group analysis demonstrated that these benefits were maintained at 8 months, and the value of group motor skills intervention with respect to participation has thus been demonstrated.

As discussed in Chapter 2, a systematic review of the impact of group motor skills or exercise intervention on participation and/or movement ability in children with Developmental Coordination Disorder (DCD) highlighted the dearth of high quality research in this area. Only one study, Hillier et al., (2010) was found to have measured participation following a group exercise intervention. As the authors did not use a standardised outcome measure of participation, it is unfortunately not possible to compare the results of both studies. Hillier et al. (2010) also studied a much younger group of children with DCD, who were as young as 5 years. Children this young are more dependent on their parents with respect to activity choices (Soref et al., 2011), and therefore cannot be readily compared to children aged 7-10 years. Therefore the results of the current study provide some of the first evidence for the
use of group motor skills intervention programmes in improving participation in children with DCD.

Children who attended the 10 week programme reported a greater diversity and intensity in their overall participation scores following intervention, compared to the control group. The overall intensity score was statistically significant, indicating that children who attended the programme went on to spend more time participating in out of school activities than the control group. By attending a class every week with other children with DCD, and practising with family at home, these children can be encouraged to do more activity in their out of school time than if not encouraged to do so. While it is possible that the higher intensity scores may simply reflect the extra time spent practising exercises as part of the group programme, further in-depth analysis of the intensity dimension reveals the specific areas of improvement.

Analysis of the domain and activity-type scores revealed that intensity was significantly improved in formal activities, recreational activities, and skill-based activities, indicating that children who took part in group intervention spent more time specifically on these activity types. With respect to the intensity score for formal and recreational activities however, this significant change is likely due to the reduction in scores of the control group, as opposed to an increase in scores in the intervention group. It is possible however, that following intervention, children either took up or returned to formal activities such as teams or clubs. The intervention group may have been encouraged to sustain these types of activities rather than giving them up. Parents may also have continued to encourage their children regarding activity following the group programme. Increased time spent on skill based activities following the group programme is a positive trend, indicating that improved motor skills led to an increased confidence in these activities. As previously discussed, the 10 week programme was also effective in improving the motor skills of the children in the intervention group. It is possible therefore that improved motor ability also made the children more likely to spend time on activities in their own spare time. This is consistent with the findings of Jarus et al., (2011), who reported a correlation between motor ability and participation in children with DCD.

The significant improvement in enjoyment scores in the specific areas of formal, recreational, and social activity types is an important finding of this study. With
respect to the emotional and psychological difficulties documented in children with DCD (Gillberg & Kadesjo, 2003), it is encouraging that enjoyment can be affected with group intervention. As reported in the parent interviews, many families reported that their children would be reluctant to take part in team or organised activities. Group intervention could be a useful means to encourage participation in formal activities, which would in turn create a basis for activities in adulthood.

In relation to physical activities, the significant increase in diversity scores of the intervention group compared to the control group is encouraging. This indicates that children chose a greater number of physical activities to do in their spare time following attendance at the 10 week programme. While the enjoyment scores in the area of physical activities did not increase significantly, the finding that more active hobbies featured following group motor skills intervention remains important. This could be due to a raised awareness in both children and families of the importance of exercise, especially as parents were informed of their child’s BMI percentile at assessment. Parental involvement is an important contributor to participation, as children of this age rely on the support of their parents to access many activities. Being physically active at physiologically beneficial intensities in childhood is important as it can prevent chronic diseases in adulthood (World Health Organisation, 2011).

The children in this study were aged between 7 and 10 years. A diagnosis of DCD is rarely made before age 5; therefore it is likely that the majority of children attending for treatment in the community will fall in this age group, or certainly between 5-10 years. This study highlights the importance of including children with DCD in groups from an early age, so that they might have an improved outlook for the future. As discussed in Chapter 1, it is well documented that the emotional and psychological problems of children with DCD persist into adulthood (Missiuna et al., 2009; Missiuna et al., 2007; Green et al., 2006). This group are also at risk of being overweight or obese (Cairney et al., 2005). Group motor skills intervention programmes that improve participation from an early age could be an effective way to limit these disadvantages in later childhood and into adulthood.

The results of the secondary long-term within-group analysis undertaken in this study have important implications for the practicalities of delivering group physiotherapy
programmes in the community. While the optimum duration of classes and layout of programmes is not known, the layout used in this study found that the children who attended the 10 week programme reported a statistically significant increase in intensity, enjoyment, and overall activity preference at both 4 months and 8 months post baseline. The sustained improvement in participation over 8 months is a promising finding for community physiotherapists, despite the relatively small number of children recruited to this study. A 10 week group motor skills intervention programme could be a feasible method for the improvement of participation in the short to medium term in children with DCD, and could be considered by community physiotherapists in service planning for this client group.

In summary, while participation is a broad concept, the use of the CAPE questionnaire in this study demonstrated the value of a 10 week group motor skills intervention programme in improving participation in children with DCD. Of the 5 dimensions of participation – diversity, intensity, with whom, where, and enjoyment; intensity was significantly improved overall following this intervention. Children and their families chose more active hobbies following intervention, and spent more time on recreational, formal, and skill-based activities compared to a control group of similar children in the same period. These benefits, sustained at 8 months, are evidence of the effectiveness of a structured group motor skills intervention programme.

### 5.4 Changes in Movement Assessment Battery for Children (MABC) Scores

The intervention group demonstrated statistically significant improvements in MABC scores when compared to the control group following their participation in the 10 week intervention programme. Secondary within-group analysis demonstrated that these improvements were maintained at 8 months post baseline. The intervention group improved in all subsections of the MABC following attendance at a 10 week intervention programme compared to the control group. Statistical significance was demonstrated in 3 of 4 categories: total score, aiming & catching, and balance. While an improvement in manual dexterity was achieved, these scores were not statistically significant, as manual dexterity tasks were not specifically performed as part of the intervention. Improvements in shoulder strength and stability are likely to have contributed somewhat to the improvement in manual dexterity scores, but without
specific practise of manual dexterity tasks, the other subsections of the MABC logically improved to a greater extent.

Peters & Wright (1999) demonstrated a similar finding following a 10 week intervention in a group of children with DCD. The authors found significant improvements in aiming & catching and balance measures, but the improvement in manual dexterity was not significant. The findings of a 10 week programme by Hung & Pang (2010) found only improvements in the total MABC score, and not in any of the subsections. This may indicate that the design of the exercise class and associated home programme in the current study’s intervention programme was more successful in targeting the majority of motor skills both through group training and in the home exercise programme. This study would suggest that some concentration on manual dexterity tasks both in the group exercise and home programme should be included in future programmes.

The large improvements observed in MABC scores in this study conflict with other previous studies that offered group intervention (Peens et al., 2008; Pless et al., 2000). It is possible that the significant improvements seen in the current study were due to the low scores of the children at baseline, who therefore had a greater capacity for improvement. Each child in this study scored below the 5th percentile in the MABC, which is in contrast to similar group intervention studies, where many of the participants scored between the 5th and 15th percentile at baseline. Of note, Pless et al., (2000) showed that a 10 week group intervention programme was beneficial for children with mild deficits, but not for those with severe movement difficulty. The discrepancy between these results may be due to the higher therapist to child ratio (1:6-10) in the study of Pless et al., (2000) than in this study (1:5). It may be speculated that a lower therapist to child ratio is favourable for children with more severe motor difficulties.

The significant improvements demonstrated by the secondary within-group analysis which were maintained at 8 months post baseline, illustrate a favourable result following intervention. While the findings were not significant at 12 months, there was a large difference in mean scores of the 4 children retested at one year post recruitment. Mean total, balance, and aiming & catching scores following intervention were found to be within normal limits at 12 months. Despite the small number of
children tested, is an encouraging trend which provides a basis for further work in the area of the long term effects of group motor skills training programmes on children with DCD. Sustained improvement in motor skills at one year post completion of a 10 week programme could have an impact on service planning in this area, however further work with a larger number of children is warranted to investigate this.

In summary, in addition to significantly impacting upon participation of children with DCD, this study has demonstrated the immense improvements in movement ability achievable with a structured group motor skills intervention programme. In addition to participation scores, the improvements in movement ability were maintained long after the intervention had been completed. It is known that children with DCD report lower perceived generalized self-efficacy with respect to their physical abilities, which may be an important factor influencing their lower levels of participation in physical activity (Cairney et al., 2005). This study has contributed to the growing body of evidence that supports group motor skills intervention in the community for children with DCD with respect to motor ability, and also with respect to improving participation.

5.5 Change in the Paediatric Balance Scale (PBS)

A statistically significant improvement in the Paediatric Balance Scale (PBS) was demonstrated following intervention. This further illustrates the significant improvement in balance ability in the children who attended the 10 week intervention. The change in the PBS was statistically significant in the intervention group compared to the control group. Similar to the MABC score, the improvement in PBS score in the intervention group upon secondary within-group analysis was significant at 4 months at 8 months. It was not statistically significant at 12 months.

The PBS is purely a measure of balance, and can be used to complement the findings of the balance test in the MABC. The PBS proved to be a quick and easy measure in assessing the children in this study. The effects of the group programme were demonstrated by changes in the measure, which may take less time than completing the entire MABC measure. While the MABC is a valuable, widely-used tool in assessing children with DCD, the PBS could be a useful measure for physiotherapists specifically evaluating the effects of therapy on balance, as some children with DCD may struggle with this specific area.
5.6 Parent Perceptions of Children’s Abilities

Parents’ perceptions of their child’s participation and the impact of their child’s movement difficulty on their lives were ascertained through parent interviews. Following intervention, the opinions of parents regarding the programme were also sought. Further in depth analysis of parents’ perception would have been desirable, however was not possible within the scope of this study, as discussed in study limitations. However, the answers provided by parents at the beginning of the study were valuable, and highlight the importance of socio-psychological factors in treating children with DCD.

Most parents (n = 25) reported that their child was aware of their physical limitations, which would be expected given that the children were aged 7-10 and the vast majority were also attending speech and language therapy, and occupational therapy. This study found that the majority of parents (n=18) also believed their child to be self-conscious of their physical abilities. This finding is consistent with other research (Cairney et al., 2005; Green et al., 2011; Schutz & Maffeis, 2002) that has proposed that children with DCD are self-conscious about their poor motor skills and therefore spend significantly less time participating in structured, physical activity than children without DCD (Green et al., 2011; Schutz & Maffeis, 2002).

Half of the parents reported that their child did not enjoy playing sports, which is consistent with the other research that has found that many children with DCD are relatively unmotivated to engage in competitive sport as they are aware that their physical abilities are poorer than their peers (Cairney et al., 2005; Poulsen et al., 2008). However despite this, the vast majority (n = 22) reported that they believed that their child enjoyed group activities, and were generally happy to try new activities (n=15). This finding is reflected in the mean CAPE diversity score at baseline, which indicated a relatively high number of activities falling into the category of social activity types. The children in this study had a relatively high level of social engagement, which is in contrast to the findings of numerous other studies (Chesson et al., 1990; Chia 1997; Segal et al., 2002; Mandich et al., 2003; Rodger & Mandich 2005).

The results of the parent interviews also reveal that some of the parents were unsure as to their child’s abilities or feelings. Some parents were unsure (n=6) of their child’s
enjoyment of trying new activities or group activities. Two parents were unable to comment as to whether they thought their child enjoyed playing sports. There is very little research on the impact of DCD on parents and parents’ perceptions of their own child’s abilities. However, it is known that children with DCD conceal their problems by avoiding certain activities (Cairney et al., 2007), which can lead to repeated experiences of failure (Mandich et al., 2003) – this is consistent with the findings in the parent interviews. It is possible that some parents were unable to comment about their child’s participation because their child concealed their problems. This highlights an important implication for practise; that physiotherapists should possibly raise this issue with parents and children together, so that expectations and goals can be better set.

Following the intervention, parents were asked their opinions of their child’s enjoyment of the classes and the home programme. The majority of parents reported that in their opinion, their child enjoyed attending the class (n=11) and enjoyed doing the home exercise programme (n=9). The majority of the parents (n=9) reported that their child needed encouragement to attend the class however it is encouraging that once they did attend, they were perceived to enjoy taking part. Some (n=7) parents commented that their child enjoyed the social aspect of the class and enjoyed meeting their friends each week. These responses correlate with the finding previously discussed, that children who attended the intervention were found to have a significantly improved level of enjoyment in social-type activities afterwards.

In summary, the feedback in relation to the programme from parents indicates that the 10 week group intervention was acceptable to both parents and children. Parents observed that their children enjoyed the social aspects of the class, which is in keeping with previous studies on group intervention in DCD, where psychological and emotional benefits have been documented (Peters & Wright, 1999; Hung & Pang 2010). Children with poor motor performance tend to be less accepted by their peers in play settings (Livesey et al., 2010), therefore the reported enjoyment of the groups with similarly performing peers is encouraging. These findings should serve as an encouragement to physiotherapists to run group sessions for children with DCD. This evidence of parental approval is a useful point for physiotherapists discussing these specific concerns with parents.
5.7 Attendance to Classes and Safety of Classes

The 10 week group exercise programme appeared to be well tolerated by participants. All children enrolled in the study completed the intervention, and adherence rates to the classes were generally high. The mean attendance of the intervention group was 85% (8.5 out of 10 sessions). Parent and child satisfaction with the classes was high, as previously discussed. No detrimental effects were noted on either participation or motor ability of the children who attended. There were no episodes of injury or evidence of emotional distress during the exercise classes.

The ratio of physiotherapist to children in the exercise classes was 1:5 at all times, which facilitated adequate supervision of the children and also enabled the children to get some individual instruction as well as taking part in a group. The ratio of therapist to children is on the whole, higher in other group intervention studies. Peters & Wright (1999) had a ratio of 1:14, Pless et al., (2000) had a ratio of 1:6-10, and Dunford (2011) had a ratio of 1:8. Hung & Pang (2010) had a similar ratio to this study, with 1:4-6 children. It is unclear what the optimum ratio of therapist to child is. The ratio of 1:5 used in this study was practical given the age of the children and the size of the gym in which the programme took place. Ultimately the age, behaviour, and cooperation of the children in the group, as well as the equipment and space available will dictate the size of any group for children with DCD.

To date, there are no available guidelines internationally on the optimum design of group programmes for children with DCD. The design of the classes in terms of frequency and duration was comparable to other group intervention studies (Pless et al., 2000, Peters & Wright 1999; Hung & Pang 2010). Other studies that have used a 10 week programme with one session per week (Pless et al., 2000, Peters & Wright 1999) had similar attendance to this study. Peters & Wright (1999) reported a mean attendance to their 10 week programme of 86%, which is similar to the 85% found in this study. Some studies on group intervention had a design that involved intense therapy, with some programmes involving between 3 to 5 sessions of therapy a week (Tsai et al., 2009; Tsai et al., 2012). The attendance of these studies was not reported. Low attendance was reported in a study by Kane (2009), which involved intervention over 6 weeks, with 2 sessions a week. Attendance was considerably
lower at 50%. It is possible that having more than one class could lead to lower attendance, as many families have multiple commitments.

In summary, the group motor skills intervention programme used in this study had an excellent attendance rate compared to other studies (Pless et al., 2000, Peters & Wright 1999). This high attendance rate to classes was in part achieved by sending a reminder by text message to parents before each class. Many parents responded to the text and remarked their appreciation for the reminder. The practise of sending reminder text messages can be easily adopted into practise by community physiotherapists as a method of optimising attendance.

5.8 Log Book

A previously discussed, the compliance to the home exercise programme as indicated by the log books was variable. The exercises in the log book did not necessarily increase with difficulty as the weeks progressed, and many of the children would have previously practised some or all of the exercises at some point in either previous physiotherapy or occupational therapy sessions. The reduction in compliance from the beginning to the end of the 10 week programme may reflect the children’s reduced interest in the exercises as the programme progressed. This could be addressed in future by perhaps holding a competition at the mid-point of the programme, or by offering an incentive to the children for the best-kept log book. Alternatively, the weekly text reminder for the group sent to the parents could include a reminder about the home programme.

Each exercise class began with a review of the home exercise for the previous week. The lowest percentage for the week 10 exercise could be explained by the fact that the exercise followed the last class of the programme, and many of the children may simply have stopped filling out the log book once the programme finished. This was a flaw in the log book design, and it may have been more straightforward to include only 9 exercises in the log book and collect them on the last day of class.

Of the 10 exercises, 4 required equipment, such as a tennis ball, gym ball, a target, and a chalk line. This led to some inconsistency in compliance to the log book, as some children made comments during the classes that they did not have the required equipment at home. The week 2 exercise, target practise, required equipment but
had the highest compliance rate. The equipment suggested for this activity in the log
book was a pair of socks and a homemade target, which were both readily available
in the children’s homes. A lower rate of compliance of 67% was recorded for the
week 6 exercise of tennis ball throwing, perhaps because some children did not have
access to a suitable ball. A low rate of compliance of 59% was also recorded in the
week 8 exercise of ball rolling. While the photo included in the log book was of a child
using a gym ball, the children were advised to use any ball they had at home for the
activity, in the case where they did not have a gym ball. The photo in the log book
may have been misleading to parents. This exercise was practised during the class
using gym balls. The other low scoring item at 64% was the line walking exercise in
week 9, which involved either drawing a chalk line or making a line with sellotape.
The set-up of this exercise may have been a barrier to compliance.

There are obvious limitations in the recording of compliance via a log book in this
manner, as the accuracy of recordings cannot be standardised. A similar approach of
using log books to record compliance to home exercise was used in the group
intervention study by Hung & Pang (2010). The mean compliance of children
attending an exercise group to home exercise was recorded as 50%. Hung & Pang
(2010) found no significant correlation between home compliance and improvement
in motor ability. However, this mean compliance was quite low. The difficulty in
analysing compliance to home programmes is further illustrated in Kane et al.,
(2009), which was a small trial with 3 children with DCD. An 8 week home
programme was given to the children. There was a large variability in compliance,
with one child failing to complete any home exercise, the second child exercising at
home on 4 occasions, and the third completing home exercise on 38 occasions.

While the value of the log book and recorded compliance may be limited, the overall
average compliance for the 10 weeks was 72%, which is relatively high compared to
other studies, and is overall satisfactory considering the schoolwork and
extracurricular activities of the children. It is clear that the children involved in the
intervention in this study practised the skills covered in class to some extent at home,
which likely contributed to the improvement in motor ability scores and in participation
scores.
Compliance to log book recording in future studies or in practise may be improved by asking participants to bring the log book to each class so that it can be checked by the physiotherapist. Similar to homework in school, this may give the child a greater sense of responsibility over their logbook. Providing an incentive to the children, such as a prize for the best logbook, may also improve compliance. However, truthful and accurate completion of a log book such as this depends on the involvement on the parents as well as the children.

5.9 Study Strengths

This study contributes to the body of evidence regarding the effects of a group motor skills intervention programme on both participation and movement ability in children with DCD. To this author’s knowledge, no study has previously examined the effects of group motor skills intervention on participation and enjoyment in children with DCD. Strengths of the study include the study design and methodological quality. A sample size calculation was performed, and the study was suitably powered to accurately detect significant improvement in the motor ability of the participants. The children were adequately randomized and the presence of control group enhanced the opportunity to reflect on the impact of change following intervention. There were no dropouts from the study and attendance to the intervention was high.

The total of 72 assessments was carried out in a standardised manner by the same researcher. It was not possible however to blind the assessor as the principal researcher undertook assessments and delivered the exercise classes, which could potentially expose the study to bias. However, the randomisation was undertaken by an individual independent to the study. All 60 exercise classes were delivered by the same researcher in a standardised manner. This is a methodological strength of the study.

Few studies involving intervention in children with DCD include long-term analysis. Long-term follow up of participants at 8 and 12 months, which allowed for analysis of the within-group changes over time, is a further strength of this study. While time constraints meant that it was not possible to follow up all 15 children who took part in the intervention, analysis of the results at 8 and 12 months was valuable.
5.10 Study Limitations

A limitation of the study was the limited quality of the parent interviews. As previously outlined in the methods section, it was not possible to record and transcribe the parent interviews as initially intended, for ethical and practical reasons. Instead, the “yes/no/unsure” responses of parents were recorded and analysed.

A potential limitation of the study was the repeated use of the MABC outcome measure, which was used at baseline and 4 months with every child, and at 8 and 12 months with some of the children, as previously outlined. The developer’s recommended retest intervals are a minimum of 6 months to minimize the possibility of a learning effect. While it is acknowledged that there may be issues with using the assessment with shorter intervals, the work by Sugden & Chambers (2006) suggests that a learning effect does not occur. It was also taken into account that with the majority (93%) of children in this study attending Occupational Therapy, there was a possibility that they would have done the MABC during an assessment elsewhere during the course of the study.

Finally, the sample size calculation was based on the MABC, as details of minimal significant change for this measure were freely available in the literature. A limitation therefore was that the study was not powered using the primary outcome measure. The CAPE was not used to calculate sample size as values for standard deviation and clinically significant change could not be found in the literature. A greater number of participants may have been required for change in the CAPE and PAC measures, as despite a trend towards improvement in participation in the intervention group, the majority of this result was not statistically significant when compared to the control group.

5.11 Recommendations

The systematic review completed as part of this study highlighted the dearth of evidence for group motor skills intervention programmes with respect to participation in children with DCD. The negative consequences of sub-optimal participation are well documented (Poulsen et al., 2008; Kolehmainen et al., 2011; Soref et al., 2011), however no intervention is known to have a positive effect on participation.
Based on the assessments conducted during this study, it is recommended that participation be measured by physiotherapists in practice using a standardised measure, and discussed with parents. As previously mentioned, some parents have a limited insight into their child’s participation, and this should be highlighted by physiotherapists. With increasing pressures on physiotherapy services in the community however, it is likely that a lengthy questionnaire would not be prioritised in practice. To this end, the CAPE questionnaire can be posted to parents and completed in the home, prior to attendance at a physiotherapy session. Physiotherapists in practice as well as parents require an increased awareness of the importance of participation in children with DCD.

While further work is warranted to confirm the findings of this study, a structured 10 week group motor skills intervention programme has been demonstrated to be a feasible and promising approach for improving motor skills and participation in children with DCD. The 10 week programme with a ratio of 1 physiotherapist to 5 children was well-attended and demonstrated significant results. As previously outlined, the maintenance of these results at 8 months is a useful guide to practice. It is possible that a typical child with DCD, providing they have no additional impairments, could be well served with one assessment, one 10 week block of physiotherapy, and one review per 12 months. This could at least provide the basis for department policy and service planning.

Longer-term analysis of participation patterns in children with DCD, following group intervention, is recommended following the results of this study. While significant results were not found at 12 months, only a small number of children were followed up at that point in the current study. It is documented that motor and psychosocial problems persist into adulthood in children with DCD (Missiuna et al., 2009; Missiuna et al., 2007; Green et al., 2006); however the impact of regular group motor skills interventions in the younger years on this age group is unknown. It is possible that improving participation and encouraging children to access a wide variety of activities in primary school could influence choices later in life; however this has not been demonstrated to date.

It is likely that other interventions by physiotherapists may have a positive impact upon participation in children with DCD. Parents were not included in the intervention
in this study, with the exception of their involvement with the logbooks. It is possible that increasing the parents’ involvement in their child’s management may have a positive impact on participation measures. It has been documented that children with DCD are more likely to participate in physical activity for example, if their primary carer does (Beutum et al., 2013). In addition, the value of individual physiotherapy sessions or joint work with other disciplines such as occupational therapists with respect to participation is also unknown, and would add to the body of evidence to guide intervention in this area. Children with DCD who are not suitable for group therapy should be included in future work in this area.

While not incorporated into the intervention in this particular study, weight management is clearly an important issue in the DCD population, with 37% of this small sample of Irish children being overweight or obese, which is above the national average of 26% (Layte & McCrory 2011). Community physiotherapists are well placed to offer health promotion advice, and given that children with DCD are at risk with respect to this health issue (Cairney et al., 2011) and cardiovascular disease (Beutum et al., 2013), weight management for families should potentially be incorporated into DCD group exercise programmes.

5.12 Conclusion

In conclusion, the hypothesis of the current study was supported, in a sample of 30 Irish children which satisfactorily represented the documented norms with respect to gender, body composition, movement ability, and participation patterns for children with DCD. Participation and movement ability were significantly improved in children with DCD following a 10 week group physiotherapy intervention. The results of the study have implications for practice, providing evidence for the use of group motor skills intervention programmes in children with DCD in the community. The importance of participation patterns in children with DCD has been highlighted, as well as areas for future research.
REFERENCES


Appendix 1 Letter of Ethical Approval from UCD

2nd October 2012

Ms Caitriona Walsh

c/o Dr Tara Cusack

UCD School of Public Health, Physiotherapy, and Population Science
Health Sciences Centre
Belfield
Dublin 4

Re: LS-12-137-Walsh-Cusack: The effect of Physiotherapy on Participation in children with Developmental Coordination Disorder

Dear Ms Walsh

Thank you for your response to the Human Research Ethics Committee – Sciences (01/10/12). The Decision of the Committee is to grant approval for this application which is subject to the conditions set out below.

Please note that approval is for the work and the time period specified in the above protocol and is subject to the following:

- If applicable, all permissions to access participants, whether internal (heads of Schools/Registrar) or external are obtained before the recruitment of the participants is commenced;
- Any amendments or requests to extend the original approved study will need to be approved by the Committee. Therefore you will need to submit by email the Request to Amend/Extend Form (HREC Doc 10);
- Any unexpected adverse events that occur during the conduct of your research should be notified to the Committee. Therefore you will need to Submit, by email, an Unexpected Adverse Events Report (HREC Doc 11);
- You or your supervisor (if applicable) are required to submit a signed End of Study Report Form (HREC Doc 12) to the Committee upon the completion of your study;
This approval is granted on condition that you ensure that, in compliance with the Data Protection Acts 1988 and 2003. If applicable, all data will be destroyed in accordance with your application and that you will confirm this in your End of Study Report (HREC Doc 12), or indicate when this will occur and how this will be communicated to the Human Research Ethics Committee;

- You may require copies of submitted documentation relating to this approved application and therefore we advise that you retain copies for your own records;
- Please note that the granting of this ethical approval is premised on the assumption that the research will be carried out within the limits of the law;
- Please also note that approved applications and any subsequent amendments are subject to a Research Ethics Compliance Review.

The Committee wishes you well with your research and look forward to receiving your End of Study Report. All forms are available on the website www.ucd.ie/researchethics please ensure that you submit the latest version of the relevant form. If you have any queries regarding the above please contact the Office of Research Ethics and please quote your reference in all correspondence.

Yours sincerely,

[Signature]

Professor William Watson
Chair, Human Research Ethics Committee - Sciences
Appendix 2 Letter of Ethical Approval from AMNCH

October 15th 2012

Re: The effect of community-based group motor skills intervention on participation levels in children aged 7-10 with Developmental Coordination Disorder

Please quote this reference in any follow up to this letter: 2012/10/32 Chairman's Action

Dear Ms. Walsh,

Thank you for your recent submission of the above proposal to the SJH/AMNCH Research Ethics Committee.

The Chairman, having reviewed the proposal on behalf of the SJH/AMNCH Research Ethics Committee has given ethical approval on behalf of the Committee.

Yours sincerely

Ms. Ursula Ryan
Secretary,
SJH/AMNCH Research Ethics Committee
Appendix 3: Information Leaflet for Health Professionals

UCD School of Public Health, Physiotherapy and Population Science

UCD Health Sciences Centre,
University College Dublin,
Belfield, Dublin 4, Ireland

T +353 1 716 6500
P +353 1 716 6501

Information Leaflet for Health Professionals

Project Title
"The effect of community-based group motor skills intervention on participation levels in children aged 7-10 with Developmental Coordination Disorder"

Aims & Objectives
The study aims to examine changes in participation and motor performance in out of school activity in children aged 7-10 with Developmental Coordination Disorder (DCD), or Movement Difficulty as defined by the Movement Assessment Battery for Children (MABC) score <15th percentile, following participation in a community-based motor skills intervention group programme. The study intends to examine the effectiveness of the 10 week gross motor intervention programme for improving participation levels in children with DCD. The value of the intervention programme will be examined objectively by means of Movement Assessment Battery for Children (MABC), Paediatric Balance Scale (PBS), and Children’s Assessment of Participation and Enjoyment Questionnaire (CAPE). The value of the programme will also be examined by means of parental interviews before and after the intervention.

Methodology
Participants
The parents of children between the ages of 7-10 who have a movement difficulty and who fulfill the inclusion criteria will be asked to consent to their child’s participation in this study.

Inclusion Criteria
Children age 7-10 (inclusive) with a movement difficulty as indicated by the Movement Assessment Battery for Children (M-ABC). Children scoring a total score at the 15th percentile or below will be included in the study.
Exclusion Criteria
Children with physical or intellectual disability that may be the cause of movement difficulty. Children with behavioural difficulty that would be unable to participate in group therapy.

Intervention
Children will be placed in either an intervention or control group. The intervention group will attend a 10 week group motor skills intervention programme consisting of 10 sessions of an hour each in the Physiotherapy Gym in Chamber House, Tallaght.

The control group will remain on the Physiotherapy waiting list for the duration of the intervention group. The control group will receive identical intervention once the study has been completed.

Statistical Analysis
Statistical analysis will be performed using the Statistical Package for the Social Sciences (SPSS) software programme. The effect of intervention on motor performance, PBS score and CAPE score in participants will be examined using parametric and non-parametric data analyses.
Appendix 4: Information Leaflet for Parents and Consent Form

Information Leaflet for Participants
The name of this study is “The effect of community-based group motor skills intervention on participation levels in children aged 7-10 with Developmental Coordination Disorder”. The research is being carried out by Ms. Caitriona Walsh (Physiotherapist) as part of a Masters programme in UCD, under the School of Public Health, Physiotherapy, and Performance Science.

What is this Research About?
This research is about how children with movement difficulty, or clumsiness, participate in sports and hobbies in their spare time. It is about how much children with clumsiness enjoy activities and taking part with other children outside of activities in school. The research is about how physiotherapy treatment might improve how these children take part in exercise and sporting activities.

Why is this Research Being Done?
Children with movement difficulty, or clumsiness, make up 6% of the school-age population. These children can often have some difficulty with everyday activities, and this may have an effect on their confidence both at school and at home. These children sometimes choose hobbies that are less active, and sometimes can prefer to be on their own rather than take part in group or team activities with other children.

The research aims to show that physiotherapy treatment can help these children to take part in more active hobbies, and to help them take part in more exercise. Physiotherapy with groups of children with similar abilities may help to improve skills like co-ordination, balance, and strength. Physiotherapy in groups may also help to improve the confidence of clumsy or uncoordinated children.

Why is your child being invited?
Your child is invited to this study as they are between 7-10 years old, and have been identified as possibly having movement difficulty, or clumsiness. Your child has been deemed suitable to take part and benefit from group physiotherapy sessions. The aim of these sessions is to improve motor skills, and to encourage participation in sporting activities in your child.
What will happen if you decide to take part in this study?
The study will be explained to you in detail and you will be required to sign a consent form on behalf of your child, should you agree to take part. You and your child will be invited to an assessment appointment, where your child will be screened by the Physiotherapist. This will take approximately one hour. Your child will be assessed for balance, and gross motor skills. Your child will fill out a questionnaire with the help of the Physiotherapist, about the kind of activities they like to do in their spare time. The Physiotherapist will conduct a brief interview with you, about your child’s abilities and hobbies. In total, 30-60 children will be screened for this study. Recruitment for this study will take approximately 3 months. Your child will not have to wait until all children are recruited, as multiple classes will be run. Once your child has completed the initial assessment, they will then be randomly allocated into a treatment or a control group. The treatment group will begin immediately after the assessment. This group will do an exercise class, which will take place once a week for 10 weeks. Each session will last one hour. This class will be run by the Physiotherapist, and will involve exercise to improve strength, balance, and co-ordination. Each child will be given one exercise to practise each week. Children will be encouraged to take part in sporting activities and to interact with other children who are at a similar level to themselves. They will be encouraged to do some exercise at home and to enjoy the activities. Parents will be provided with a log book to keep record of how many exercises are done at home each week.
The control group will get the same Physiotherapy group treatment, but this will take place after the research period is over. Children in the control group will wait 10 weeks for group treatment. At the end of the 10 week programme, your child will be reassessed individually by the same Physiotherapist.

Data
Your child’s scores will be used at the end of the study to see if levels of participation improved after the Physiotherapy sessions. All data provided by you and your child will be kept confidential by the researcher and will be coded and kept in a locked cabinet. Your child’s identity will remain confidential and their name will not be published. All data will be destroyed upon completion of the study, and will be held for a maximum of 5 years.
Benefits
Your child will benefit from this study as they will be taking place in weekly Physiotherapy treatment, and will be working on a specific exercise programme each week.

Risks
As with any physical activity, there is a small risk of injury to your child during the exercise classes. The Physiotherapist is trained in First Aid. Your child may experience some tiredness during the exercises. It is possible that your child may experience some feelings of frustration or upset during some exercises that they may find challenging. The Physiotherapist running the classes will provide reassurance and encouragement to your child during any activity they find difficult.

Withdrawal
You are free to change your mind and withdraw your child from the study at any time should you wish to do so. Participation in this study is voluntary and you will not be penalised for withdrawal of your child.

Alternative Treatment
Your child does not have to be part of this study to receive Physiotherapy treatment.

Outcome
You will be given detailed feedback on your child’s results and the overall results of the study both in writing and in person from the researching Physiotherapist.

Further Information
You can read more about movement difficulty and Physiotherapy treatment for this condition at the following websites: www.dypraxisfoundation.org.uk or www.dypraxis.ie

Contact Details
Please take time to consider whether you want to take part in this research or not. If you have any questions about the research, please telephone me, Caitriona Walsh at 086-7810146 or contact me by e-mail caitriona.walsh4@ucdconnect.ie. You may also contact the supervisor of this study, Dr. Tara Cusack, at 01-7166313 or by email t_cusack@ucd.ie. If you agree to take part in the research, please sign the form below and keep one copy of this agreement for your future reference.
Consent Form

Statement of Consent:

I have read this consent form and discussed it with my child. I have had time to consider whether my child will take part in this study. I understand that his/her participation is voluntary (it is his or her choice) and that we are free to withdraw from the research at any time without disadvantage. I agree that my child may take part in this research. I agree that the data can be used in the publication of higher degrees or scientific publications, and I understand that my name or my child’s name will not be identified.

Name of Child Participating (in block letters)

________________________

Name of Parent/Guardian (in block letters)

________________________

Signature: ________________________________

Date: __________________

Child’s Assent

I have read this consent form and I agree to take part in this research.

Name of Child (in block letters)

________________________

Signature of Child:

________________________

Date: __________________
Appendix 5: Information Leaflet for Children

Information Leaflet for Children

Who am I?
My name is Caithriona and I am a Physiotherapist. A Physiotherapist, or Physio, works in places to do with health and sports. A Physio helps people with the movement of their bodies.

What is this Study about?
This study is about sports and hobbies you enjoy doing in your spare time. I am trying to find out if Physio will help you take part in more games and sports outside of school.
Why am I being asked to take part in this study?
I am looking for children aged 7-10 who need Physio to help with their balance, strength, and hobbies that involve sports. You are being invited to take part because you are the right age and I think Physio groups will help you to take part in more activities at home.

What will I have to do?
You will be asked to come to the Physio gym with your parent and I will ask you a few questions about your favourite hobbies. Then we will do some games together to see what your balance, throwing, catching, and drawing is like. We will do this to see what things you are best at, and what things you need to practise a little more.
Then you will come to after-school Physio exercise groups with some other children who are close in age to you. We will have 10 weeks of group sessions together. In these groups we will play games and some sports to help things like balancing, running, kicking balls, and aiming and catching. This might be similar to your P.E. classes in school.
After we finish the exercise classes, we will do a test together again to see if the exercise classes helped your skills.

What if I don’t like it?
I hope you will have fun at the exercises classes, but if you don’t like it, you can talk to your Mum or Dad about it, and if you really don’t like it, you can stop coming at any time.
Appendix 6: Correspondence from Pearson PLC regarding use of CAPE/PAC

from: HAS-SAT Shared Dist. and Licensing pas.Licensing@pearson.com

:  

to: walshc6@gmail.com

date: Fri, Aug 17, 2012 at 3:36 PM

subj: Permission Request related to the NCS Pearson owned CAPE and the Pearson UK owned Movement ABC tests for student thesis research at University College Dublin, Ireland

mail ed-by: pearson.com

Dear Ms Walsh,

Permission to use a Pearson assessment is inherent in the qualified purchase of the test materials in sufficient quantity to meet your research goals. In any event, Pearson has no objection to you using the Children’s Assessment of Participation and Enjoyment (CAPE) and you may take this email response as formal permission from Pearson to use the test in its as-published formats in your student research.

The Movement Assessment Battery for Children, Second Edition (Movement ABC) is not an NCS Pearson owned test and we do not have authority to grant permission. The Test is owned/copyrighted by our Pearson Assessment office in the UK, and you must seek your permission from them - permission other than the inherent permission granted with qualified purchase of the test materials. The link to the Movement ABC permission page in the UK catalog is: http://www.pearsonclinical.co.uk/Psychology/ChildCognitionNeuropsychologyandLanguage/ChildPerceptionandVisuomotorAbilities/MABC-2/ForThisProduct/Permissions.aspx

The CAPE represents Pearson copyright and trade secret material. As such, Pearson does not permit photocopying or other reproduction of our test materials by any means and for any purpose when they are readily available in our catalog. Consequently, you may not simply reproduce the CAPE test forms. As a resident of Ireland (Eire), your source to purchase the CAPE is our Pearson office in the UK.

The qualification level required to purchase a CAPE Kit or other test materials is CL-3. Please visit the following link to the product page in our online catalog: http://www.pearsonclinical.co.uk/AlliedHealth/PaediatricAssessments/Participation/CAPEPAC/CAPEPAC.aspx

Finally, because of test security concerns, permission is not granted for appending tests to theses, dissertations, or reports of any kind. You may not include any actual assessment test items, discussion of any actual test items or inclusion of the actual assessment product in the body or appendix of your dissertation or thesis. You are only permitted to describe the test, its function and how it is administered and discuss the fact that you used the Test, your analysis, summary statistics, and the results.

Regards,

William H. Schryver
Senior Licensing Specialist
Clinical Assessment
Pearson
19500 Bulverde Road
San Antonio, TX 78259 T: (210) 339-5345
Dear Caitriona

Thank you for your various emails and I am sorry that you've had to repeat yourself - we are working towards trying to streamline this process....

My US colleagues are correct that whilst Pearson Education Ltd own the copyright of this assessment, you do not need to seek permission to use this in your research as you are not reproduce or copying any part of it.

I wish you well with your research.

with best regards
Sarah

Sarah Weinberg
Export & Permissions
Pearson
Clinical Assessment

80 Strand
London  WC2R 0RL

Tel:  +44 (0)20 7010 2864

Pearson
Always Learning
www.pearsonclinical.co.uk
Appendix 8: Parent Questionnaire Schedule of Questions

1. How would you describe your child’s levels of participation in physical activity?
   
   Are they going out to play active games?
   
   If yes, how often are they going out? How many times a day? How many times a week?
   
   If no, can you give me some examples of what they prefer to do?

2. Do you think your child enjoys playing sports?
   
   If yes, why do you think this?
   
   If no, why do you think this?

3. Do you think your child enjoys taking part in group activities?
   
   If yes, how do you know?
   
   If no, why do you think this?

4. Do you think your child is aware of their physical limitations?
   
   If yes, how do you know?
   
   If no, why do you think this?

5. Do you think your child is self conscious about their physical abilities?
   
   If yes, in what way do you perceive this?
   
   If no, in what way do you perceive this?

6. Does your child enjoy taking part in new activities?
   
   If yes, can you give me some examples?

7. Has your child expressed a sense of failure?
   
   If yes, could you tell me about their experience? Do you think it was as a direct result of their physical limitations?
Appendix 9: Assessment Form

Name: ___________________________ DOB: __________

Age at Recruitment: ___ years ___ months

Address: __________________________

___________________________________________________________________________

Parent(s) Names: ___________________________

Parent Phone: ___________________________

Initial Assessment: __________ Review Assessment: __________

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<thead>
<tr>
<th>Height (cm)</th>
<th>Height (cm)</th>
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<td>Weight (kg)</td>
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<td>ABC Total</td>
<td>ABC Total</td>
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<tr>
<td>ABC Manual Dexterity</td>
<td>ABC Manual Dexterity</td>
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<tr>
<td>ABC Aiming &amp; Catching</td>
<td>ABC Aiming &amp; Catching</td>
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<td>ABC Balance</td>
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<td>PBS Score</td>
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<td>PAC Score</td>
<td>PAC Score</td>
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<tr>
<td>Parent Interview Completed</td>
<td>Parent Interview Completed</td>
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</table>

Intervention | Control
Appendix 10: Log Book

Exercise Log Book

Child’s Name: _______________________________

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<thead>
<tr>
<th>Week</th>
<th>Activity</th>
<th>Description</th>
<th>Date:</th>
<th>You will need:</th>
<th>Comment - Number of steps completed?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wheelbarrows</td>
<td>Start in a crawling position. Ask your partner to pick up your feet and walk behind you. Try to do as many steps on your hands as you can!</td>
<td></td>
<td>A partner to help!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<td>Day 6</td>
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<tr>
<td>Group</td>
<td></td>
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<tr>
<td>(Day 7)</td>
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</tbody>
</table>
### Activity
**Target Practise**

### You will Need:
A pair of socks & a target

### Description
Ask your Mum or Dad to set up a target (like a piece of paper or a mat) 2 meters away from where you are standing. See how many times out of 10 you can throw a balled up pair of socks onto your target!

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<thead>
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<th>Two</th>
<th>Date:</th>
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</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Target Practise</td>
<td>You will Need: A pair of socks &amp; a target</td>
</tr>
<tr>
<td>Description</td>
<td>Ask your Mum or Dad to set up a target (like a piece of paper or a mat) 2 meters away from where you are standing. See how many times out of 10 you can throw a balled up pair of socks onto your target!</td>
<td></td>
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<tr>
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<td>Three</td>
<td>Date:</td>
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<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Crabwalk</td>
<td>You will need: Just yourself!</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Sit on the floor, use your hands and legs to lift your bottom off the floor, and try to do as many steps like this as you can!</td>
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<th>Comment - Number of steps completed?</th>
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<td>Day 6</td>
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<tr>
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</tr>
<tr>
<td>Four</td>
<td>Hopping</td>
<td>Stand on your good leg and try to hop up and down the room as many times as you can. Try it on your other leg too!</td>
<td>Just yourself!</td>
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<tr>
<td>Activity</td>
<td>Supermans</td>
<td>You will Need:</td>
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<tr>
<td>Description</td>
<td>Lie on your tummy on the floor. Imagine you are superman flying through the air with your arms and legs stretched out - try to hold it for as long as you can!</td>
<td>Just yourself!</td>
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<tr>
<td><strong>Activity</strong></td>
<td>Tennis Ball Throwing against wall</td>
<td><strong>You will Need:</strong> A tennis ball or a bouncy ball</td>
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</tr>
<tr>
<td><strong>Description</strong></td>
<td>Throw your tennis ball against the wall and see can you catch it when it bounces back to you. See how many you can catch out of 10 tries!</td>
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<tr>
<td><strong>Activity</strong></td>
<td>Lunge Position – Throwing and Catching</td>
<td><strong>You will Need:</strong> A partner and a ball</td>
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<tr>
<td><strong>Description</strong></td>
<td>Stand in a lunge position, and ask your partner to throw a ball to you – see how many times you can catch it out of 10 tries!</td>
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<td></td>
<td></td>
<td>Rolling a Ball up the Wall</td>
<td>The biggest ball you have!</td>
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<tr>
<td>Activity</td>
<td>Line Walking</td>
<td>You will need:</td>
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<tr>
<td>Description</td>
<td>Draw a long line with chalk outside. Try to walk up and down the line on your tippy toes. See how many steps you can do in a row!</td>
<td>A chalk line</td>
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<tr>
<td>Activity</td>
<td>Hedgehogs</td>
<td>You will need: Just yourself!</td>
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<tr>
<td>Description</td>
<td>Lie on the floor and curl yourself up into a ball, like a hedgehog. See how many seconds you can hold it for!</td>
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Appendix 11: Recruitment and Testing Schedule

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<tr>
<th>Group Name</th>
<th>Screening</th>
<th>Intervention</th>
<th>Reassessment</th>
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<tr>
<td>Control 1 (n=5)</td>
<td>November 2012 – January 2013</td>
<td>May – July 2013</td>
<td>April 2013</td>
</tr>
<tr>
<td>Intervention 2 (n=5)</td>
<td>February – April 2013</td>
<td>May – July 2013</td>
<td>August 2013, January 2014</td>
</tr>
<tr>
<td>Control 2 (n=5)</td>
<td>February – April 2013</td>
<td>August – October 2013</td>
<td>August 2013</td>
</tr>
<tr>
<td>Intervention 3 (n=5)</td>
<td>June – August 2013</td>
<td>October – December 2013</td>
<td>January 2014</td>
</tr>
<tr>
<td>Control 3 (n=5)</td>
<td>June – August 2013</td>
<td>January – March 2014</td>
<td>January 2014</td>
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Appendix 11: Conference Poster from the Irish Society of Chartered Physiotherapists, 7-8\textsuperscript{th} November 2014

The Effect of a Community-Based Group Motor Skills Programme on Participation and Movement Ability in Children with Developmental Coordination Disorder

Caitriona Morton, Physiotherapy Department, HSE Dublin South West
Tara Cusack, UCD School of Public Health, Physiotherapy and Population Science


text from poster

Introduction
Developmental Coordination Disorder (DCD) is a disability that affects approximately 6% of school age-children worldwide, according to international estimates (American Psychiatric Association, 2013). Children with DCD participate and enjoy active hobbies less than their peers (Jarus et al., 2011).

This study was primarily concerned with the participation of children with DCD, as defined by the World Health Organisation (WHO) as the “involvement in life situations” (International Classification of Functioning, Disability, and Health; WHO 2001).

Children with DCD are frequently treated in community-based groups (Hung & Pang 2010), however the effects of group motor skills interventions on participation are unknown.

Study Aim
The aim of this study was to examine the effect of a group motor skills programme on participation and movement ability in children aged 7-10 with Developmental Coordination Disorder (DCD).

Method:
Participants were recruited from community services in Tallaght and from Tallaght Hospital DCD clinic.

Participants were assessed by one researcher at baseline and then randomised into control and intervention groups. Following intervention, all participants were reassessed and results were compared.

Results
Following completion of the group programme, motor performance improved significantly (p=0.01) in the intervention group (n=15) at 4 months post baseline compared to the control group (n=16) and also remained significantly improved from baseline at 8 months post intervention (p=0.005).

Outcome Measures:
Movement Assessment Battery for Children (MABC)
Children Assessment of Participation and Enjoyment (CAPE)

Intervention
A structured 10 week exercise programme was delivered by the principal researcher, which ran for one hour each week with 5 children in each group. The sessions consisted of gross motor skills, balance work, and core strength exercises. Each child was given a home exercise log book at the beginning of the programme and compliance was recorded.

Data Analysis
Nonparametric testing was used on SPSS for between-group (Mann-Whitney U) and within-group analysis (Wilcoxon-signed rank) following intervention. The study was sufficiently powered.

Conclusion
A specific 10 week physiotherapy programme improved participation and motor performance in children with DCD, with results maintained at 8 months.

References