ANTHROPOMETRIC CHARACTERISTICS, GRIP STRENGTH AND PHYSICAL ACTIVITY LEVELS OF CHILDREN WITH PHYSICAL DISABILITIES: A CASE STUDY

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DECLARATION

I, Micaela Dorfling, (Student number: 216021150) declare that:

1. The research reported in this dissertation, except where otherwise indicated, is my original research.

2. This dissertation has not been submitted for any degree or examination at any other university

3. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

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ABSTRACT

Introduction

Physical disability impedes the completion of daily functioning and tasks in children with disability often resulting in exclusion from participating in physical activity. The problem is that a lack of physical activity results in a higher risk of non-communicable lifestyle diseases, to which an individual with physical disability is already predisposed. The participation of children with disability in sports and recreational activities promotes inclusion, minimises deconditioning, optimises physical functioning, and enhances overall well-being. Despite these benefits, children with disability are more restricted in their participation, have lower levels of fitness, and have higher levels of obesity than their peers without disabilities.

Therefore, the screening and monitoring of children using simple health indicators such as anthropometry, physical activity levels and grip strength is essential to identify children who may be at risk for chronic diseases, for those who can improve their quality of life through changes in their lifestyle; and it can help raise awareness of the need to increase their participation in physical activity. Often physical activity is underestimated for children with disability, well-informed decisions with regards to types and best suited physical activity programmes are more easily formulated following identification of overall health status and individual activity preferences, such as through measurement of physical activity levels, anthropometric characteristics and hand grip strength.

Aim

The aim of the study was to determine the relationships between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities.

Methods

This research was conducted as a quantitative case study, of 53 children from two schools in KwaZulu-Natal. The study involved a convenient sample of children with physical disabilities. Physical activity questionnaires were completed by the participants regarding their physical activity status. Muscle strength testing using the pressure air biofeedback (PAB®)and hand grip dynamometre was conducted for hand grip strength. Anthropometrical data (body fat percentages, body mass index (BMI) and fat mass) were collected using bioelectrical impedance analysis, and waist and hip circumferences were measured. A physical activity questionnaire provided information on the physical activity status of the children. Descriptive statistics, such as means and standard deviations, where calculated. The Chi-square goodness-of-fit-test was used on categorical variables to test whether any of the response options were selected significantly more or less often that the others. The Chi-square test of independence was used on cross-tabulations to see whether a significant relationship existed between two variables represented in the cross-tabulation. Analysis of variance (ANOVA) was used to test for several independent samples that compared two or more groups of cases in one variable. Pearson's correlation coefficient is a measurement of linear association. The level of significance was set at $p \leq 0.05$.

Results

The highest number of participants (52.8%, n=28) spent most of their time in a week on quiet activities. The participants had a shorter stature than normal. The mean total weight was 36.46 kg and was below the standard age norms slightly. However, the weight results were widely spread. BMI and waist circumference were below the cut off points for being high risk for cardiovascular disease. The participants in this study have significantly lower hand grip strength norms to abled children their age. The trend seen in these results is that participants with less severe forms of disabilities such as loss of sight or speech are more physically active than those with more severe physical disabilities such as muscular disorders and cerebral palsy. There were no significant differences between disability types and hand grip strength results.

Conclusion

Regardless of the type of disability, implementation and education of more inclusive disability physical activity within the school curriculum and physical therapy based on the children’s strength profile, need to be introduced. Furthermore, healthy eating habits ensuring correct nutrition should be implemented by having a multidisciplinary team of healthcare workers including dieticians.

Keywords

Body mass index, physical activity, cerebral palsy, disability

CHAPTER ONE

1 Introduction

A physical disability is a long-term condition in which there is a limitation on a person's physical functioning, mobility, dexterity or stamina. It is any restriction or lack (resulting from an impairment) of ability to perform an activity in a manner, or within the range, considered normal for a human being (Kaplan, 2000). Physical activity is defined as any bodily movement produced by skeletal muscles which requires energy expenditure, from the spectrum of recreational, competitive and social activities (Law *et al*., 2006). Physical activity is crucial to maintain health and functioning and improve the well-being of an individual (Kosma *et al*., 2014).

Children with disability are excluded from many aspects of life, one being physical activity. According to the World Health Organisation (WHO) (Srinivasan, O'Fallon and Dearry, 2003), the lack of physical activity has been identified as the fourth leading cause of global mortality, which is especially elevated in children with disability who are already at risk for the development of secondary health conditions which can be prevented by physical activity. Many people with disability have a greater difficulty in participating in a variety of health-promoting behaviors. Lack of health education and health awareness exacerbates this limited access to participation and puts children with disability at a higher risk of a variety of health problems (Rimmer and Rowland, 2008). A lack of physical activity, and being overweight, contributes to an increased risk of cardiovascular disease (CVD) (Durstine *et al*., 2000), it is important to monitor their physical activity levels and body composition and make sure they maintain within healthy levels to avoid the possibility of secondary disease. Children with disability have higher levels of obesity than their peers without disability (Murphy and Carbone, 2008). The consequences of poor health and physical inactivity lead to an increase in CVD risk, which in children with disability results in poor long-term health, a suboptimal quality of life, and more dependence on others (Durstine *et al*., 2000). The lack of physical activity and healthcare services for children with disability can therefore result in a shorter lifespan (Murphy and Carbone, 2008). The life expectancy of children with disability is slowly increasing into adulthood and has been accompanied by the transfer of rehabilitation and healthcare services from institutions to homes; and this begins with the promotion of physical activity and education, therefore monitoring their levels of physical activity and anthropometric characteristics is the first step in the promotion of improving their well-being.

Hand grip strength is considered important as a measure of general health and is often estimated in screenings of normal motor function. From early childhood it is necessary to produce enough grip force to independently manage everyday tasks (Häger-Ross, C., Rösblad, B., 2002). This is a strength which is sometimes low in children with disability; and it can be a good indication of the ability to be included in the activities of daily living and is a general measurement of strength (Häger-Ross, C., Rösblad, B., 2002). Sometimes small factors such as hand grip strength is overlooked, especially in settings with children with disability because it is often not a main focus due to limited resources (Häger-Ross, C., Rösblad, B., 2002). Hand grip strength can be a big factor in identifying overall quality of life due to ability to perform daily activities, measuring one's hand grip strength can help give an indicator of an area of weakness which could be improved and which could improve one's overall well-being.

Law *et al*., (2006) found that children with physical disabilities only participated in 3/10 physical activities. This is a very low statistic and is the reason why there has been an increase in the number of overweight children. Anthropometric measurements can be helpful in assessing nutritional status to identify those children at risk for being obese. These measurements include weight, height, body fat percentage and body composition These can be estimated using bioelectrical impedance analysis (BIA), which is readily available, and is an indicator of growth and development in children, as well as long-term health (Hardy *et al*., 2018). Research by Hardy *et al*., (2018) found that anthropometry and BIA are relatively easy to measure in children with physical disabilities in a school setting and can help identify those who present with a poor nutritional status, either by being under- or overweight.

According to statistics, in South Africa, 10.8% of children aged 5-9, and 4.1% of children aged 10-14 have been reported to have a disability in the broad spectrum of disabilities, including sight, hearing, communicating, physical impairment or loss of limb, difficulty in walking and undertaking self-care. One of the bigger problems resulting from the number of children with disability is the economic impact – people with disability account for a high proportion of healthcare costs, because of poor health conditions and a lack of primary healthcare to prevent secondary conditions (Rimmer and Rowland, 2008). An increase in healthcare, such as an increase in physical activity, good nutritional care and preventative examinations, can help prevent obesity and poor healthcare in children with disability (Rimmer and Rowland, 2008). The primary reason for increasing physical activity and awareness is to demonstrate the importance of healthcare to children with disability; to reverse deconditioning and secondary or impaired mobility; to optimise physical functioning; to enhance overall wellbeing; and to prevent any secondary health complications such as CVD (Murphy and Carbone, 2008). An increase in physical activity is especially beneficial in children with disability as it allows for an increase in self-esteem, self-image and confidence; and the numerous health benefits make it vital to include it in the daily lifestyle of children. This can begin in the schools (Kosma *et al.,* 2014).

1.1 Aim

The aim of the study was to determine the relationships between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities.

1.2 Research Questions

1. What is the level of physical activity and sport participation in children with physical disabilities at two schools for learners with special educational needs in KwaZulu-Natal?
2. What are the anthropometric characteristics and hand grip strength measurements in children with physical disabilities at two schools for learners with special educational needs in KwaZulu-Natal?
3. What is the relationship between the physical activity and sport participation levels, anthropometric characteristics, and hand grip strength in children with disability?

1.3 Objectives

1. To determine the level of physical activity and sport participation in children with physical disabilities;
2. To determine the anthropometric characteristics (body mass index, waist to hip ratio, and body fat percentage) and strength (hand grip, Pressure Air Biofeedback) in children with physical disabilities; and
3. To determine the relationship between the physical activity and sport participation levels, anthropometric characteristics, and hand grip strength in children with physical disabilities.

1.4 Significance of Study

Law *et al*., (2006) found that children with physical disability only participated in 3/10 physical activities. Given the current frequency of therapy intervention and issues of childhood obesity, this level of involvement is a cause for concern. Research is needed among more diverse populations of children with physical disabilities, and the factors affecting their participation and physical health, most research does not include a variety of physical disabilities (Bult *et al*., 2011).

Increasing the number of individuals with disabilities who are physically active is a public health priority; and starting this from a young age is highly beneficial (Kosma, Cardinal and Rintala, 2002). Therefore, research focusing on exploring the effect of physical disability on physical activity levels and health of children with various disabilities is a starting point in KwaZulu-Natal to improve health, life expectancy and quality of life. Although doctors help children with disability with treatment of secondary conditions, they seldom recommend lifestyle changes to the parents to help treat the cause (Froehlich-Grobe, Lee and Washburn, 2013). This research could create awareness around the importance of physical activity and health in children with disability, and will highlight the possible gaps in current measures.

1.5 Definition of Terms

Anthropometry: the measurement of physical features such as body shape and body composition (Karwowski, 2001)

Body composition: the proportion of fat and non-fat mass in one's body; used to describe the amount of fat, water, bone and muscle in a human body (Karwowski, 2001)

Body mass index: an approximate measure of whether someone is over- or underweight, calculated using one's weight and height (Karwowski, 2001)

Chronic disease: a long-term health condition (Clark *et al*., 1995)

Dexterity: ability to use coordinated hand and finger movements to both hold and maneuver items (Kreutzer *et al*., 2011).

Endurance: ability of a muscle or group of muscles to be able to sustain repeated contractions against a resistance for an extended period of time (Beachle and Earle, 2008).

Fine motor skills: the co-ordination of the small muscle groups in the hands (Smith, 2003)

Impairment: diminishment or loss of function or ability (Smith, 2003)

Lifespan: the average length of a person's life in a particular environment or condition (Clark *et al*., 1995)

Mobility: the ability to move freely and easily (Beachle and Earle, 2008)

Nutrition: obtaining the right food for growth, metabolism and repair (Beachle and Earle, 2008).

Participation: involvement in a life situation (Law *et al.,* 2006, King *et al*., 2003)

Physical activity: any bodily movement produced by skeletal muscles which requires energy expenditure, from the spectrum of recreational, competitive and social activities (Law *et al*., 2006)

Physical disability: a long-term loss in which there is a limitation on a person's physical functioning, mobility, dexterity or stamina; also known as any restriction or lack (resulting from an impairment) of ability to perform an activity in a manner, or within the range, considered normal for a human being (Kaplan, 2000)

Physical inactivity: doing no, or very limited, physical activity at work, home and school (Micklesfield *et al*., 2014)

Quantitative: measuring the quantity (amounts or numbers) of something rather than its quality (Brink *et al.,* 2012)

Strength: the ability to move a load against a resistance (Bizley, 2002)

Obesity: having a BMI of greater than, or equal to, 30 (Liou, Pi-Sunyer and Laferrere, 2005)

Well-being: the state of being healthy and happy (Clark *et al*., 1995)

1.6 Abbreviations

BIA: bioelectrical impendence analysis

BF%: body fat percent

BMI: body mass index

BREC: Biomedical Research Ethics Committee

CAD: coronary artery disease

CVD: cardiovascular disease

CVE: cardiovascular endurance

D: dominant hand

ICF: International classification of functioning, disability and health

KZN: KwaZulu-Natal

LBM: lean body mass

ND: non-dominant hand

PAB® : pressure air biofeedback

PAD: physical activity for people with disability

REE: resting energy expenditure

SPSS: Statistical Package for Social Sciences

TEE: total energy expenditure

TEF: thermic effect of food

WHO: World Health Organisation

WHR: waist-to-hip ratio

1.7 Conclusion

This qualitative, case study aimed to examine the relationship between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities. The anthropometrical characteristics assessed were body mass index and body fat percentage, as well as waist and hip circumference. The strength tests performed included hand grip strength.

This study aimed, potentially, to fill a gap in the literature, specifically in KwaZulu-Natal, and to provide a possible solution and recommendations of improving the amount of physical activity in which children with disability are included, as a way to improve their health and quality of life.

1.8 Structure of the dissertation

The dissertation will be presented as a full dissertation for a Master in Sports Science.

The dissertation is presented as follows:

<u>Chapter One: Introduction</u>

The introduction includes an overview of the study and why it was conducted.

<u>Chapter Two: Literature Review</u>

The literature review includes detailed information around the topic being studied.

<u>Chapter Three: Methodology</u>

The methodology includes details on how the study was conducted.

<u>Chapter Four: Manuscript</u>

The manuscript is the version which was submitted to the International Journal on Disability and Human Development.

<u>Chapter Five: Conclusion</u>

The conclusion includes the concluding remarks of the study and recommendations for future research.

CHAPTER TWO

2 Literature Review

2.1 Introduction

According to the international classification of functioning, disability and health, the World Health Organisation defines participation as 'involvement in a life situation' (Law *et al*., 2006, King *et al*., 2003). Children and youth with physical disabilities are at risk of limited participation, not only with regards to physical activity, but in life and social events; and this may be due to a lack of physical functioning (Law *et al*., 2006). Participation is important for a person's well-being. The extent to which people engage in meaningful activity and pursue goals is relevant to their quality of life (King ., 2003). The literature on this topic is limited when it comes to children with various physical disabilities. An individual is defined as having a severe disability if he/she has limited voluntary movement ability; an inconsistent ability to communicate; medical complications; and an inability to function independently (Rimmer and Rowland, 2008). Many people with disability have greater difficulty in participating in a variety of health-promoting behaviors. Lack of health education and health awareness exacerbates this limited access to participation and puts children with disability at a higher risk for a variety of health problems (Rimmer and Rowland, 2008).

This literature review will comprise the following sections:

Section A: Children with physical disability

2.1.1 Different models of Disability

2.1.2 Factors influencing participation in daily activities

Section B: Physical disability and physical activity

2.1.3 Importance of physical activity

2.1.4 Effect of disability on physical activity participation

2.1.5 Benefits of physical activity

Section A: Children with Physical Disability

A physical disability is a long-term loss in which there is a limitation on a person's physical functioning, mobility, dexterity or stamina. It is also known as any restriction or lack (resulting from an impairment) of ability to perform an activity in a manner, or within the range, considered normal for a human being (Kaplan, 2000). Children similarly to adults experience physical disability and are often excluded from many aspects of life, one being physical activity. According to the WHO (Srinivasan, O'Fallon and Dearry, 2003), the lack of physical activity has been identified as the fourth leading cause of global mortality. This is especially elevated in children with disability who are already at risk for the development of secondary health conditions which can be prevented by physical activity.

2.1.1 Different Models of Disability

According to Kaplan (2000) there are different models of disability. The first model includes the moral model of disability, where families with a member who has a disability hide that person away and exclude them from having any important role in society. The medical model states that the person is seen as 'sick' and is therefore excluded from the moral obligations of society, such as getting a job, having their own family and being included in many daily activities. The rehabilitation model notes that a person with a disability requires a variety of medical rehabilitation services to make up for the deficiency caused by the disability. There are more cases of disability where the family takes up the model which involves excluding the child, instead of getting them involved in rehabilitation and healthcare services to help improve quality of life (King *et al.,* 2003).

According to statistics, in South Africa, 10.8% of children aged 5-9, and 4.1% of children aged 10-14 have been reported to have a disability in the broad spectrum of disabilities, including sight, hearing, communicating, physical impairment or loss of limb, difficulty walking and self-care. One of the bigger problems resulting from the number of children with disability is the economic impact: people with disability account for a high proportion of healthcare costs because of poor health conditions and a lack of primary health care to prevent secondary conditions (Rimmer and Rowland, 2008). An increase in healthcare, such as an increase in physical activity, good nutrition and preventative examinations can help prevent obesity and poor health in children with disability (Rimmer and Rowland, 2008). The primary reasons for increasing physical activity and awareness of the importance of healthcare in children with disability are to reverse deconditioning and secondary to impaired mobility; to optimise physical functioning; to enhance overall wellbeing; and to prevent any secondary healthcare implications (Murphy and Carbone, 2008). An increase in physical activity is especially beneficial in children with disability as it leads to an increase in self-esteem, self-image and confidence and the numerous health benefits make it vital include it in the daily lifestyle of children (Kosma *et al*., 2014). In the US, physical disability comprises about 75% of all disabilities. People with disabilities are at a high risk for secondary health conditions and healthcare for people with disability should shift towards the prevention of these conditions (Liou, Pi-Sunyer and Laferrere, 2005). Inclusion in physical education facilitates motor engagement, motor performance and self-concept of children, no matter their level of disability (Vogler, Koranda and Romance, 2000).

2.1.2 Factors influencing participation in daily activities

Children with physical disability generally have poor motor function. Factors which then affect their participation in daily activities include poor parental education, and a lack of equipment, support and information (Bult *et al.,* 2011). An ecological model by Gibson states that what the environment affords people determines where and how they live (Goodwin and Watkinson, 2000). This provides an insight into the current healthcare structures: there is a great lack of resources and funds for healthcare services for children with disability, and this limits them in receiving adequate healthcare and preventative treatment (Goodwin and Watkinson, 2000). Rather than exclusion from normal sports participation, the goal is for the inclusion of all children with disability, in appropriate activities (Murphy and Carbone, 2008). It has been found that the level of gross motor functioning is an important factor associated with participation in children: more severe gross motor problems in children are associated with greater restrictions on their participation in daily activities and physical activity (Bult *et al*., 2011). The severity of disability, the number of limbs affected and more severe spasticity is related to frequency of participation in physical activity and activities of daily living. According to Bult *et al.*,(2011), there is a positive relationship between communication skills and participation in leisure activities. Children with a physical disability and an additional hearing impairment or visual impairment are also at risk for lower levels of participation, and therefore an unhealthy lifestyle. They are more at risk for becoming overweight and having a poor quality of life (Bult *et al.,* 2011; Srinivasan, O'Fallon and Dearry, 2003). Research has also shown that another factor affecting physical activity in disabled children is increasing age, which is related to less participation in activities (Bult *et al.,* 2011). Children's lifestyles will affect their adult lives and lifespans. As they age, they are more predisposed to less activity and more health-related issues (Van Antwerp, 1995).

By examining the ecological contexts of success of parenting is particularly important too, social problems such as health care, family relations, inadequate income, unemployment and educational difficulties all fall under the ecological model and would enable practitioners to assess factors that are relevant to problems in children with disability. The Bronfenbrenner's ecological system framework is one which could be applied to the system of development in children with physical disability. It is a theory which views the child's development as a complex one through a variety of relationships on multiple levels of the surrounding environment (Algood *et al*., 2013). To study a child's development , one must look not only at the child and her immediate environment, but also at the interaction of the larger environment as well, such as their school, family, ethnic, and social interactions. There are different levels to this theory which can help explain interactions and their impact on the child, however, the microsystem is the most influential level of the ecological systems theory. This is the most immediate environmental settings containing the developing child, such as family and school, people who they have the most direct contact with. Findings show that the parent child relations or the care-taker and child relations are important in playing a role in the child's environment with which they are placed (Algood *et al*., 2013).. Caregivers and parents of children with disability are at increased risk of stress, depression and negative emotions which could directly undermine parenting practices and parent-child relations, often leading to neglect in the form of interactions, participation in after school activities for the child as well as positive, influential role models and relationships (Algood *et al*., 2013).

Section B: Physical Disability and Physical Activity

2.1.3 Importance of physical activity

Physical activity is defined as any physical movement produced by skeletal muscles which requires energy expenditure, from the spectrum of recreational, competitive and social activities (Law *et al*., 2006). Physical activity is crucial to maintain health and functioning and to improve the well-being of an individual (Kosma *et al*., 2014). Research shows that regular physical activity leads to a decreased risk of cardiovascular disease and coronary artery disease (CAD) (Durstine *et al.,* 2000). Exercise prevents or delays the development of high blood pressure, maintains normal muscle strength and joint functioning, and helps prevent obesity (King *et al.,* 2003). Weight-bearing exercise is important, especially in childhood, for skeletal development and it improves overall physical functioning especially in children with disability (Durstine *et al.,* 2000). The promotion of physical activity and healthcare services therefore needs to increase to improve the quality of life and health of children with disability, and to prevent the development of secondary conditions such as heart disease, stroke, respiratory disease, low endurance and emotional difficulties (Antle *et al.,* 2008). Physical activity is also viewed as a means to improve other valued goals, such as self-discipline and self-confidence (Antle *et al.,* 2008). Being active and involved in freely-chosen activities is essential for the development of skills, socialising with peers, exploring personal interests, and enjoying life (Bult *et al.,* 2011). Participation in leisure and physical activity contributes to quality of life in children, but literature indicates that children with disability participate less in leisure and physical activities than their able-bodied peers (Bult *et al.,* 2011; King *et al*., 2003).

2.1.4 Effect of disability on physical activity participation

Research has found that, even if children with disability are taking part in physical activity, their intensity is much lower than children without disability and they are involved more in informal activities rather than formal activities, which are more suited for a higher level of physical fitness and better physical functioning (Law *et al.,* 2006). The activity of children with disability is limited two- to three-fold more than that of children with other chronic conditions, such as asthma (Law *et al.,* 2006). There is less variation regarding recreational activities, and children with disability spend more time on quieter activities. This limits their energy expenditure and results in more children with disability being overweight and at risk for secondary conditions (Law *et al*., 2006; King *et al.,* 2003). For all individuals with disability, the secondary conditions associated with an increase in weight include type 2 diabetes; hypertension; hyperlipidemia; osteoarthritis; stroke and metabolic syndrome; as well as an even larger limitation in physical function (Froehlich-Grobe, Lee and Washburn, 2013). Therefore, health screening is important, especially in children with disability who are already more likely to be physically inactive, to help with the prevention of secondary disease, as well as to see which individuals are at high risk (Froehlich-Grobe, Lee and Washburn, 2013). An article by Hay and Missiuna (1998) found that children with poor self-perception of their abilities, and who have no preference for childhood physical activities, are found to be much less motor-competent than their peers. Children with disability often demonstrate incompetence in certain activities, a lack of confidence and face exclusion from community engagement, this then leads to difficulties in moving, which results in the tendency to avoid participating in physical activity as a coping strategy. Observations show that, during their school break-times, these children fail to engage in physical tasks and are significantly more sedentary than their peers (Hay and Missiuna, 1998).

2.1.5 Benefits of physical activity

The benefits of exercise and physical activity in individuals with disabilities have been well documented. However, very few people with disabilities are active (Kosma, Cardinal and Rintala, 2002). Regular physical activity (three or more days per week, of 45-60 minute sessions of moderate intensity activity) can increase health-related physical fitness, such as cardiovascular endurance (CVE), muscle strength and endurance, flexibility and weight control. This, in turn, helps prevent or improve other health-related conditions such as CVD; diabetes; cancer; hypertension; osteoporosis and arthritis. It improves physical functioning and also improves body composition, while decreasing the risk of obesity (Kosma, Cardinal and Rintala, 2002). Additional benefits include psychological improvements, such as a decrease in anxiety and depression, with a positive improvement in emotions, self-esteem and self-confidence, which is especially important in children with disability, who already have been documented to have low self-worth (Kosma, Cardinal and Rintala, 2002). Another positive result from participating in sports and exercise, for children with disability, is an enhanced perceived self-competence in an outside sports setting; improved social integration; and better goal setting and accomplishment (Kosma, Cardinal and Rintala, 2002). In spite of the benefits, in a study conducted by Kosma, Cardinal and Rintala, 2002 on persons with disabilities, only 23% of individuals with disabilities engage in regular physical activity, this might be due to low motivation and barriers to participation, as well as a lack of education. The way to encourage participation in children with disability is to heighten their awareness about the health benefits of physical activity by increasing their choices, and thus their motivation to participate in physical activity (Kosma, Cardinal and Rintala, 2002).

2.1.6 Physical disability and mobility limitations

In children with disability, another important consideration is their ability to maintain mobility; the extent to which limitations exist; the ease with which movement can be performed; and how the functionality of their joints affects the extent to which they can perform daily living tasks (Durstine *et al*., 2000). Limitations exist with mobility due to poor muscular control and muscle contractures, which then limit their mobility and ability to move freely (Pinkham, Haley and O'Neil, 2008). According to Durstine *et al.* (2000), between 35 and 43 million Americans have chronic diseases or disabilities that restrict their performance of one or more daily activities, and about 38% exhibit some difficulty with ambulation. The most appropriate help for mobility limitations are therapeutic interventions, which include a variety of muscle strengthening activities and physical activity (Durstine *et al.,* 2000). A weekly exercise routine needs to include mobility and stretching to ensure that the joints can move effectively and more functionally, making their exercise regimes most beneficial (Jin, Yun and Agliovlasitis, 2017).

2.1.7 Recommended activity guidelines for children with physical disability

Activities are recommended for children with disability to help improve functioning and strength; to prevent contractures; to reduce body mass and fat; to improve self-esteem; to help in metabolic control; to increase range of motion; to improve ambulation and orthostatic response. These activities include aquatic activities; walking; jogging; wheelchair sports; various endurance-based activities; recreational games; cycling; therapeutic exercises; and any other sport that is able to be adapted (Durstine *et al.,* 2000., Pinkham, Haley and O'Neil, 2008). Properly designed and implemented physical activity programmes should include developing and maintaining cardiovascular endurance, flexibility and muscular strength (Durstine *et al.,* 2000). Basic exercise guidelines can be used for the disability population, such as training for at least 180min per week of moderate intensity exercise and 60min per week of high intensity exercise. However, safety considerations and special adaptations must be made for children with disability, along with making the programmes accessible, safe, effective and enjoyable (Durstine *et al*., 2000., Jin, Yun and Agiovlasitis, 2017). Recent research shows that, with disability, sometimes it is more beneficial to break sessions down into three shorter sessions a day, rather than one longer session in the day (Durstine *et al*., 2000). Improving physical fitness levels in children and youth with motor disabilities will translate into improved functional outcomes and will result in participation in activities, making the child more included in daily life (Wiart, Darrah, Kelly and Legg, 2015). Cardiovascular exercise is especially important as a component of health-related physical fitness and research suggests aerobic exercise on land

and in-water are most beneficial. Results in improvements in health seem to be more beneficial when they include both strength training and aerobic exercise (Pinkham, Haley and O'Neil, 2008). The American Academy of Pediatric recommends strength training for a minimum of two-to-four times per week, for 20-30 minutes, to improve muscular strength in children with disability. The Canadian Society for Exercise Physiology recommends this be done on non-consecutive days (Wiart, Darrah, Kelly and Legg, 2015). The consequences of a lack of physical activity for some individuals with physical disability include not only an increase in body mass and a decrease in physical functioning, but also osteoporosis; orthostatic intolerance; impaired circulation to the lower extremities leading to eventual thrombosis formation; diminished self-efficacy; and more dependence on others in their daily activities – and therefore other conditions such as depression. The main goal of physical activity is to improve physical functioning and prevent obesity; and therefore, prevent secondary disease, and many other consequences (Durstine *et al*., 2000).

2.1.8 Barriers to physical activity

In order to promote the inclusion in physical activity of children with physical disability, it is important to understand the factors that determine physical activity behavior. Van der Ploeg *et al.,* proposed the Physical Activity for People with a Disability (PAD) model. This model uses the international classification of functioning, disability and health (ICF). The model states that the functioning of an individual requires a complex relationship between environmental and personal factors. According to PAD, there are many personal and environmental factors which influences physical activity behavior. In children with physical disability, ambulatory status or gross motor function, rather than gender, were found to be associated with participation in physical activity. It is important to find out which subgroups are at risk for physical inactivity. However, it is more important to identify the modifiable factors.

To change an individual's physical activity status, it is important that modifiable psychological, physical and environmental factors are identified. Personal and psychological barriers which limit children with disability from participating in physical activity are a lack of energy, or fatigue; not perceiving the health benefits; feeling uncomfortable or ashamed; fear of injuries; and lack of motivation. Environmental barriers include a lack of social support; bad weather; limited facilities; transportation problems; lack of knowledge and personnel; and costs, including transport and facilitation (Buffart *et al.,* 2009). In a study Wiart *et al*., (2015), they identified a few environmental barriers that parents of children with disability listed.

Environmental barriers played a big role, as children with more severe disability need to be lifted out of wheelchairs, transferred between places, and given personal care. There is a lack of appropriate pool lifts, skills and knowledge; and staff in facilities lack a positive attitude to help get these children more involved (Wiart, Darrah, Kelly and Legg, 2015).

It has been found that, as children grow into adolescence, they lose interest in physical activity programmes; yet these are the years when they should be getting involved in such activity. It is important to motivate them from a young age to get involved and participate in the communities they live in (Wiart, Darrah, Kelly and Legg, 2015). One type of exercise programme does not fit the needs of all families with children with disability. Families need choices to determine what is best going to suit their lifestyle and their child's lifestyle. More choice and inclusion in activities can help increase participation and willingness to be involved (Wiart, Darrah, Kelly and Legg, 2015).

Rehabilitation professionals are important in promoting physical activity in children with disability and helping them overcome these modifiable barriers to being involved in physical activity. It starts with informing parents on the importance and health benefits of exercise; educating them on how and why; finding equipment and setting up programmes (Buffart *et al.,* 2009). Social support is important and combining social aspects with physical activity may be the way to overcome a physical activity barrier in children with physical disability, as well as finding out what they enjoy and letting them take part in those activities in an adapted, safe manner best suited for them (Buffart *et al.,* 2009).

Section C: Physical Disability and Anthropometric Characteristics

Anthropometric measurements in children, including weight, height, body circumferences and body composition estimates using BIA, are an important part of an overall clinical assessment. They can also be readily obtained and allow evaluation of an individual's nutritional status (Hardy, Kuter, Campbell and Canoy, 2018). These measurements can also be helpful in healthcare preventative screening, as a high body fat index indicates an increased risk of health issues (Froehlich-Grobe, Lee and Washburn, 2013). Body mass index (BMI) is a measurement of body composition, based on a person's height and weight (Froehlich-Grobe, Lee and Washburn, 2013). The national health interview survey reports that the prevalence of obesity

(BMI >/= 30) is higher among individuals with disabilities (24.9% – 31.6%) than without (15.1% – 18.7%) (Froehlich-Grobe, Lee and Washburn, 2013; Rimmer and Rowland, 2008). The National Health and Nutrition Examination Survey in the US found that 30% of adults with disabilities are obese, compared with 23% of adults without disabilities. It is important to begin health education and body awareness from a young age so that it does not become a bigger problem as one gets older (Liou, Pi-Sunyer and Laferrere, 2005).

People with physical disability experience changes in their body composition and energy expenditure through physiological changes as a result of their diseases, and this plays a role in the early development of obesity. It was found that the body composition of people with physical disability shows a decrease in fat-free mass and an increase of fat mass; although not in individuals with malnutrition (Liou, Pi-Sunyer and Laferrere, 2005).

Total daily energy expenditure (TEE) consists of resting energy expenditure (REE), the thermic effect of food (TEF), and the thermic effect of physical activity. TEE has been found to be lower among people with physical disability, as due to their already sedentary lifestyle, they are not expending much energy through physical activity. Therefore, the high rate of inactivity is associated with a high prevalence of obesity in this population (Liou, Pi-Sunyer and Laferrere, 2005).

Increasing severity of disability is directly related to increased chronic disease risk factors, such as higher rates of obesity, waist circumference, and BMI (Froehlich-Grobe, Lee and Washburn, 2013). Factors such as poor physical functioning, a large waist circumference, and high body fat due to increased weight, puts one more at risk (Froehlich-Grobe, Lee and Washburn, 2013). Individuals with disabilities, especially children, are more seriously affected by obesity. It results in more functional limitations. It can make wheelchair transfers or ambulating with assistive devices difficult, which makes it harder for them to be included in physical activity and therapeutic rehabilitation exercises (Liou, Pi-Sunyer and Laferrere, 2005). Obesity is associated with high rates of morbidity and mortality, which contribute to a shorter lifespan in children with physical disability (Liou, Pi-Sunyer and Laferrere, 2005). Continuing efforts to address and reverse obesity and improve health in children with disability cannot be neglected.

2.1.9 Malnutrition

On the other end of the weight scale comes malnutrition, and children with disability who are underweight. Malnutrition is common in children with disability, especially those with CP (Samson-Fang and Stevenson, 2007). A high prevalence of malnutrition is often reported in children with disability and this results in worsening health and development (Groce *et al*., 2014). Malnutrition is defined as the lack of proper nutrition (Groce *et al*., 2014). Childhood malnutrition is a public health issue in low- and middle-income countries, especially affecting children with disability (Jahan *et al.,* 2018). A study by Jahan *et al*., (2018) states that 80% of children with disability are reported in low- and middle-income countries. The consequences of malnutrition are many and are clinically significant. Identification and correction of children with physical disability who are either under- or overweight is paramount (Samson-Fang and Stevenson, 2007). Malnutrition occurs when there is an increased need of nutrients (which is common in children with physical disability), increased nutrient loss, and decreased nutrient intake (Hume-Nixon and Kuper, 2018). Factors leading to a decrease in nutrient intake include certain physical impairments, such as difficulty eating or swallowing, resulting in the need for prolonged feeding times, especially for children with CP, which sometimes is not considered (Hume-Nixon and Kuper, 2018). Malnutrition leads to decreased muscular strength; diminished cardiac work capacity; disturbances in immune function; and impairment in cerebral growth, cognitive development and motor progression; making one prone to secondary disease, and discouraging participation in physical activity (Samson-Fang and Stevenson, 2007; Groce *et al.,* 2014). An undernourished child will be disadvantaged in many daily activities, including participating in play, school or rehabilitation (Samson-Fang and Stevenson, 2007). Malnutrition leads to altered body composition and body proportions of fat, muscle, bone density and water weight (Samson-Fang and Stevenson, 2007). Malabsorption of nutrients is common in children with certain conditions. Some children need additional nutrients to cope with the health problems associated with their disability (Groce *et al.,* 2014). Problems with ensuring that children get the correct nutritional needs for their bodies include lack of knowledge from caretakers and parents and lack of money for the correct proportions of nutrients and essential supplements (Groce *et al.,* 2014). Groce *et al.*,(2014) state that females with disability may more often be underweight than males. This could be because, in disadvantaged communities where there are limited resources, culturally determined families may prioritise the needs of the males over females (Groce *et al.,* 2014). However, identifying all children with disability and, regardless of gender, with nutrition problems, is one of the first steps in improving their quality of life.

Section D: Physical Disability and Hand Grip Strength

Muscle strength is an important aspect to health status, and when one has decreased muscular strength it can result in functional limitations (Wind, Takken, Helders and Engelbert, 2009). Muscle strength measurements are widely done by therapists and physicians and there are many different methods. Muscular strength is determined by children's age, height and weight (Wind, Takken, Helders and Engelbert, 2009).

Many disabilities, especially cerebral palsy, affect the brain structures responsible for skilled hand movements (Arnould, Penta and Thonnard, 2007). The severity and type of hand impairments vary widely, based on the amount of cerebral damage. Both sensory and motor hand impairments are responsible for difficulties with daily activities in children with disability (Arnould, Penta and Thonnard, 2007). Hand impairments can be measured directly with physical units such as grip strength (Arnould, Penta and Thonnard, 2007). A study by Arnould, Penta and Thonnard (2007) found that hand impairments are less prevalent on the dominant hand than the non-dominant hand.

From early childhood, it is necessary to produce enough hand grip strength for normal motor function and co-ordination of fine motor skills (Häger-Ross and Rösblad, 2002). Hand grip strength is also a measure of functionality and is one of the most reliable clinical methods for estimating overall muscular strength, especially for children, and it has become a routine part of clinical assessment (Häger-Ross and Rösblad, 2002; Wind, Takken, Helders and Engelbert, 2009). An estimation of hand grip strength is made to identify level of development and degree of disability and can also help identify individual rehabilitative care goals (Häger-Ross and Rösblad, 2002).

Section E: Increasing Awareness for Inclusion

'Inclusion should be considered a philosophical approach to implementing social justice in our schools and society so that all persons are valued as unique contributing members of society and included' (Place and Hodge, 2001). One benefit of inclusion is that students with disabilities can gain from social interactions which, if positive and frequent, and equal from both parties, encourage the formation of relationships, which increases social acceptance (Place and Hodge, 2001)

There are currently laws in place in America which exist to protect the rights of children with disability. The federal laws state that individuals with disabilities receive free, appropriate public education in the least restricted environment, and that no individual should be excluded because of disability. Physical education is, therefore, federally mandated in special education services, including the promotion of physical and motor fitness, fundamental motor skills, and skills in individual and group games and sports (Murphy and Carbone, 2008). Schools are required to modify programmes or activities according to the disability of each child (Murphy and Carbone, 2008). This law helps improve inclusion and physical activity, but is limited only to the US; and therefore, many other children with disability are still being excluded (Murphy and Carbone, 2008). The main goal is to increase awareness of health in children with disability and educate people to help improve their health, while increasing resources available, as well as inclusion in daily activities to maintain a healthy lifestyle and improve quality of life (Murphy and Carbone, 2008).

CHAPTER THREE

3 Methodology

3.1 Research design

This research was conducted using a qualitative, case study design. A qualitative case study methodology is one which allows the researcher to study complex phenomena within their contexts and it can help develop theories, evaluate programmes and develop interventions (Brink et al., 2012). A case study is a design which allows one to do an in-depth study on a particular topic. It is used to narrow a very broad field of research down into a smaller topic, and allow further elaboration and hypothesis creation on the topic of interest (Brink *et al.,* 2012).

3.2 Population and sample

3.2.1 Population

The population consisted of children with physical disabilities from two schools in KwaZulu-Natal, school 1 and school 2. The total population size was 65 children between the ages of 10 and 12 with physical disabilities. Non-probability sampling was conducted using the convenience sampling method. The participants who met the inclusion and exclusion criteria, explaining the phenomenon being researched, and were willing to take part in the study (Brink *et al.,* 2012).

3.2.2 Sample

According to the Department of Basic Education, there are 74 schools for children with physical disability in KwaZulu-Natal. Two schools were selected for the study based on convenience. Schools were in close proximity to the university (less than 50 km)

3.2.3 Inclusion and exclusion criteria

Participants adhered to the following inclusion and exclusion criteria:

<u>Inclusion Criteria:</u>

- males and females between the ages of 10 and 12;
- the presence of any physical disability, including sight; hearing; communication; physical impairment or loss of limb; difficulty walking and taking care of self;
- the presence of one or more the following: amputation; cerebral palsy (CP); cerebral vascular accident/stroke (vascular brain disorders); congenital anomalies; hydrocephalus; juvenile arthritis; muscular disorders (non-progressive); neuropathy; orthopaedic conditions (e.g. scoliosis); spinal cord injury; spina bifida; and traumatic brain injury (Law *et al*., 2006).

Exclusion Criteria:

- the presence of one or more of the following: progressive disorders (e.g. cancer or muscular dystrophy); cleft lip and palate; developmental delay; cognitive/mental conditions (e.g. Down syndrome); learning problems; behavioural/emotional issues (e.g. pervasive developmental disorder; autism; attention-deficit disorder; Asperger's syndrome); microcephalus; epilepsy; psychiatric disorders; anomalies of inner organs (e.g. heart, respiratory, metabolism); and syndromes with a recognised component of intellectual delay (Law *et al*., 2006).

A sample consisting of 53 children who met the inclusion and exclusion criteria participated in the study.

3.3 Testing procedures and protocol

3.3.1 Procedures

A letter requesting gate keepers' permission from the Department of Basic Education was sought (Appendix 1). Permission was also granted from the two school principals (Appendix 2). Once ethical clearance from the Biomedical Research Ethics Committee (BREC) at the university was granted (Appendix 3), the recruitment of participants began. Participants were recruited from two schools in KwaZulu-Natal. Participants were recruited through an information and education session where they were informed of the research and literature and were able to ask any questions. This began with the principle and healthcare workers, who then agreed for data collection to take place at their school.

An information sheet and parental consent (Appendix 4) form were completed prior to the testing protocol. Additionally, children signed and gave assent (Appendix 4). All forms were available in English and IsiZulu.

3.3.2 Protocol

Step 1: The physical activity questionnaire was administered

Step 2: Height and weight measured

Step 3: BIA Administered

Step 4: Waist and Hip circumference measured

Step 5: Hand grip strength was tested

Step 1

A physical activity questionnaire (Appendix 5) was administered and collected immediately upon completion. An IsiZulu speaking assistant was available to interact and interpret answers the children had for the questionnaire. The same assistant was used throughout the study to do the questionnaires in order to assure validity.

Figure 3.1: Physical activity questionnaire being administered

Step 2

Height and weight were measured. Body mass was measured by using the Nagata BW-1122H scale. The scale was calibrated before testing started with the use of two separate weights, of which the exact values were known. A 2kg weight was used as well as a 45 kg weight. This was to assess whether the scale produced accurate lower and higher weight readings, respectively. Children who were able to stand unassisted, stood on the scale where their weight was taken; and stood up straight for their height to be taken using a wall stadiometre. Children who were unable to stand on their own had their weight taken by being held by an assistant. Their weight together was taken and then the assistant's weight was taken alone; and this weight was subtracted from their joint weight on the calibrated scale. Height was recorded in a lying down, supine position, where a ruler was used to ensure that the measurement was taken accurately at the top of the head. BMI was calculated using the height and weight measurements.

Step 3

Using the body stat machine, Quadscan 4000, body fat percentage and fat mass were calculated with the child lying in a supine position with no limbs touching. The participant lay down in a supine position for five minutes before the measurements were taken. The tester thoroughly wiped the area of the skin where the electrodes were placed with alcohol swabs. Two electrodes were placed on the right foot, one behind the second toe and the other on the ankle between the medial and lateral malleoli. Two alligator clips were then attached to the electrodes. Two electrodes were placed on the right hand, one behind the knuckle of the index finger and the other on the wrist next to the ulna head. Two alligator clips were then attached to the electrodes. The body stat machine was then turned on and the participant's height, weight and age entered. The subject then lay still while the test took place and results were recorded. Calibration of the machine occurred every morning prior to beginning testing.

Figure 3.2: BIA being administered using the Quadscan 4000

Step 4

Using a tape measure, waist and hip circumference was measured. A standard tape measure was used. At all times, the tester ensured that there were no folds in the tape measure and that the tape was held tightly on the participant's body. For the waist, the tape measure was placed around the smallest part of the torso, just above the belly button. For the hip, the tape measure was placed around the largest part of the buttocks.

Step 5

Grip strength was tested using the pressure air biofeedback (PAB®) and a hand grip strength dynamometre. Participants' details were added to the system and a participant code given, which was recorded and used for anonymity. Hand dominance was determined by holding a pen out of reach of the participants' arms, and asking them to grab it. Where there was uncertainty, they were asked to pick up and throw a ball. The participants sat on a chair and had their arms bent to 90 degrees at the elbow, while keeping their elbows next to their bodies and their backs straight. They were tested on one hand at a time. The pressure air biofeedback was calibrated between each subject. They were allowed one practice round and then two tests were administered and the highest results used. The air grips were used for testing with the PAB®. Tests were set to record strength over a five second isometric squeeze. Participants sat in the same position and held onto the hand grip dynamometre, performing a five second isometric squeeze. The results were recorded.

Figure 3.3: PAB® Hand grip strength being administered

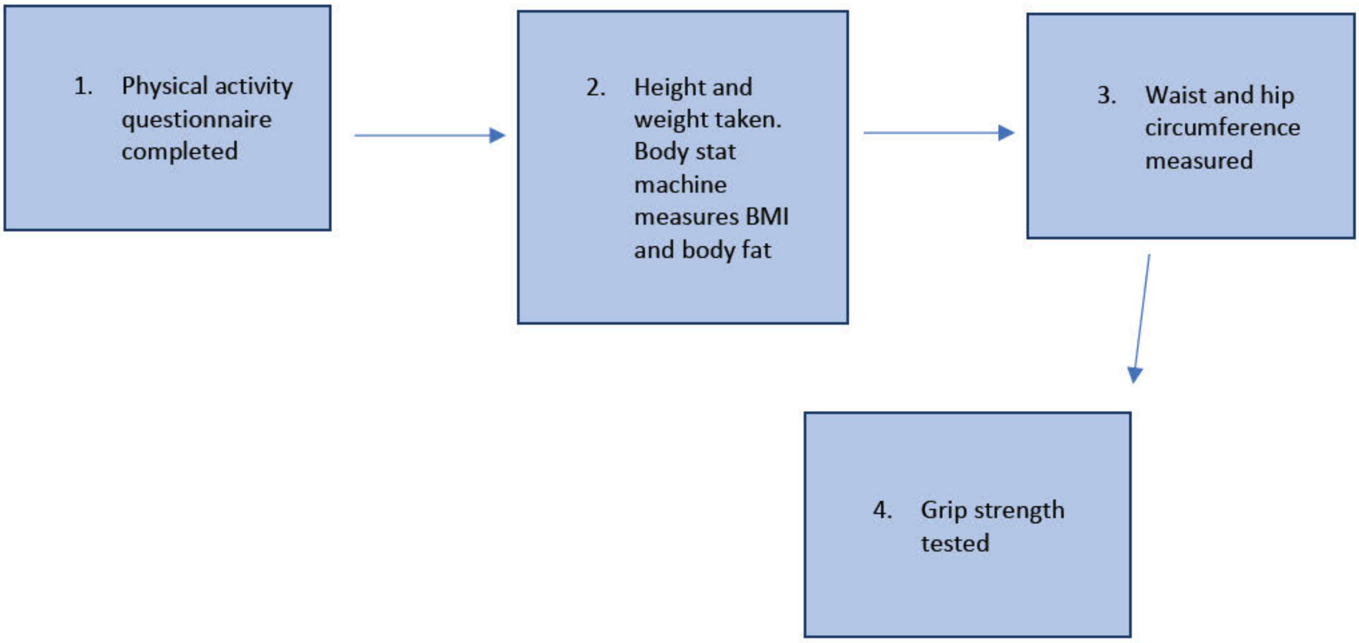

Figure 3.4: Flow chart displaying the testing protocol

3.4 Data collection

The testing was conducted by a qualified Biokineticist (the investigator) who was assisted by qualified exercise scientists, who were trained and educated on the use of the instrumentation. The researcher was also thoroughly trained in the use of the instrumentation. All investigators knew the questionnaire well and how to answer questions that arose. The data was collected in a controlled environment, which did not allow for excess noise or distractions, in order to minimise measurement errors. Data was recorded on a data collection sheet (Appendix 6).

3.4.1 Pilot study

A pilot study was performed on a group of five children from RP Moodley School who met the inclusion criteria and were not included in the actual sample of the research. The pilot study confirmed that the questionnaire was adequate and reliable to provide the data needed for the study. It also helped confirm how to administer the questionnaire. Initially the children were going to complete the questionnaire with their teacher. However, researcher realised that, for inter-tester reliability, it was more accurate to have one research assistant administer all questionnaires for both the schools and to test participants. It was also found in the pilot study that it was best for the measurement of the children in wheelchairs for weight be taken with them being held and weighed together with an assistant and for their height to be taken in a supine position to match the standing height taken with the stadiometre.

3.5 Instrumentation

3.5.1 Questionnaire

The questionnaire (Appendix 7) is a combination and adaptation of two separate questionnaires. A self-report questionnaire was used for assessment of physical activity levels as it is low-cost and can be easily administered to large populations. The first one used is the physical activity scale for individuals with disability (PASIPD), an instrument designed to measure physical activity in individuals with physical disabilities, and providing preliminary support for its construct validity. This PASIPD instrument is short, easily administered and scored, and is suitable for administration either in person or by telephone. The PASIPD has a variety of sections, including for leisure time activity, household work and work activity. However, for the purpose of this study, the leisure time activity section was the only one used

(FACSM *et al.,* 2001). The second questionnaire used and adapted is the physical activity questionnaire for older children (PAQ-C). The PAQ-C was developed and validated and has a strong correlation coefficient with other physical activity measurements (Voss *et al.,* 2017). It was developed to assess normal functioning in children between the ages of 8 and 14. In this study, it was used for children between the ages of 10 and 14 only, and was adapted for children with physical disability. The questionnaire was piloted.

3.5.2 Body stat machine

BIA is an accurate technique to measure body composition which is non-invasive and portable. It requires low maintenance and minimal operator training, as well as being economical for quantitatively estimating body compartments (Barbosa-Silva and Barros, 2005). Tetrapolar impedance is a valid and reliable method that can be useful in the field for assessing body composition at different frequencies (Lukaski *et al.,* 1986). According to Huang, Chen, Chuang, Chiang, Lu, Lin, Chen, Hsiao and Hsieh (2015), the QuadScan 4000 used in this study is commonly used to assess body composition and appears to represent a reasonable and practical application for assessing body fat characteristics (Valliant and Tidwell, 2007). The reliability of the machine is good, with inter-machine reliability within 99% of the machines within 0.2% of each others readings (Lukaski *et al.,* 1986)..

3.5.3 Pressure air biofeedback

The PAB® is a portable, valid and reliable device that was designed to test isometric muscle strength. A strong relationship ($r = 0.997$, $p < 0.01$) between average PAB® force data (mb), calculated over two days in relation to calibrated weights, was also found. The calibration results demonstrated high validity between measurements (calibrated weight in kg) and the associated criterion (PAB® force in mb). The PAB® uses air to measure muscle force, and therefore to test muscle strength imbalances. It is a small device which consists of the different connectors, the one used in this study being the hand grip senso cushion and the cables which connect it to the laptop in order for data to be read. The PAB® is easy to calibrate, which was done before use on each participant. It is calibrated by removing the cable from the needle and attachment and allowing the air to enter for three to four seconds, to allow it to equalise with atmospheric pressure, and then putting the cable back into the attachment. It is, therefore, very quick to calibrate. (Pienaar and Barnard, 2016).

3.5.4 Hand grip dynamometre

Grip strength is often used as it is a predictor of important outcomes (Bohannon, 2006). There are good test-retest reliability coefficients for a variety of grip strength dynamometres (Bohannon, 2006). In this study, the hand grip dynamometres is used as well as the PAB®. This is because some children may not have enough strength to get accurate readings on the dynamometre. It measures isometric grip strength of the hand and forearm muscles and is a great indicator of overall muscular strength (Hardy, Kuter, Campbell and Canoy, 2018). It is easy to administer and complies with strong validity (Bohannon, 2006).

3.6 Ethical considerations

Many ethical considerations were considered, the most important being respect for persons. The study did not commence until gatekeepers and ethical clearance was sought to follow the correct protocol, ethical approval was obtained from the biomedical research ethics committee (BREC) (protocol reference: BREC/00000659/2019). Anonymity of every individual was guaranteed throughout the study by assigning to each participant a code. The participants had the right to decide whether or not to participate in this study, without the risk of penalty or prejudicial treatment, and the researcher undertook to treat the participants according to their own desires, within the bounds of accepted testing. The participants had the right to withdraw from the study at any time, to refuse to give information and to ask for clarification of the purposes of the study. The principle of beneficence was followed, which entailed that the researcher secured the well-being of the participants, who had the right to protection from discomfort and harm, be it physical, psychological, emotional, spiritual, economic, social or legal. Non-maleficence was practised throughout the study. The participants' confidentiality and privacy were ensured throughout, as all the information where participants were identified was only available to the researchers. Once the participants met the inclusion and exclusion criteria they were informed of all the necessary information regarding the study on the informed consent sheet (Appendix 3). The participants had to give written consent with a witnessed signature; or because they were minors, consent by a parent or guardian (Brink *et al.,* 2012), and then verbal assent given by the participants prior to testing commencing. The testing procedure was extremely low-risk as it involved minimal equipment, a constant and monitored environment and very limited movement. Therefore, there was no risk of injury. If, at any time, in the testing a subject felt uncomfortable, testing was terminated immediately to prevent any discomfort.

3.7 Statistical analyses

The data collected in this study were subjected to various statistical procedures. All the data were analysed using the Statistical Package for the Social Sciences Version 19.

Tests used to analyse the data included descriptive statistics, such as means and standard deviations. The Chi-square goodness-of-fit-test, a univariate test, was used on categorical variables to test whether any of the response options were selected significantly more or less often that the others. Under the null hypothesis, it was assumed that all responses are equally selected. The Chi-square test of independence was used on cross-tabulations to see whether a significant relationship existed between two variables represented in the cross-tabulation. When conditions were not met, Fisher's exact test was used. Analysis of Variance (ANOVA) was used to test for several independent samples that compared two or more groups of cases in one variable. Pearson's correlation coefficient determined linear associations. Friedman's test is a non-parametric test and was used to detect differences across multiple tests. A p-value of 0.05 was used to indicate significance.

3.8 Conclusion

The methods which have been described in this chapter were used to answer the questions and objectives of the study. The next chapter focuses on the results obtained from the testing.

CHAPTER FOUR

4 Manuscript

4.1 Introduction

The manuscript has been submitted to the International Journal on Disability and Human Development. The authors guidelines are displayed in Appendix 8.

ANTHROPOMETRIC CHARACTERISTICS, GRIP STRENGTH AND PHYSICAL ACTIVITY LEVELS OF CHILDREN WITH PHYSICAL DISABILITIES: A CASE STUDY

ABSTRACT

Physical disability influences activities of daily living, and in children with disability, this often results in exclusion from participating in physical activity. This paper aimed to determine the relationship between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities A quantitative case study approach was employed, children (n=53) with physical disabilities aged 10-12 years from two schools for learners with special educational needs, KwaZulu-Natal, South Africa. A physical activity questionnaire, muscle strength testing (pressure air biofeedback (PAB®) device and hand grip dynamometre) anthropometrical data (bioelectrical impedance analysis, including waist and hip circumferences measurements) were completed. The highest number of participants (52.8%, n=28) spent most of their time in a week on quiet activities. The participants were shorter than normal. Their mean total weight was 36.46kg and was slightly below the standard age norm. BMI and waist circumference were below the cut-off points for being high risk for cardiovascular disease. Significantly, lower hand grip strengths, compared to the norms for able-bodied children in their age group, were found. A trend was seen among the participants that those with less severe forms of disability, such as loss of sight or speech, were more physically active than those with more severe physical disabilities, such as muscular disorders and CP. Regardless of the type of disability, implementation of, and education in, physical activity more inclusive of disability, within the school curriculum, and physical therapy based on the children’s strength profile, need to be introduced.

Keywords: Body composition, muscular strength, cerebral palsy

1. Introduction

Disability is a multi-level concept that is globally understood as a disease, condition and/or physical impairment that often results in functional limitations and a restriction to participation in daily life. Individuals experiencing disability are further limited by environmental and contextual factors such as poor access to healthcare, stigma and inadequate community programmes[1]. In South Africa, 10.8% of children aged between five and nine years, and 4.1% of children aged 10-to-14 years, have been reported to have disabilities in the broader spectrum of impairments and functional limitations, affecting sight, hearing or communicating; and physical impairments or the loss of limbs, leading to difficulties in walking and undertaking self-care[1].

In this paper, we refer to physical disabilities. A physical disability is specifically defined as a long-term condition in which there is a limitation on a person's physical functioning, mobility, dexterity or stamina, resulting in activity limitation and involvement in life situations. It is any restriction or lack (resulting from an impairment) of ability to perform an activity in a manner, or within the range, considered normal for a human being[2].

The benefits of exercise and physical activity for individuals with disabilities have been well-documented[2]. However, very few people with disabilities are active[3]. Regular physical activity improves physical functioning and also improves body composition, while decreasing the risk of obesity, and improving the muscle mass of individuals who are underweight[3]. Other positive results from participation in sports and exercise, for children with disability, are an enhanced, perceived self-competence in an outside sports setting; improved social integration; and better goal setting and accomplishment[3]. However, it is known that special needs schools in South Africa, and specifically in the province of KwaZulu-Natal, lack resources, proper education, funds and personnel to facilitate beneficial exercise therapy, which leads to a lack of participation in physical activity[1].

The lack of physical activity has been identified as the fourth leading cause of global mortality, and is especially elevated in children with disability who are already at risk of developing secondary health conditions[3].These secondary health conditions, such as hypertension, high cholesterol, diabetes mellitus, obesity, coronary artery disease and cardiovascular disease, can be managed, and often prevented, by physical activity [4,5]. A lack of physical activity, and being overweight, contributes to an increased risk of cardiovascular disease (CVD)[5]. Children with disability have higher levels of obesity than their peers without disability[6]. The consequences of poor health and physical inactivity potentially lead to poor long-term health, a suboptimal quality of life, and more dependence on others[5].

Children with disability are less involved in physical activity than their typically developing peers. Regular participation in physical activity by children, abled or disabled, enhances anthropometrical characteristics, bone health and psychological health, and promotes social engagement. Furthermore, children with physical disabilities often have delayed gross and fine motor development, delayed development of balance and co-ordination, and poor functional capacity due to lower grip strength; all of which could potentially be improved by participation in physical activity[7].

In a study conducted in Britain among 576 children with and without disabilities, the children with a physical disability only participated in 3/10 of physical and home-based activities[4]. Given that the current frequency of therapy is at a minimum, and with issues of childhood obesity, this level of involvement is a cause for concern. Research is needed in more diverse populations of children with physical disabilities, to examine the factors affecting their participation and physical health; as limited evidence exists on children with various types of physical disabilities [4]. In South Africa, there is an insufficient level of physical activity among children with physical disabilities[7].

The increasing severity of disability is directly related to more chronic disease risk factors, reflected in higher rates of obesity, and larger waist circumference and BMI measurements[7]. Factors such as poor physical functioning, a large waist circumference, and high body fat due to increased weight, put one more at risk[7]. Individuals with disabilities, and especially children, are more seriously affected by obesity. It results in more functional limitations. It can make wheelchair transfers or ambulating with assistive devices difficult, which makes it harder for them to be included in physical activity and therapeutic rehabilitation exercises[8]. Obesity is associated with high rates of morbidity and mortality, which contribute to a shorter lifespan in children with physical disability[8.] Continuing efforts to address and reverse obesity and improve health in children with disability cannot be neglected.

On the other end of the weight scale comes malnutrition, and children with disability are often underweight. Malnutrition is common in children with disability, especially those with cerebral palsy (CP)[9]. A high prevalence of malnutrition is often reported in children with disability and this results in worsening health and development[10]. Malnutrition is defined as the lack of proper nutrition[10]. Childhood malnutrition is a public health issue in low- and middle-income countries, especially affecting children with disability[11]. It was found that 80% of children with disability are reported in low- and middle-income countries[11]. The consequences of malnutrition are many and are clinically significant. Identification and correction of children with physical disabilities who are either under- or overweight is paramount[9].

Anthropometric measurements in children, including weight, height, body circumferences and body composition estimates using the Bioelectrical Impedance Analysis (BIA) are an important part of an overall clinical assessment. They can also be readily obtained and allow evaluation of an individual's nutritional status[12]. These measurements can also be helpful in healthcare preventative screening, as a high body fat index indicates an increased risk to health issues[2]. People with physical disability experience changes in their body composition and energy expenditure through physiological changes as a result of their diseases, and this plays a role in the early development of obesity. It has been found that the body composition of people with physical disability shows a decrease in fat-free mass and an increase of fat mass; although not in individuals with malnutrition[8].

Muscle strength is an important aspect of health status, and when one has decreased muscular strength it can result in functional limitations[12]. Many disabilities, especially CP, affect the brain structures responsible for skilled hand movements[13]. The severity and type of hand impairments vary widely, based on the amount of cerebral damage. Both sensory and motor hand impairments are responsible for difficulties with daily activities in children with disability[13]. Strength is the ability to perform activities with an exerted effort, and grip strength is regarded as a measure of general health and is used to assess normal motor function[12]. From a young age, it is necessary to produce enough grip strength to be able to perform daily activities, including movements requiring fine and gross motor skills[14].

There is a strong correlation between grip strength and total muscle strength[12]. Estimating grip strength helps identify the level of development and degree of disability. Testing grip strength in children has become a routine part of the clinical assessment of hand function, since many children with various diseases or lesions have reduced grip strength[14]. Therefore, grip strength results could be used as a general indicator for increasing physical activity and could help improve both overall muscle strength and functionality, leading to a better quality of life and inclusion in daily activities[12].

We believe that in order to help improve the level of physical activity levels of children with disability, the profiling of the physical activity levels, anthropometric characteristics and strength measurements in school-going children with physical disabilities, is the first step. Hence the aim of this study was to determine the relationship between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities between the ages of 10 and 12 at two special educational needs schools.

2. Methods

A quantitative case study approach was adopted at two schools for learners with special educational needs (LSEN) in KwaZulu-Natal, South Africa. Fifty-three participants, with a broad range of physical disabilities, underwent anthropometric tests and hand grip strength tests, and completed a questionnaire on their physical activity levels, to assist in determining a relationship between these variables. With the study being a quantitative case study, it allowed for a more focused investigation on the study population, and this case study design assisted with narrowing down a broad field of research into a smaller topic.

Ethical considerations

Permission to conduct the study was obtained from the provincial Department of Basic Education. Child assent and parental consent was obtained, and the school principals granted permission for the study to commence. Ethical approval for this study was received from the University's Biomedical Research Ethics Committee (BREC/00000659/2019). Many ethical considerations were considered, the most important being respect for persons. The study did not commence until gatekeepers' and ethical clearance had been sought to follow the correct protocol. Anonymity of every individual was guaranteed throughout the study by assigning to each participant a code. The participants had the right to decide whether or not to participate in this study, without the risk of penalty or prejudicial treatment, and the researcher undertook to treat the participants according to their own desires, within the bounds of accepted testing. The participants had the right to withdraw from the study at any time, to refuse to give information and to ask for clarification of the purposes of the study.

Setting

The two LSEN schools enrol children with all types of disabilities, including physical and mental disabilities. However, for the purpose of this study, only children with physical disability were recruited. Both schools employed a permanent occupational therapist, as well as a physiotherapist. Each participant's disability type was confirmed by the physiotherapists at both schools based on medical records.

Participant recruitment and sample selection

Non-probability convenience sampling was used to recruit the participants. Sixty-five children between the ages of 10 and 12 years, with physical disabilities, volunteered to participate in this study. The inclusion and exclusion criteria were as follows: Children with a physical disability, including loss of sight or hearing; poor ability to communicate; a physical impairment or loss of a limb; and difficulty in walking or taking care of oneself were included. Children with one or more the following: amputation; CP; cerebral vascular accident/stroke (vascular brain disorders); congenital anomalies; hydrocephalus; juvenile arthritis; muscular disorders (non-progressive); neuropathy; orthopaedic conditions (e.g. scoliosis); spinal cord injury; spina bifida; and traumatic brain injury, were also included in the study. Children with the presence of one or more of the following: progressive disorders (e.g. cancer or muscular dystrophy); cleft lip and palate; developmental delay; cognitive/mental conditions (e.g. Down syndrome); learning problems; behavioural/emotional issues (e.g. pervasive developmental disorder; autism; attention-deficit disorder; Asperger's syndrome); microcephalus; epilepsy; psychiatric disorders; anomalies of inner organs (e.g. heart, respiratory, metabolism); and syndromes with a recognised component of intellectual delay [4] were excluded from the study.

A sample of 53 (ten from one school and 43 from the other school) participants with visual impairments, speech impairments, cerebral palsy, amputations, orthopaedic conditions and muscular disorders met the inclusion/exclusion criteria.

Data collection tools

A validated self-reported physical activity scale questionnaire for individuals with disability (PASIPD) was used for assessment of physical activity levels as it is low-cost and can be easily administered to large populations[15]. The instrument was designed to measure physical activity in individuals with physical disabilities, providing preliminary support for its construct validity. This PASIPD is short and easily administered and scored. The PASIPD has several sections, including for leisure time activity, household work and work activity. However, for the purpose of this study, the leisure time activity section was only used[15]. A second questionnaire, adapted from the physical activity questionnaire for older children (PAQ-C), was also used. The PAQ-C was developed and validated and has a strong correlation coefficient with other physical activity measurements[16]. It was developed to assess normal functioning in children between the ages of 8 and 14. In this study, it was used for children between the ages of 10 and 14 only, and was adapted for children with physical disability. All questionnaires were piloted among children with disability who had fit the inclusion/exclusion criteria for this study. Minor adjustments like the simplification of selected questions were made prior to use in the main study.

Height and weight were measured with a calibrated scale and wall stadiometre and children who were unable to stand independently were assisted. The research assistant's weight was measured independently and subtracted from the combined value. For children who were unable to stand, height was recorded in a supine position, where a ruler was used to ensure that the measurement was taken accurately at the top of the head. Body mass index (BMI) was calculated using the height and weight measurements.

The BIA, which is non-invasive and portable, is an accurate technique to measure body composition[17]. The Quad scan 4000 was used in this study and is commonly used to assess body composition. It appears to be a reasonable and practical application for assessing body fat characteristics[17]. Using the Quad scan 4000, body fat percentage (BF%) and fat mass (FM) were calculated with the child lying in a supine position with no limbs touching. Calibration of the machine occurred every morning prior to testing.

Using a tape measure, waist and hip circumference were measured. A standard tape measure was used. At all times, the tester ensured that there were no folds in the tape measure and that the tape was held tightly on the participant's body. For the waist, the tape measure was placed around the smallest part of the torso, just above the belly button. For the hip, the tape measure was placed around the largest part of the buttocks. If participants were able to stand the measurements were taken in a relaxed standing position. If they were in a wheelchair, they lay supine and the tape was carefully placed around their bodies.

Prior to the grip strength testing, hand dominance was determined by holding a pen out of reach of the participants' arms, and asking them to grab it. This was tested a few times to see if the same hand reached out each time to grab it. Where there was uncertainty about the participant's hand dominance, a further test was conducted, which involved throwing a ball to the participant and identifying which hand reached out to catch it.

The hand grip strength test measured isometric grip strength of the hand and forearm muscles and is an excellent indicator of overall muscular strength[11]. Good test-retest reliability coefficients for hand grip strength dynamometres have been reported[18].

The pressure air biofeedback (PAB®) is a relatively new, portable, valid and reliable device that was designed to test isometric muscle strength. The PAB® system calibration results demonstrate high validity between measurements of strength (calibrated weight in kg.) and the associated criterion (PAB® force in mb)[19]. The participants sat on a chair and had their arms bent to 90 degrees at the elbow, while keeping their elbows next to their bodies and their backs straight (Figure I). One hand was tested at a time. The air grips used are soft and easy to squeeze, replicating squeezing a soft ball in the hand, which made it easy to administer for those with hand grip weaknesses. They were allowed one practice round and then two tests were administered and the highest results were used. The air grips were used for testing with the PAB®. Tests were set to record strength over a five second isometric squeeze. Participants sat in the same position and held onto the hand grip dynamometre, performing a five second isometric squeeze. The results were recorded. The PAB® was calibrated after each participant was tested.

Figure I: PAB® hand grip strength test

All measurements as well as the administration of the questionnaire were conducted by the lead author and trained sport scientists. A minimum of two sport scientists were present at each testing station during the data collection.

Statistical Analysis

Data were captured on an excel spreadsheet and analysed using the Statistical Package for the Social Sciences Version 19. Tests used to analyse the data included descriptive statistics, such as means and standard deviations, where applicable. The Chi-square goodness-of-fit-test, a univariate test, was used on categorical variables to test whether any of the response options were selected significantly more or less often that the others. The Chi-square test of independence was used on cross-tabulations to see whether a significant relationship existed between the two variables represented in the cross-tabulation. When conditions were not met, Fisher's exact test was used.

One-way analysis of variance (ANOVA) was used to test for significant differences in interval-measured variables across disability types. Pearson's correlation coefficient was used to measure the linear association between physical activity and the anthropometrical and strength measurements. Friedman's test was used to detect differences across multiple related test measurements. Results were statistically significant if $p < 0.05$.

3. **Results**

The average age of the sample was 10.98 years (SD=.888). Of the 53 participants, 54.7% were male and 45.3% were female. Almost one-quarter of the sample (22.6%; n=12) were wheelchair-users, while 77.4%; n=41 were not.

Weekly activity participation

Table 1 shows the number of hours which were spent weekly on quiet activities; walking activities; light, moderate and strenuous sport/activities; and exercise to increase muscular strength and endurance.

Table 1: Duration of weekly physical activities

	<1 hour per day n (%)	**1-<2 hours per day n (%)**	**2-4 hours per day n (%)**	**>4 hours per day n (%)**	**p-value**	**Chi-square**
Quiet activities	2 (3.8)	18 (34)	28 (52.8)	5 (9.4)	<.0005	32.811
Walking activities	10 (24.4)	22 (53.7)	2 (4.9)	0 (0)	<.0005	17.882
Light intensity sport/activities	43 (81.1)	10 (18.9)	0 (0)	0 (0)	<.0005	20.547
Moderate intensity sport/activities	43 (81.1)	10 (18.9)	0 (0)	0 (0)	<.0005	20.547
Strenuous intensity sport/activities	43 (81.1)	10 (18.9)	0 (0)	0 (0)	<.0005	20.547

Exercise to increase muscular strength and endurance	10 (100)	0 (0)	0 (0)	0 (0)	<.0005	20.547

Analysis shows that the majority of participants do quiet activities (86.8%), walking activities (64.7% of those who can walk) for between one and two hours a day; and light, moderate and strenuous exercise (81.1% in each case) for less than an hour a day. The 10 participants who exercised to increase muscular strength and endurance all did it for less than an hour a day. The low intensity sporting activities which were performed weekly included physiotherapy and occupational therapy at both of the schools.

One school had hydrotherapy sessions with the children and the other school had structured physical activity sessions, for less than one hour a week, to increase muscular strength and endurance. This same school also had physical exercise sessions weekly for between one and two hours. Of the 53 children, 13.2 % reported that they did not participate in physical activity over the weekend, but the rest reported that they participated in physical activity over weekends. Physical activities included ball sports, boccia, table tennis, volleyball, running, boccia and wheelchair racing. Many of the children reported that they would like to participate in athletics, cycling, cricket, netball, golf, competitive soccer, swimming and tennis. Only two of the participants stated that they do not like sport so they would not choose to participate in any physical activity.

Furthermore, it was found that the participants were spending some time on quiet activities, such as reading, watching TV and playing computer games. A significant number of the participants indicated that they did quiet activities either ‘sometimes’ (three-to-four days out of the previous seven days: 22 (41.5%) or ‘often’ (five-to-seven days out of the previous seven days: 22 (41.5%) ($p=.041$).

Participants ‘seldom’ participated in light, moderate or strenuous activity. A large majority (81.1%) reported that they ‘never’ do exercise to specifically increase muscular strength and endurance ($p<.0005$); while the same number of participants ‘never’ participate in physical education lessons at school ($p<.0005$). When asked about participation in physical activities over the weekend, 30.2% indicated that they ‘seldom’ participate, and 45.3% indicated that they ‘sometimes’ participate in such activity ($p<.0005$).

Anthropometric data

Table 2 shows the anthropometric data of the sample. This includes BMI, waist circumference (WC) and hip circumference (HC).

Table 2: Anthropometric data

	Height (cm)	**Weight (kg)**	**BMI (kg/m^2)**	**WH (cm)**	**HC (cm)**	**BF%**	**Fat Mass (kg)**	**Lean Body Mass (LBM)**
Mean	139.73	36.46	19.08	64.50	75.82	22.79	9.25	27.83
SD	13.05	13.79	7.05	12.04	15.79	10.66	7.44	8.22
Minimum	100.20	12.00	11.53	45.70	46.2	5.10	1.20	9.20
Maximum	165.50	77.00	55.80	108.80	105.50	45.90	33.90	49.00

The anthropometric data varied widely between the participants in the study.

Hand grip strength data

The hand grip strength was measured by the hand grip dynamometre and the PAB®, according to hand dominance. Nine participants (17%) were left-hand dominant and 44 participants (83%) were right-hand dominant.

Table 3 reflects the hand grip strength results from the hand grip dynamometre and the PAB®.

Table 3: Hand grip strength results from the hand grip dynamometre and PAB® for dominant (D) and non-dominant (ND) hands

	Grip Strength (kg) D	**Grip strength (kg) ND**	**PAB® Max strength (kg/force) D**	**PAB® Max strength (kg/force) ND**	**PAB® Relative strength (kg/force) D**	**PAB® Relative strength (kg/force) ND**	**PAB® Total work (kg/force) D**	**PAB® Total work (kg/force) ND**
Mean	12.65	12.22	4.06	4.73	37.30	46.72	1246.66	1621.90
SD	10.09	10.05	2.56	2.75	33.19	33.94	1045.45	1127.07
Minimum	2.00	.00	.08	.51	.49	2.32	19.97	46.44
Maximum	46.00	39.00	10.41	10.73	171.27	157.49	4624.26	4252.29

Hand grip strength data from both the hand grip dynamometre and PAB® yielded a range of results. When compared to the norm, it was clear that the participants' measurements were below accepted normal readings and they need help to increase their functionality.

The relationship between disability type and physical activity participation, anthropometric data and hand grip strength

Results from the Fisher's exact test show that there was a significant relationship between disability and frequency of walking (Fisher's exact = 22.532, p=.003). A significant number of those with sight loss 'sometimes' walk; those with an orthopaedic condition 'often' walk; and those with a muscular disorder 'never' walk. A significant relationship was also evident between disability and amount of time spent daily on these walking activities (Fisher's exact=15.422, p=.002). Those with loss of speech, who had reported that they walked, performed this activity for less than one hour per day. Half of those with an orthopaedic condition walked for between two and four hours per day.

There was a significant relationship between type of disability and participation in exercise to specifically increase muscular strength and endurance, as well as participation in school physical education lessons (Fisher's exact = 20.969, p<.0005). Compared to other types of disabilities, a significant number of those with loss of speech performed these activities 'seldom' as opposed to 'never' doing them.

Results also showed that during school recess, a significant number of those with loss of speech were not very active, or spent some of the time on games/activities (Fishers exact = 22.474, p=.001).

Regarding activity during their free time in the previous seven days, the only participant who indicated being physically active five to six times a week suffered from loss of sight. Those with loss of speech were active once or twice a week; and those with orthopaedic conditions were active three-to-four times a week (Fisher's exact = 19.132, p=.044).

There was a significant difference in height, depending on the disability: F statistic (4,48) = 3.868, p=.008. Those with loss of speech (mean height=153.72, SD=5.82) are significantly taller than those with CP (mean height=136.39, SD=12.83).

There was a significant difference in weight, depending on disability: F statistic (4,48) = 3.892, p=.008. Those with loss of speech (mean weight=53.06, SD=15.85) have a significantly higher weight than those with CP (mean weight=33.59, SD=12.65).

There was a significant difference in lean body mass (LBM) depending on disability: F statistic (4,45)=6.026, p=.001. Those with loss of speech (mean LBM= 37.88, SD=8.30) had a significantly higher LBM than those with CP (mean LBM=25.80, SD=25.81), orthopaedic conditions (mean LBM= 20.55, SD=2.62) or muscular disorders (mean LBM=19.25, SD= 3.88).

4. Discussion

This study aimed to examine the relationship between physical activity levels, anthropometric characteristics and hand grip strength in children with varying physical disabilities. The paper set out to assess physical activity levels and sport participation; to determine anthropometric characteristics using bioelectrical impedance analysis; to determine hand grip strength; and to assess the impact of the type of physical disability in children on these different test items in two LSEN schools in KwaZulu-Natal, South Africa. Results found that the participants did not meet the guidelines with regards to how much physical activity they should be performing on a weekly basis. Their anthropometrical characteristics varied over a wide range and indicated the need for nutritional improvements. There were poor hand grip strength results across all the participants.

A lack of physical activity, as well as the type of physical activity, in children with disability is found to have possible negative consequences in the long term[3]. Physical activity is crucial to maintain health and functioning and improve the well-being of an individual[3]. The level of physical activity and sport participation in children with various physical disabilities at both schools was found to be very low, with more time spent on quiet activities than beneficial physical activities. This is similar to the findings of previous studies[4]. South Africa, due its history, is a country with a lack of resources, a lack of social support, limited facilities, transportation challenges, and other environmental barriers[20]. The most evident barriers to participation in physical activity include a lack of assistance to lift the children out of their wheelchairs, transfers and personal care[21]. This problem is evident in KwaZulu-Natal as many of the schools have very limited resources and funds to provide the necessary support to children with disability. Children with disability are two-to-three-fold more limited in their activities than those with other chronic conditions[4]. Regular physical activity participation is important for children's growth, development and health. More than 35 million children worldwide attend school for approximately only 175 days per year, making it an ideal setting, not only for providing and promoting physical activity, but also for increasing and sustaining it at all levels, regardless of disability, race, ethnicity or socioeconomic status[4].

In the current study, it was found that the highest number of participants spent most of their time (three-to-four days, or as often as five-to-seven days, a week) on quiet activities. Most of them reported watching TV, while some read, and others reported playing board games, doing hand crafts, and playing computer/tablet games. Therefore, more time is spent being sedentary rather than physically active, as more time is spent on quiet activities. Law *et al.*[4] found that children and youth generally spend much of their out-of-school time at home. Given this amount of time at home, their home environment activities are essential to improving their skills and development, as well as determining how physically active they are. These findings are corroborated in the current study, where the children spent most of their free time watching TV and performing their own quiet activities, instead of involvement and participation in family activities. Children with physical disabilities, in their school recess, fail to engage in physical tasks and are significantly more sedentary than their peers[22].This was evident in this study, as most of the children reported that they sit quietly during school recess. Increasing activities such as 'free play' will help improve children's ability to interact and will build their confidence. Being able to be physically active, without it being a specific routine, will also allow the child to have fun while being active, instead of sedentary. It will build peer relationships and help grow their confidence[23].

When comparing time spent on light, moderate and strenuous physical activity, this study revealed no differences in how often children participated, or in the hours spent weekly on these activities. The mean time spent on each of these activities was two hours each week. The World Health Organisation (WHO) states that training at least 60 minutes per day of moderate-vigorous intensity exercise for children should be used as a basic guideline for how much physical activity one should be performing[23]. Therefore, this study shows that the children with physical disabilities did not achieve the minimum weekly amount of moderate intensity exercise recommended. However, they did meet the minimum requirements for strenuous exercise.

Muscle strengthening programmes result in improved function and ability to perform daily activities, while muscular endurance is important to function optimally for long periods of time without fatigue[23]. In this study, most of the children reported that they did not perform exercises specifically to increase muscular strength and endurance. It would be greatly beneficial for children with physical disabilities, in this environment, to increase the amount of exercise done weekly, specifically to increase muscular strength and endurance. Muscular strengthening exercises are beneficial to improve whole body muscular strength, and help improve bone mineral density[21]. The trend demonstrated in the results revealed that children with disability, such as loss of sight or speech, are more physically active than those with physical disabilities such as muscular disorders and CP. Children with more severe physical disabilities (such as muscular disorders and CP) have more physical limitations due to the severity of their disabilities. These limitations are not only physical, but are limited by the available resources, including wheelchair access and the inability of caregivers to adapt to, and accommodate, the disability, making them more likely to be less physically active[7].

The children at both schools had varying results with regards to their stature. The maximum height was slightly above the age percentile. However, the mean height was below the average, which could indicate poor dietary habits affecting growth[10]. A study in 2000, found that short stature, with or without being underweight, is common in disabled children[5]. This was evident in this study, as the mean height for the sample is below age standard norms for the children[10]. Eating problems, such as delayed self-feeding, oral-motor dysfunction, lack of appetite and meal-time tantrums are common in children with disability. This can be of great concern as it may have an impact on the children's relationship with eating, their nutritional status and growth. Furthermore, a high prevalence of malnutrition is often reported in children with disability and this results in worsening health and development[10].

The anthropometric characteristics of the children in the current study varied widely, from being underweight to overweight, as well as being at risk for either malnutrition or obesity. The results showed that the mean total weight was below the standard age norm. Similarly, the weights measured differed widely across the sample, which shows that the nutritional status among the participants varied. It is believed that some of the children are at risk of malnutrition and being underweight; and some are at risk of chronic diseases such as cardiovascular disease, due to being overweight. People with physical disability experience changes in their body composition and energy expenditure through physiological changes as a result of their diseases, and this plays a role in the early development of obesity or malnutrition. It was found that the body composition of people with physical disability shows a decrease in fat-free mass and an increase of fat mass[8].

BMI, waist circumference and body fat percentage correlate with cardiovascular risk factors in childhood, which often continue into adulthood. When they fall outside the acceptable range, they indicate an increased likelihood of cardiovascular and secondary disease. Body fat percentage is an indicator of health[23]. It can give a more accurate representation of the anthropometry of an individual than BMI. When body fat percentage is too high, or too low, children face the risk of having less resistance to disease and they are also at risk of other health issues[23]. According to healthy ranges recorded by a study in 2007, it was found that, for the sample, the mean body fat percentage, waist circumference and BMI fell into the healthy range[2]. Some of the participants on the higher and lower ends of the scale are at risk for health issues. Total daily energy expenditure (TEE) consists of resting energy expenditure (REE), the thermic effect of food (TEF), and the thermic effect of physical activity. TEE has been found to be lower among people with physical disability, as due to their already sedentary lifestyle, they are not expending much energy through physical activity. Therefore, the high rate of inactivity is associated with a high prevalence of varying body fat percentages[8]. In this study, the anthropometric values for the sample were below the cut-off point for being at high risk. However, improvements could be made. An improvement in anthropometric values can indicate improved health status and quality of life [8].

Hand grip strength is an important measure of strength and an indicator of health status. Measuring hand grip strength is an easy and inexpensive test to perform[12]. Hand grip strength is considered the single most representative clinical measure of body strength in humans [12]. In children, hand grip strength is important as many school activities require fine motor and manual dexterity skills. Measuring grip strength can indicate their ability to perform fine motor skills which require the co-ordination of small muscles in movements and the synchronisation of the hands and fingers with the eyes and body[12]. Measuring hand grip strength is important to indicate the degree of disability, to determine the efficacy of rehabilitation and to assess the integrity of upper limb functions[12]. The participants in this study also had significantly lower hand grip strength compared to the norm for able-bodied children their age. This was expected, due to the fact that research reveals that most children with disability have impairments with hand grip, based on the amount of cerebral damage and severity of the disability [13]. The severity of disability has an effect on the degree of hand impairments[12]. While this study sample had significantly lower hand grip strength than abled children their age, there were no significant differences between disability types (loss of sight, loss of speech, CP, orthopedic conditions, and muscular disorders) and hand grip strength. Improving hand grip strength in children with disability would help improve their overall quality of life and functionality. It is a strength factor that needs to be considered by clinicians when prescribing therapy[12].

Results from this study identified relationships between physical activity, anthropometry and the hand grip strength of participants, based on disability type. There has been very limited research conducted on the factors affecting children with disability and how all of these factors relate to one another[5]. Research has revealed that those with a higher level of exercise self-efficacy had a greater probability of maintaining an exercise routine [25]. In this study, the findings revealed that all participants spent much time on quieter activities, regardless of the disability type[25]. This could be due to a lack of resources and caregivers, especially in a low-resource country[20]. However, those with loss of sight and orthopaedic conditions sometimes, or often, spent time walking, which could be because walking is an activity which requires no equipment[20].

In the current study, participation in light, moderate and strenuous activities was no different in children with the various disabilities. However, participants with loss of speech performed all these activities for longer. Similarly, participants with loss of speech and CP performed muscular strength and endurance exercises, although seldom. On the other hand, these exercises were never performed by the participants with other disabilities. Participants with loss of speech were most active during their recess, while those with the other disabilities were less active or sat quietly during recess. Their participation was not enough to reach the minimum required for weekly activity[20]. These results align with other studies, where it has been found that children with more severe gross motor problems, such as CP, experience greater restrictions on their participation in physical activity, compared to those with loss of certain senses (sight, speech, hearing) only[20]. However, another study found that there was no relationship between exercise participation and disability variables (sex, age, education, general health, degree, type of disability, income and BMI)[25,4]. It was found that, when primary caregivers of those with disability perceived the greater benefits of physical activity, they incorporated it into a routine more frequently, making their children more physically active, regardless of disability [25]. This highlights the importance of educating caregivers, parents and disability schools on the importance of physical activity in order to improve physical activity, levels regardless of disability type.

With regards to hand grip strength, there was a broad range of results, and no significant differences between disability types and hand grip strength. Other research has found that those with more severe disabilities and contractures had lower hand grip strength[20]. However, in this study there were few participants with hand contractures which would affect their ability to perform a hand grip test.

More inclusive physical activity interventions, suited to all types of disabilities, need to be incorporated into all disability school curricula. Parents and caretakers need to be educated on ways to improve the health and lifestyle of children, including through home physical activity programmes which can complement the school programme. Furthermore, more health education, specifically on nutrition, should be included in the curriculum; health and nutrition awareness need to be improved among parents and caretakers.

Future studies need to explore feasible approaches to integrate physical activity into the school curriculum for children, and to find potential solutions to the challenges experienced by the teachers and caregivers, with regards to the effective delivery of physical activity programmes. Future studies can also explore ways to improve eating habits, ensuring correct nutrition in combination with an increase in physical activity; which could together contribute to improving body composition.

These findings will, potentially, offer a basis for school intervention programmes to improve physical activity and increase strength in children with disability. The study will help to increase awareness of the benefits of physical activity for children with disability. Our results confirm the need for children with disability to participate in physical activity from a young age; the integral role of families and teachers and their need for support; and the need for education to improve the facilitation and incorporation of beneficial physical activity programmes at all schools for children with disability.

The study had several limitations including the low number of participants; gender differences were not considered; and children with mental impairments and disabilities were not included.

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Informed consent was obtained by all participants who had the right to choose to participate in the study.

Anonymity of every individual was guaranteed throughout the study by assigning to each participant a code.

6. References

1. Pather S. Evidence on inclusion and support for learners with disabilities in mainstream schools in South Africa: off the policy radar? International Journal of Inclusive Education. 2011;15(10):1103-1117.
2. Froehlich-Grobe K, Lee J, Washburn R. Disparities in Obesity and Related Conditions Among Americans with Disabilities. American Journal of Preventive Medicine. 2013;45(1):83-90.
3. Kosma M, Cardinal B, Rintala P. Motivating Individuals with Disabilities to Be Physically Active. Quest. 2002;54(2):116-132.
4. Law M, King G, King S, Kertoy M, Hurley P, Rosenbaum P *et al.* Patterns of participation in recreational and leisure activities among children with complex physical disabilities. Developmental Medicine and Child Neurology. 2006;48(5):337-342.
5. Durstine J, Painter P, Franklin B, Morgan D, Pitetti K, Roberts S. Physical Activity for the Chronically Ill and Disabled. Sports Medicine. 2000;30(3):207-219.
6. Murphy N, Carbone P. Promoting the Participation of Children with disability in Sports, Recreation, and Physical Activities. PEDIATRICS. 2008;121(5):1057-1061.
7. Shields N, Synnot A. Perceived barriers and facilitators to participation in physical activity for children with disability: a qualitative study. BMC Pediatrics. 2016;16(1).
8. Liou T, Pi-Sunyer F, Laferrere B. Physical Disability and Obesity. Nutrition Reviews. 2005;63(10):321-331.
9. Samson-Fang L, Stevenson R. Identification of malnutrition in children with cerebral palsy: poor performance of weight-for-height centiles. Developmental Medicine and Child Neurology. 2007;42(3):162-168.

10. Groce N, London J, Stein M. Inheritance, poverty, and disability. Disability and Society. 2014;29(10):1554-1568.
11. Hardy J, Kuter H, Campbell M, Canoy D. Reliability of anthropometric measurements in children with special needs. Archives of Disease in Childhood. 2018;103(8):757-762.
12. Wind A, Takken T, Helders P, Engelbert R. Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults?. European Journal of Pediatrics. 2009;169(3):281-287.
13. Arnould C, Penta M, Thonnard J. Hand impairments and their relationship with manual ability in children with cerebral palsy. Journal of Rehabilitation Medicine. 2007;39(9):708-714.
14. Häger-Ross C, Rösblad B. Norms for grip strength in children aged 4-16 years. Acta Paediatrica. 2007;91(6):617-625.
15. Zhu W, McAuley E, Frogley M, Figoni S. A PHYSICAL ACTIVITY SCALE FOR INDIVIDUALS WITH PHYSICAL DISABILITIES (PASIPD). Medicine and Science in Sports and Exercise. 2001;33(5):S120.
16. Voss C, Dean P, Gardner R, Duncombe S, Harris K. Validity and reliability of the Physical Activity Questionnaire for Children (PAQ-C) and Adolescents (PAQ-A) in individuals with congenital heart disease. PLOS ONE. 2017;12(4):e0175806.
17. Valliant M, Tidwell D. Validation of Bioelectrical Impedance Against Dual-Energy X-Ray Absorptiometry in Adult, African American Females. Journal of the American Dietetic Association. 2007;107(8):A29.
18. Bohannon R. Test-retest reliability of the MicroFET 4 hand-grip dynamometer. Physiotherapy Theory and Practice. 2006;22(4):219-221.
19. Pienaar A, Barnard J. Development, validity and reliability of a new pressure air biofeedback device (PAB) for measuring isometric extension strength of the lumbar spine. Journal of Medical Engineering and Technology. 2016;41(3):216-222.
20. Buffart L, Westendorp T, van den Berg-Emons R, Stam H, Roebroeck M. Perceived barriers to and facilitators of physical activity in young adults with childhood-onset physical disabilities. Journal of Rehabilitation Medicine. 2009;41(11):881-885.
21. Wiart L, Darrah J, Kelly M, Legg D. Community Fitness Programs: What Is Available for Children and Youth with Motor Disabilities and What Do Parents Want? Physical and Occupational Therapy In Pediatrics. 2014;35(1):73-87.

22. Hay J, Missiuna C. Motor Proficiency in Children Reporting Low Levels of Participation in Physical Activity. Canadian Journal of Occupational Therapy. 1998;65(2):64-71.
23. Rimmer J, Rowland J. Health Promotion for People With Disabilities: Implications for Empowering the Person and Promoting Disability-Friendly Environments. American Journal of Lifestyle Medicine. 2008;2(5):409-420.
24. Goulding A, Taylor R, Jones I, Manning P, Williams S. Spinal Overload: A Concern for Obese Children and Adolescents? Osteoporosis International. 2002;13(10):835-840.
25. Lui K, Hui S. Participation in and Adherence to Physical Activity in People With Physical Disability. Hong Kong Physiotherapy Journal. 2009;27(1):30-38.

CHAPTER FIVE

5 Conclusions, Recommendations, Limitations and Summary

5.1 Introduction

The final chapter presents conclusions taking into consideration the study's overarching aim and the objectives. The aim of the study was to determine the relationships between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities The first objective of the study were to assess children with physical disability on their physical activity levels, based on how much weekly exercise they have been getting in and out of school. The second objective was to assess their anthropometric characteristics and hand grip strength. The third aim was to assess relationships between physical activity levels, anthropometrical characteristics and hand grip strength. Additionally, recommendations and limitations of the study will be presented.

5.2 Summary

The study investigated anthropometric characteristics, hand grip strength and physical activity levels of children with physical disabilities. The objectives were to determine their level of physical activity and sport participation, determine their anthropometric characteristics and hand grip strength and see if these values had any relationships with specific disability type. The highest number of participants (52.8%, n=28) spent most of their time in a week on quiet activities. The participants were shorter than normal. Their mean total weight was 36.46kg and was slightly below the standard age norm. However, the weight results were widely spread. BMI and waist circumference were below the cut-off points for being high risk for cardiovascular disease Significantly, lower hand grip strengths, compared to the norms for able-bodied children in their age group, were found. A trend was seen among the participants that those with less severe forms of disability, such as loss of sight or speech, were more physically active than those with more severe physical disabilities, such as muscular disorders and CP. However, there were no significant differences between disability types and hand grip strength results. The implementation of more inclusive physical activity interventions need to be incorporated into school's curriculum, suited to all types of disabilities. These schools should include mainstream schools as well as schools for children with disability. Parents and caretakers need to be educated on ways to improve the health and lifestyle of children, which will positively impact their physical health. The education needs to include ways they can incorporate home physical activity programmes into a weekly schedule which can positively complement the school physical activity programme. Furthermore, parents and caretakers need education on nutrition and healthy lifestyle habits.

5.3 Strengths of the Study

These findings will offer a potential basis for school intervention programmes aiming to increase physical activity and increase strength in children with disability. It will help increase awareness of the benefits of physical activity for children with disability. Our results confirm children with disability need for participation in physical activity and it highlights the integral role of families and teachers. The results also confirm the need for education to improve facilitation of beneficial physical activity programmes at all schools with children with disability.

5.4 Limitations of the Study

The study had several limitations. Firstly, the number of participants in this study was small due to the COVID-19 pandemic and the closure of schools. Secondly, as gender differences were not considered there were an unequal number of males and females which may have an effect on the results. Lastly, the study only utilised children with physical disability and not include those with cognitive and mental impairments resulting in disability.

5.5 Recommendations

There is a need for an intervention study that includes a larger sample size, and more schools. Gender attributes need to be factored into the large intervention study. Similar studies should be conducted in other provinces throughout South Africa. Future research can utilise children with physical and mental disability and find out more on their limitations and ways to make a difference and improve health care for all with no discrimination. Further research can also target all types of aspects of exclusion for children with disability in Kwa-Zulu natal, and not just physical activity exclusion. Future research can incorporate testing of blood sugar, cholesterol and triglycerides to determine cardiovascular disease risk. Improved eating habits as well as exercise and health education should be encouraged to children with disability as well as promoted to their parents and caretakers from a young age.

5.6 Conclusions

Results revealed that the highest number of participants spent most of their time on quiet activities (watching TV, doing handcrafts, play computer games) instead of being physically active. They did partake in light, moderate and strenuous intensity physical activity weekly, however the time they spent on these activities was not sufficient to meet recommended guidelines and 81.1% of them never participated in exercises to increase muscular strength and endurance. The children's level of physical activity and sport participation was inadequate. The children were found to be interested in many sports that they are currently not involved in such as athletics, cricket, netball, golf and swimming, and, stated that they would participate if there were adaptations and resources to do so. It can be concluded that there is a need to increase physical activity awareness in schools with children with disability. Education on the implementation of physical activity regimens would be beneficial for the mental and physical health and wellbeing of children with disability.

When looking at the anthropometric characteristics, results revealed to be varying between the participants. However, the mean results revealed that the participants were below weight for their age and the nutritional status. Some are at risk for malnutrition and being underweight, and some at risk for chronic diseases due to being overweight. The sample revealed close to the cut-off points for being at high risk for cardiovascular disease according to waist circumference and BMI, but a healthy range for body fat percentage. In conclusion, their nutritional status varies but improvement can be made. Incorporating educational programmes on nutrition for the schools and parents can be beneficial in improving nutritional status among children with disability.

The results revealed that the children in this study have significantly lower hand grip strength norms to abled children their age. In conclusion, improving hand grip strength in children with disability would help improve overall quality of life and functionality and it is a strength factor that needs to be considered by clinicians when prescribing therapy, and the healthcare professional can include hand and forearm exercises into the therapy to improve strength and dexterity.

With regards to the various types of disabilities the trend seen in the results revealed children with disability such as loss of sight or speech (loss of a sense) are more physically active than those with more severe physical disabilities such as muscular disorders and CP. Children with CP also have a lower body weight and height than those with other disabilities.

In conclusion, regardless of type of disability, an implementation strategy including education of a healthier lifestyle incorporating correct nutritional information and goals for weekly exercise participation need to be implemented. In order to offer a more inclusive disability sports environment; physical activity, and therapy based on the children’s strength needs should be included. This information needs to be introduced to schools with children with physical disability, as well as to parents and caretakers to help improve inclusion and quality of life for children with physical disability.

References

1. Algood, C. and Harris, C., 2013. Parenting Success and challenges for families of children with disabilities: An ecological systems analysis. Journal of Human behaviour in the social environment, 23:126-136.
2. Antle, B., Mills, W., Steele, C., Kalnins, I. and Rossen, B., 2008. An exploratory study of parents' approaches to health promotion in families of adolescents with physical disabilities. Child: Care, Health and Development, 34(2), pp.185-193.

3. Arnould, C., Penta, M. and Thonnard, J., 2007. Hand impairments and their relationship with manual ability in children with cerebral palsy. *Journal of Rehabilitation Medicine*, 39(9), pp.708-714.
4. Beache, T.R. and Earle,R.W., 2008. Essentials of strength training and conditioning/Champaign, IL: Human Kinetics.
5. Bizley,K., 2002. Revise for PE GCSE. 1st ed. Oxford: Heinemann Educational Publishers.
6. Brink,H., Van der walt, C., Van Rensburg,G., 2012. Fundamentals of Research Methodology for Healthcare Professionals. Juta and Company, third edition.
7. Brittain, I., 2004. The role of schools in constructing self-perceptions of sport and physical education in relation to people with disabilities. *Sport, Education and Society*, 9(1), pp.75-94.
8. Bohannon, R., 2006. Test-retest reliability of the MicroFET 4 hand-grip dynamometer. *Physiotherapy Theory and Practice*, 22(4), pp.219-221.
9. Buffart, L., Westendorp, T., van den Berg-Emons, R., Stam, H. and Roebroeck, M., 2009. Perceived barriers to and facilitators of physical activity in young adults with childhood-onset physical disabilities. *Journal of Rehabilitation Medicine*, 41(11), pp.881-885.
10. Bult, M., Verschuren, O., Jongmans, M., Lindeman, E. and Ketelaar, M., 2011. What influences participation in leisure activities of children and youth with physical disabilities? A systematic review. Research in Developmental Disabilities, 32(5), pp.1521-1529.
11. Clark, D., Korff, M., Saunders, K., Balugh, W. and Simon, G., 1995. A Chronic Disease Score with Empirically Derived Weights. *Medical Care*, 33(8), pp.783-795.
12. Cross, P., Shim, A., Verhulst, A., Trost, A., Schmidt, R., Lynde, R. and Hauer, P., 2011. Assessing various body composition measurements as an appropriate tool for estimating body fat in Division I female collegiate athletes. Journal of Science and Medicine in Sport, 14, p.e93.
13. Durstine, J., Painter, P., Franklin, B., Morgan, D., Pitetti, K. and Roberts, S., 2000. Physical Activity for the Chronically Ill and Disabled. Sports Medicine, 30(3), pp.207-219.

14. Froehlich-Grobe, K., Lee, J. and Washburn, R., 2013. Disparities in Obesity and Related Conditions Among Americans with Disabilities. American Journal of Preventive Medicine, 45(1), pp.83-90.
15. Goddard, W. and Melville, S., 2011. *Research Methodology*. Kenwyn, South Africa: Juta and Co.
16. Goodwin, D. and Watkinson, E., 2000. Inclusive Physical Education from the Perspective of Students with Physical Disabilities. Adapted Physical Activity Quarterly, 17(2), pp.144-160.
17. Groce, N., Challenger, E., Berman-Bieler, R., Farkas, A., Yilmaz, N., Schultink, W., Clark, D., Kaplan, C. and Kerac, M., 2014. Malnutrition and disability: unexplored opportunities for collaboration. *Paediatrics and International Child Health*, 34(4), pp.308-314.
18. Goulding A, Taylor R, Jones I, Manning P, and Williams S., 2002 Spinal Overload: A Concern for Obese Children and Adolescents?. Osteoporosis International, 13(10):835-840.
19. Häger-Ross, C. and Rösblad, B., 2002. Norms for grip strength in children aged 4-16 years. Acta Paediatrica, 91(6), pp.617-625.
20. Hardy, J., Kuter, H., Campbell, M. and Canoy, D., 2018. Reliability of anthropometric measurements in children with special needs. *Archives of Disease in Childhood*, 103(8), pp.757-762.
21. Hay, J. and Missiuna, C., 1998. Motor Proficiency in Children Reporting Low Levels of Participation in Physical Activity. *Canadian Journal of Occupational Therapy*, 65(2), pp.64-71.
22. Hutzler, Y. and Levi, I., 2008. Including children with disability in physical education: General and specific attitudes of high school students. *European Journal of Adapted Physical Activity*, 1(2), pp.21-30.
23. Hume-Nixon, M. and Kuper, H., 2018. The association between malnutrition and childhood disability in low- and middle- income countries: systematic review and meta-analysis of observational studies. *Tropical Medicine and International Health*, 23(11), pp.1158-1175.
24. Imms, C., 2008. Review of the Children's Assessment of Participation and Enjoyment and the Preferences for Activity of Children. Physical and Occupational Therapy In Pediatrics, 28(4), pp.389-404.

25. Jahan, I., Muhit, M., Karim, T., Smithers-Sheedy, H., Novak, I., Jones, C., Badawi, N. and Khandaker, G., 2018. What makes children with cerebral palsy vulnerable to malnutrition? Findings from the Bangladesh cerebral palsy register (BCPR). *Disability and Rehabilitation*, 41(19), pp.2247-2254.
26. Kaplan, D. (2000). The Definition of Disability: Perspective of the Disability Community. Journal of health care, law and policy, 3(2), pp.352-364.
27. Karwowski, W., 2001. *International Encyclopaedia Of Ergonomics And Human Factors*. 3rd ed. London: Taylor and Francis, p.879.
28. King, G., Lawm, M., King, S., Rosenbaum, P., Kertoy, M. and Young, N., 2003. A Conceptual Model of the Factors Affecting the Recreation and Leisure Participation of Children with disability. Physical and Occupational Therapy In Pediatrics, 23(1), pp.63-90.
29. Kreutzer,J., Caplan,B. and DeLuca,J., 2011. Encyclopedia of clinical neuropsychology. New York: Springer.
30. Kosma, M., Cardinal, B. and Rintala, P., 2002. Motivating Individuals With Disabilities to Be Physically Active. Quest, 54(2), pp.116-132.
31. Law, M., Anaby, D., Teplicky, R., Khetani, M., Coster, W. and Bedell, G., 2013. Participation in the Home Environment among Children and Youth with and without Disabilities. *British Journal of Occupational Therapy*, 76(2), pp.58-66.
32. Law, M., King, G., King, S., Kertoy, M., Hurley, P., Rosenbaum, P., Young, N. and Hanna, S., 2006. Patterns of participation in recreational and leisure activities among children with complex physical disabilities. Developmental Medicine and Child Neurology, 48(05), p.337.
33. Liou, T., Pi-Sunyer, X. and Laferrere, B., 2005. Physical disability and Obesity. *Nutrition reviews*, 63(10), pp.321-331.
34. Lounsbery, M., 2017. School Physical Activity: Policy Matters. *Kinesiology Review*, 6(1), pp.51-59.
35. Lui K, Hui S., 2009. Participation in and Adherence to Physical Activity in People With Physical Disability. Hong Kong Physiotherapy Journal. 27(1):30-38.
36. Murphy, N. and Carbone, P., 2008. Promoting the Participation of Children with disability in Sports, Recreation, and Physical Activities. pediatrics, 121(5), pp.1057-1061.

37. Omar, M., Alghadir, A., Zafar, H. and Al Baker, S., 2018. Hand grip strength and dexterity function in children aged 6-12 years: A cross-sectional study. *Journal of Hand Therapy*, 31(1), pp.93-101.
38. Pather, S., 2011. Evidence on inclusion and support for learners with disabilities in mainstream schools in South Africa: off the policy radar?. *International Journal of Inclusive Education*, 15(10), pp.1103-1117.
39. Pienaar, A., and Barnard, J., 2016. Development, validity and reliability of a new pressure air biofeedback device (PAB®) for measuring isometric extension strength of the lumbar spine. *Journal Of Medical Engineering and Technology*, *41*(3), 216-222.
40. Place, K. and Hodge, S., 2001. Social Inclusion of Students with Physical Disabilities in General Physical Education: A Behavioral Analysis. *Adapted Physical Activity Quarterly*, 18(4), pp.389-404.
41. Potvin, M., Snider, L., Prelock, P., Kehayia, E. and Wood-Dauphinee, S., 2013. Children's Assessment of Participation and Enjoyment/Preference for Activities of Children: Psychometric Properties in a Population With High-Functioning Autism. American Journal of Occupational Therapy, 67(2), pp.209-217.
42. Rimmer, J. and Rowland, J., 2008. Health Promotion for People With Disabilities: Implications for Empowering the Person and Promoting Disability-Friendly Environments. American Journal of Lifestyle Medicine, 2(5), pp.409-420.
43. Samson-Fang, L. and Stevenson, R., 2007. Identification of malnutrition in children with cerebral palsy: poor performance of weight-for-height centiles. *Developmental Medicine and Child Neurology*, 42(3), pp.162-168.
44. Sartorio, A., Lafortuna, C., Pogliaghi, S. and Trecate, L., 2002. The impact of gender, body dimension and body composition on hand-grip strength in healthy children. *Journal of Endocrinological Investigation*, 25(5), pp.431-435.
45. Smith,J. (2003) Activities for Fine Motor Skills Development. Huntington Beach: Teacher Created Materials, Inc.
46. Sung, R., Ku, C., Choi, K., Mcmanus, A., Li, A., Xu, S., Chan, D., Lo, A., Chan, J. and Fok, T., 2007. Waist circumference and body mass index in Chinese children: cutoff values for predicting cardiovascular risk factors. *International journal of obesity*, 31, pp.550-558.

47. Srinivasan, S., O'Fallon, L. and Dearry, A., 2003. Creating Healthy Communities, Healthy Homes, Healthy People: Initiating a Research Agenda on the Built Environment and Public Health. American Journal of Public Health, 93(9), pp.1446-1450.
48. Taylor, R., Jones, I., Williams, S. and Goulding, A., 2002. Body fat percentages measured by dual-energy X-ray absorptiometry corresponding to recently recommended body mass index cut-offs for overweight and obesity in children and adolescents aged 3–18 y. *The American Journal of Clinical Nutrition*, 76(6), pp.1416-1421.
49. Thomessen, M., Heiberg, A., Kase, B., Larsen, S., and Riis,G., 1991. Feeding Problems, Height and Weight in Different Groups of Disabled Children. *Acta Paediatrica*, 80(5), pp.527-533.
50. Valliant, M. and Tidwell, D., 2007. Validation of Bioelectrical Impedance Against Dual-Energy X-Ray Absorptiometry in Adult, African American Females. *Journal of the American Dietetic Association*, 107(8), p.A29.
51. VanAntwerp, C., 1995. The lifestyle questionnaire for school-aged ■ children: A tool for primary care ■. *Journal of Pediatric Health Care*, 9(6), pp.251-255.
52. Vogler, E., Koranda, P. and Romance, T., 2000. Including a Child with Severe Cerebral Palsy in Physical Education: A Case Study. *Adapted Physical Activity Quarterly*, 17(2), pp.161-175.
53. Voss, C., Dean, P., Gardner, R., Duncombe, S. and Harris, K., 2017. Validity and reliability of the Physical Activity Questionnaire for Children (PAQ-C) and Adolescents (PAQ-A) in individuals with congenital heart disease. *Plos one*, 12(4), p.e0175806.
54. Wiart, L., Darrah, J., Kelly, M. and Legg, D., 2015. Community Fitness Programs: What Is Available for Children and Youth with Motor Disabilities and What Do Parents Want?. *Physical and Occupational Therapy In Pediatrics*, 35(1), pp.73-87.
55. Wind, A., Takken, T., Helders, P. and Engelbert, R., 2009. Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults?. *European Journal of Pediatrics*, 169(3), pp.281-287.
56. Zhu, W., McAuley, E., Frogley, M. and Figoni, S., 2001. A physical activity scale for individuals with physical disabilities (PASIPD). Medicine and Science in Sports and Exercise, 33(5), p.S120.

Appendices

Appendix 1: Gate keepers: Department of Basic Education

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma/Buyi Ntuli   **Tel**: 033 392 1063/51   **Ref.** 2/4/8/4040

Ms Micaela Ashley Brown
2 Cassia Close Kloof
DURBAN
3610

Dear Ms Brown

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"ANTHROPOMETRIC CHARACTERISTICS, GRIP STRENGTH AND PHYSICAL ACTIVITY LEVELS OF CHILDREN WITH PHYSICAL DISABILITIES IN KWAZULU-NATAL"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 23 January 2020 to 10 January 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma /Mrs Buyi Ntuli at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

[redacted]

Dr. EV Nzama
Head of Department: Education
Date: 23 January 2020

...Championing Quality Education - Creating and Securing a Brighter Future

KWAZULU-NATAL DEPARTMENT OF EDUCATION
Postal Address: Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa
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Facebook: KZNDOE....Twitter: @DBE_KZN....Instagram: kzn_education....Youtube:kzndoe

Appendix 2: Gate Keepers: Principals permission letter

Gatekeepers information and consent sheet for principal of school

February 2020

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Dear Sir/Madam

RE: Permission to conduct research on anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities in Kwa-Zulu Natal

I am currently registered as a Masters student (Discipline of Biokinetics, Exercise and Leisure sciences) at the University of KwaZulu-Natal.

The title of my project is:

Anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities in Kwa-Zulu Natal

The primary aim of the study is to determine the relationships between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities..

The objectives of the study are:

1. To determine the physical activity and sport participation in children with physical disabilities.
2. To determine the anthropometric characteristics (body mass index (BMI), waist to hip ratio, and body fat percentage) in children with physical disabilities.
3. To measure the strength (hand grip) in children with physical disabilities.

I would like to collect this information in January/ February 2020, pending ethical approval from the University. My supervisor is Dr Rowena Naidoo and she is available for further enquiries.

We look forward to a favourable response.

Kind regards

Researcher: Micaela Brown
University of KwaZulu-Natal
Mobile: 0722291097
micky.b@mweb.co.za

Supervisor: Dr Rowena Naidoo
University of KwaZulu-Natal
Tel work: 0837772813
naidoor3@ukzn.ac.za

CONSENT FROM THE PRINCIPAL OF THE SCHOOL

I. ADHRISH NUNKUMAR .... manager of
.... ETHEMBENI SCHOOL .... give my permission to Micaela Brown, a student at the University of Kwa-Zulu Natal to conduct a study to determine anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities in Kwa-Zulu Natal.

I am aware that the children's' participation is voluntary and that there are no risks involved for them participating in the study. I have read the informed consent sheet explaining the information I and the children need to know.

Signed at. INCHANGA this 21 day of. FEBRUARY....2020

Signature: [redacted] ....

A.D NUNKUMAR
DEPUTY PRINCIPAL
ETHEMBENI SCHOOL

SCHOOL FOR
...ICALLY DISABLED
...ALLY IMPAIRED
..20 -02- 21
P/BAG X 1021
HILLCREST
3650

ETHEMBENI SCHOOL FOR
THE PHYSICALLY DISABLED
AND VISUALLY IMPAIRED
2020 -02- 21
P/BAG X 1021
HILLCREST
3650

Appendix 3: BREC Full approval

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

26 February 2020

Miss Micaela Ashley Brown (216021150)
School Of Health Sciences
Westville

Dear Miss Micaela Ashley Brown,

Protocol reference number: BREC/00000659/2019
Project title: Anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities in Kwa-Zulu Natal
Degree Purposes: Honours in Sports Science

FULL APPROVAL LETTER

The Biomedical Research Ethics Committee (BREC) has considered the abovementioned application at a meeting held on 12 November 2019.

I wish to advise you that your response to BREC letter dated 25 November 2019 was noted and approved by a sub-committee of the Biomedical Research Ethics Committee. Please ensure that site permissions are obtained and forwarded to BREC for approval before commencing research at a new site.

This approval is valid for one year from **26 February 2020.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

Pg 1/...

Biomedical Research Ethics Committee
Prof V Rambiritch (Chair)
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Website: http://research.ukzn.ac.za/Research-Ethics/

Founding Campuses: Edgewood | Howard College | Medical School | Pietermaritzburg | Westville

INSPIRING GREATNESS

The following Committee members were present at the meeting that took place on 12 November 2019:

Prof V Rambiritch	Pharmacology (Chair)
Prof D Wassenaar	Psychology (Deputy Chair)
Prof C Aldous	Genetics
Rev SD Chili	External – Community member
Dr R Harrichandparsad	Neurosurgery
Dr H Humphries	Research Psychology and Public Health
Dr R Lessells	Infectious Diseases Specialist
Dr S Paruk	Psychiatry
Prof C Rout	Anaesthetics
Dr T Sookan	Biokineticist

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

This approval will be noted at the next BREC meeting to be held on 10 March 2020.

Yours sincerely

[redacted]

PROFESSOR V RAMBIRITCH
Chair: Biomedical Research Ethics Committee

Biomedical Research Ethics Committee
Prof V Rambiritch (Chair)
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Website: http://research.ukzn.ac.za/Research-Ethics/

Appendix 4: Parent/Guardian consent and information and Assent sheet

UKZN BIOMEDICAL RESEARCH ETHICS COMMITTEE

Information Sheet and Consent to Participate in Research

Dear Parent/Guardian

My name is Micaela Brown from the school of Biokinetics, Exercise and Leisure sciences. I am currently registered as a Masters student (Discipline of Biokinetics, Exercise and Leisure sciences) at the University of KwaZulu-Natal. The title of my project is:

Anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities: A Case study

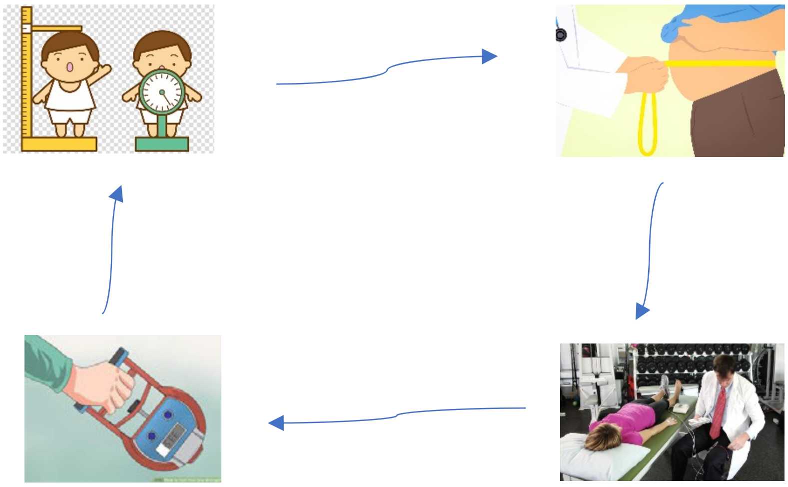
The primary aim of the study is to determine the relationships between physical activity levels, anthropometric characteristics and hand grip strength in children with physical disabilities..

The secondary aim of the study is to create awareness around physical activity and healthy living importance in children with disability.

You are being invited to consider participating in this study, the study is expected to enrol (53) participants in total from various schools in Kwa-Zulu Natal.

<u>It will involve the following procedures:</u>

Completion of questionnaires which will be based specifically on physical activity levels. The anthropometrical measurements will be taken will include height and weight, waist and hip circumference, body fat percentage and BMI, as well as hand grip strength.



The duration of your participation if you choose to enrol and remain in the study is expected to be 5 minutes for the questionnaire, 2 minutes for height and weight measurements and 10-15 minutes for the tests (waist and hip circumference, body fat percentage, BMI and hand grip strength).

There are no/minimal risks and or discomfort that the participant may experience during the testing. The researchers are trained to perform all tests and will be present at all times to minimise risks.

I hope that the study will create the following benefits:

- Awareness of the importance of a healthy lifestyle in children with disability
- Awareness of the poor physical activity levels in children with disability
- Education on ways to improve physical activity and health in children with disability

Children's participation in this research study is strictly voluntary. Children can withdraw from the research study at any point, they you may do so. In the event of refusal/withdrawal of participation you will not incur penalty or loss of treatment or other benefit to which you are normally entitled.

All testers are qualified in first aid level 2.

Data obtained from the research will be available to all the participants who complete the testing.

For protection of confidentiality of personal/clinical information, the names of children will not be used in the results, as they will be allocated a number and alphabetical code to ensure anonymity.

Results of this study may be published but any data included will be in no way linked to your child. The data will be secured in such a way that only the researchers will be able to gain access to it. At the end of the project, any personal information will be destroyed immediately except that, as in accordance with the University's research policy. Raw data on which the results of the project will depend will be retained in a secure storage place for five years, after which will be destroyed by incineration.

There will be no compensation for participating in this study.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (approval number BREC/00000659/2019).

In the event of any problems or concerns/questions you may contact the researcher, my supervisor or the UKZN Biomedical Research Ethics Committee, contact details as follows:

Researcher: Micaela Brown
University of KwaZulu-Natal
Mobile: 0722291097
Micky.b@mweb.co.za

Supervisor: Dr Rowena Naidoo
University of KwaZulu-Natal
Mobile: 0837772813
naidoor3@ukzn.ac.za

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769 - Fax: 27 31 2604609

Email: BREC@ukzn.ac.za

PARENTAL CONSENT TO PARTICIPATE:

I…………………………………………………………..(name of parent/ legal guardian) give informed consent on behalf of my child ……………….(name of child) to participate in the above-mentioned study. I have been informed about the study entitled: "Anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities: A Case study" by Micaela Brown.

I understand the purpose and procedures of the study and fully understand the information provided. I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my child's participation in this study is entirely voluntary and that I may withdraw at any time without prejudice, if he or she wish to do so. I understand that my child's participation in the project does not involve any remuneration for participation. The data will be destroyed at the conclusion of the project but any raw data on which the results of the project depend on will be retained in secure storage for five years, after which will be destroyed. The results of the project may be published but my child's anonymity will be preserved.

Please note that a copy of the signed consent form will be given to you.

______________________ ______________________

Signature of Participant/ Guardian **Date**

______________________ ______________________

Witness **Date**

ASSENT TO PARTICIPATE (CHILD):

I …………………………….(name of child) agree that I understand what is being asked of me, to participate in this research study. I understand that my participation is entirely voluntary; there will be no remuneration for participating in this study. I understand that I will be asked to complete anthropometrical testing, answer a questionnaire and complete a hand grip test. I understand that I can stop participating at any stage by simply saying I would no longer like to be in this research study. This is entirely my choice, and whatever my decision is, I will not be judged based on it.

____________________ ____________________

Signature of Child **Date**

Appendix 5: Data collection sheet

Anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities: A Case Study

Participant code:

Name:

Age:

Disability:

Gender:

Dominant hand:

Data collected:

Station 1

- Height:
- Weight:
- BMI:
- Waist circumference:
- Hip circumference

Station 2

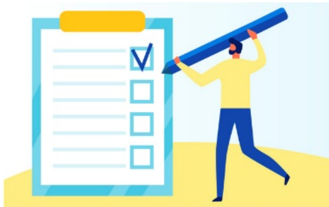
- Body fat Percentage:
- Fat mass:

Station 3

- Hand grip strength (dynamometre): R: L:
- Hand grip strength (Pressure air biofeedback): R: L:

Appendix 6: Questionnaire

<u>Anthropometric characteristics, grip strength and physical activity levels of children with physical disabilities: A Case Study</u>



<u>Questionnaire:</u>

<u>Name:</u>

<u>Participant code:</u>

<u>Please circle the correct answer and fill in short answers where necessary on the blank lines</u>

1. During the past 7 days how often did you engage in stationary activities such as reading, watching TV, computer games or doing handcrafts?

   a) Never (go to question 2)
   b) Seldom (1-2d)
   c) Sometimes (3-4d)
   d) Often (5-7d)

   What were these activities? ----------

   On average how many hours per day did you spend doing these stationary activities?

   a) Less than 1 hr.
   b) 1 but less than 2 hr.
   c) 2-4 hr.

d) More than 4hr

2. During the past 7 days, how often did you walk, or do other activity other than specifically exercise, such as walking your dog, walking around the mall or other activities?
   a) Never (go to question 3)
   b) Seldom (1-2d)
   c) Sometimes (3-4d)
   d) Often (5-7d)

   If so, on average how many hours a day?

   a) Less than 1 hr.
   b) 1 but less than 2 hr.
   c) 2-4 hr.
   d) More than 4hr

3. During the past 7 days, how often did you engage in light sport, or recreational activities such as bowling, fishing, therapeutic exercise, stretching or other similar activities?

   a)Never (go to question 4)

   b) Seldom (1-2d)

   c) Sometimes (3-4d)
   d) Often (5-7d)

   What were these activities? ----------

   If so, on average how many hours a day?

   a) Less than 1 hr.
   b) 1 but less than 2 hr.
   c) 2-4 hr.
   d) More than 4hr

4. During the past 7 days, how often did you engage in moderate sport and recreational activities such as tennis, golf, dancing, or other physical activities?
   a) Never (go to question 5)
   b) Seldom (1-2d)
   c) Sometimes (3-4d)

d) Often (5-7d)

What were these activities? ----------

If so, on average how many hours a day?

a) Less than 1 hr.
b) 1 but less than 2 hr.
c) 2-4 hr.
d) More than 4hr

5. During the past 7 days, how often did you engage in strenuous sport and recreational activities such as jogging, wheelchair racing, swimming, arm cranking, cycling (hand or arm), walking with/without assistance)?
   a) Never (go to question 6)
   b) Seldom (1-2d)
   c) Sometimes (3-4d)
   d) Often (5-7d)

   What were these activities? ---------

   If so, on average how many hours a day?

   a) Less than 1 hr.
   b) 1 but less than 2 hr.
   c) 2-4 hr.
   d) More than 4hr

6. During the past 7 days how often did you do any exercise specifically to increase muscle strength and endurance?
   a) Never
   b) Seldom (1-2d)
   c) Sometimes (3-4d)
   d) Often (5-7d)

   What were these activites? ----------

   If so, on average how many hours a day?

   a) Less than 1 hr.

b) 1 but less than 2 hr.
c) 2-4 hr.
d) More than 4hr

7. During the past 7 days, how often did you participate in physical education (PE) at school?
   a) I don't do PE
   b) Seldom(1-2d)
   c) Sometimes(3-4d)
   d) Often (5-7d)

8. During the past 7 days, what did you do in your school recess/lunch time breaks?
   a) Sat down
   b) Was partially active
   c) Partook in an exercise game/activity for a little bit
   d) Partook in an exercise game/activity most of the time

9. On the last weekend, how often did you partake in physical activity, including sports, dancing, playing games/ adapted games and sport etc.?
   a) None
   b) 1 time
   c) 2-3 times
   d) 3 or more times

If yes, what physical activity did you participate in?

10. Which of the following statements describes you best for the last 7 days? Read all 5 statements and decide
    a) All or most of my free time was spent doing things that involve little physical effort
    b) I sometimes (1-2 times last week) did physical activity in my free time
    c) I often (3-4 times last week) did physical activity in my free time
    d) I quite often (5-6 times) did physical activity in my free time
    e) I very often (7 or more times last week) did physical activities in my free time

11. Were you sick last week, or did anything prevent you specifically from partaking in physical activity?

a) Yes

b) No

If yes, what prevented you? --------------

If there was no barriers to physical activity what would be your preferred activity?

Appendix 7: Disability specific results

	Height (cm)	Weight (kg)	BMI (Kg/m2)	Waist Circum ference (cm)	Hip Circum ference (cm)	WHR	BF %	Fat Mass (kg)	LBM
Loss of sight	146.32 (±8.99)	40.98 (±10.40)	19.22 (±4.39)	65.38 (±7.77)	83.63 (±9.67)	.78 (±.02)	19.72 (±7.26)	8.61 (±5.16)	32.37 (±5.73)
Loss of speech	153.71 (±5.82)	53.06 (±15.85)	22.50 (±6.63)	74.91 (±13.14)	87.08 (±10.08)	.85 (±.08)	27.25 (±7.54)	15.18 (±8.73)	37.88 (±8.30)
CP	136.38 (±12.83)	33.59 (±12.65)	18.87 (±7.84)	63.25 (±12.55)	72.34 (±17.14)	.84 (±.08)	22.1219 (±11.72)	8.50 (±7.77)	25.80 (±7.09)
Orthopaedic condition	128.70 (±1.55)	27.45 (±2.33)	16.70 (±1.13)	57.70 (±2.68)	69.85 (±8.27)	.82 (±.06)	24.45 (±15.90)	6.90 (±4.94)	20.55 (±2.61)
Muscular disorder	141.00 (±18.95)	27.70 (±2.54)	14.25 (±2.61)	58.20 (±1.41)	77.80 (±1.83)	.75 (±.00)	30.80 (±7.63)	8.45 (±1.34)	19.25 (±3.88)
Sample	139.73 (±13.05)	36.46 (±13.79)	19.08 (±7.05)	64.49 (±12.04)	75.82 (±15.79)	.83 (±.07)	22.79 (±10.66)	9.25 (±7.44)	27.83 (±8.22)

ANOVA	
Test Item	Significance (P)
Height(cm)	.008
Weight(kg)	.008
BMI(Kg/m2)	.641
Waist circumference (cm)	.192
Hip circumference (cm)	.131
WHR	.124
BF%	.572
Fat mass (kg)	.361
LBM (kg)	.001

		Mean	Std. Deviation
Hand grip strength - dominant hand	Loss of sight	12.0375	9.51299
	Loss of speech	13.8333	7.93515
	Cerebral Palsy (CP)	13.1097	11.24338
	Orthopedic condition	9.6500	2.33345
	Muscular disorder	7.5000	6.92965
	Total	12.6531	10.08628
Hand grip strength-non-dominant hand	Loss of sight	13.6000	12.22141
	Loss of speech	11.1667	9.60035
	Cerebral Palsy (CP)	12.4419	10.37059
	Orthopedic condition	9.6500	3.46482
	Muscular disorder	9.1000	6.64680
	Total	12.2245	10.04690
PAB- Max strength (kg/force) Dominant	Loss of sight	3.2463	1.94488
	Loss of speech	4.6900	2.71390
	Cerebral Palsy (CP)	4.3052	2.68287
	Orthopedic condition	3.5350	3.62746
	Muscular disorder	1.9050	1.76070
	Total	4.0600	2.56668
	Loss of sight	3.6487	2.43679
	Loss of speech	6.3520	2.81558

PAB- Max strength (kg/force) Non-dominant	Cerebral Palsy (CP)	4.9206	2.76244
	Orthopedic condition	4.2200	3.43654
	Muscular disorder	2.2150	2.31224
	Total	4.7278	2.75380
PAB-Relative strength (kg/force) Dominant	Loss of sight	23.7788	18.80990
	Loss of speech	23.0800	16.98743
	Cerebral Palsy (CP)	44.6665	37.45973
	Orthopedic condition	36.2650	39.19493
	Muscular disorder	20.9150	20.25861
	Total	37.3006	33.18518
PAB-relative strength (kg/force) Non-dominant	Loss of sight	29.1662	26.57327
	Loss of speech	32.9940	14.17537
	Cerebral Palsy (CP)	53.0833	35.96388
	Orthopedic condition	58.7700	52.59460
	Muscular disorder	34.1550	34.76844
	Total	46.7180	33.94476
PAB-total work (kg/force) Dominant	Loss of sight	914.6563	663.64636
	Loss of speech	1233.5250	890.05189
	Cerebral Palsy (CP)	1394.4519	1176.07888
	Orthopedic condition	955.7050	1000.94500
	Muscular disorder	614.2400	626.24205
	Total	1246.6592	1045.44693

PAB-total work (kg/force) Non-dominant	Loss of sight	1199.7712	1136.61489
	Loss of speech	1740.6760	381.79665
	Cerebral Palsy (CP)	1747.3406	1211.17714
	Orthopedic condition	1560.3850	1321.73107
	Muscular disorder	1005.4500	1070.02227
	Total	1621.9092	1127.06579

ANOVA	
Test Item	Significance (P)
Hand grip strength-dominant	.935
Hand grip strength-non-dominant	.971
PAB- Max strength(kg/force)-dominant	.580
PAB-Max strength (kg/force)-non-dominant	.307
PAB-relative strength(kg/force)-dominant	.358
PAB-relative strength(kg/force)-non-dominant	.334
PAB – total work (kg/force)-dominant	.695
PAB-total work (kg/force)-non-dominant	.717

Appendix 8: Manuscript guidelines

The manuscript is currently in the process of being published with The International Journal on Disability and Human Movement.

The manuscript should be typed in Times New Roman 12-point font and have the following components in numbered order and each beginning on a new page. The text should be under the headings, Abstract, Keywords, Introduction, Methods, Results, Discussion, Acknowledgements, References, Tables, and Figures. Abstracts should not exceed 250 words and should incorporate background, objective, study group, methods, results, and conclusions. At least three key words should appear under the abstract.

Please remove any identifying information, such as authors' names or affiliations, from your manuscript before submission. As well as removing names and affiliations under the title within the manuscript, other steps need to be taken to ensure the manuscript is correctly prepared for double blind peer review. The key points to consider are:

Make sure that figures and tables do not contain any reference to author affiliations.

Choose file names with care, and ensure that the file's "properties" are also anonymised. If you are using Office 2007 or later, consider using the Document Inspector Tool prior to submission.

The Title Page will remain separate from the manuscript throughout the peer-review process and will not be sent to the reviewers. The Title Page should include:

A concise and informative title
All authors' complete names with academic degrees and complete affiliations
A complete address for the corresponding author, including an e-mail address

If you have variations of the title that you would like Nova to use as the Running Head, please mark that at the beginning of the article.

<u>Illustrations</u>

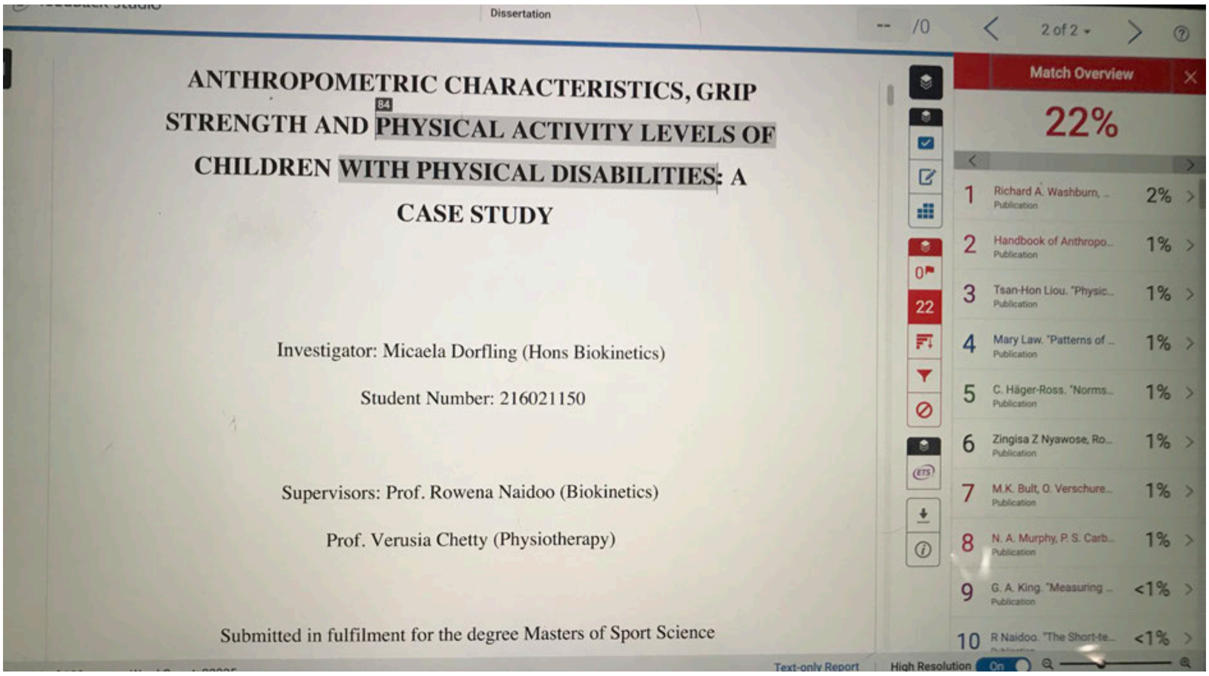
All diagrams, photographs, illustrations, and charts (not tables) should be referred to in the text as Figures, and they should be numbered consecutively with Arabic numerals. These figures must be supplied as separate electronic files named in the format in which they were created, and they must be one of the following types: tiff, bitmap, jpeg, gif, ppt, psd, png, or eps. The resolution of these figures must be at least 300 dpi and of good contrast. Please use patterning instead of colors for all graphs and charts when possible. Each Figure should include a title and short description.

Figures must also be placed inside or at the end of the manuscript. If scanned images are used, please retain the original hard copy of the figure for possible transmission to Nova Science Publishers. If previously published figures are used, written permission from the copyright holders must be obtained and submitted along with the text indicating the copyright holder's citation instructions. Such permissions must grant unrestricted use.

References

All references should adhere to the Vancouver Reference Style, as recommended by the International Committee of Medical Journals Editors. A maximum of 25 references should be used for articles, 40 for review articles, and 5 for case reports. They should be cited consecutively (enclosing the number in parentheses) in the text and listed in the same numerical order at the end of the paper.

Appendix 9: Turn it in report



NB: The percentage is higher than 15% due to the manuscript been submitted to the journal, hence, duplication of work

Appendix 10: Results analysis detailed

RESULTS

Introduction

This chapter presents the results obtained from the study. There was a 100% compliance of 53 children with physical disability. Results will be presented according to the following headings: Demographics and sample distribution, Anthropometric data, Hand grip strength, Physical activity Questionnaire data, and data to show the relationships.

Demographics and sample distribution

There was a total number of 53 participants included in this study. The distribution of the numbers between the schools included 10 children from RP Moodley and 43 from Ethembeni school.

The average age of the whole sample (n=53) was 10.98 years (SD=.888). 54.7% of the sample were male and 45.3% were female. Included in the sample were children who were in wheelchairs, 12 children in the sample (22.6%) were in a wheelchair, and 41 (77.4%) were not in a wheelchair.

Figure 5 describes the sample (n=53) distribution according to age ranging from 10-12 years old

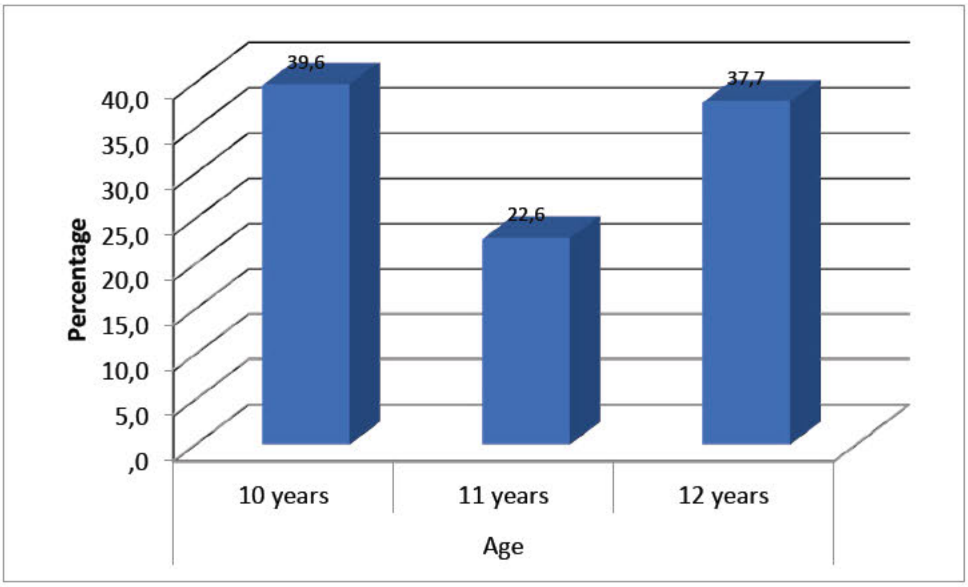


Figure 5: Age distribution of the participants

There were a wide variety of disabilities categorised into broader categories. The disabilities prevalent in the sample included loss of sight, loss of speech, Cerebral Palsy, Orthopedic conditions and muscular disorder (non-progressive). CP was the most prevalent disability with 64.2% of the children reporting to have CP.

Figure 6 describes the sample distribution according to their gender (n=53)

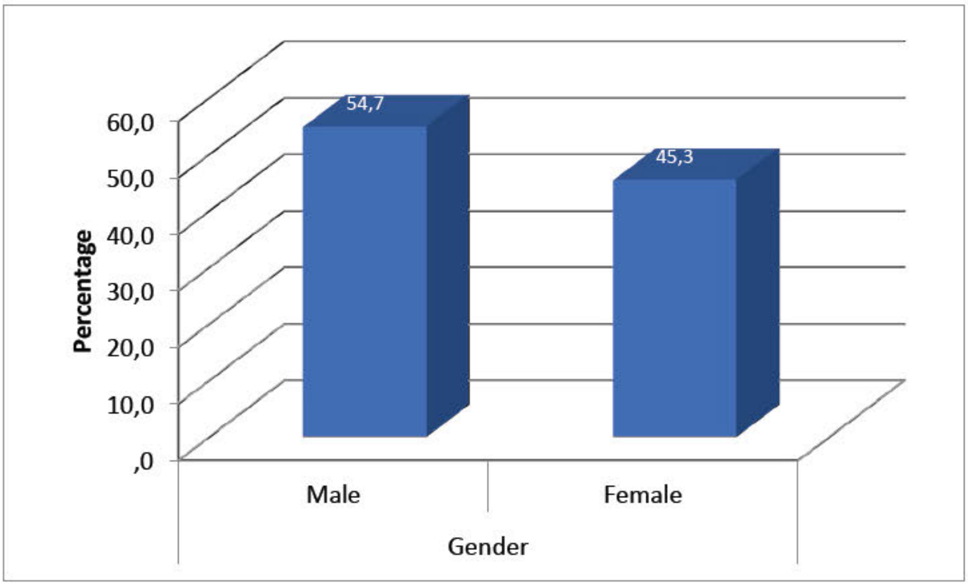


Figure 6: Sample distribution of participants according to gender

Figure 7 describes the various disabilities

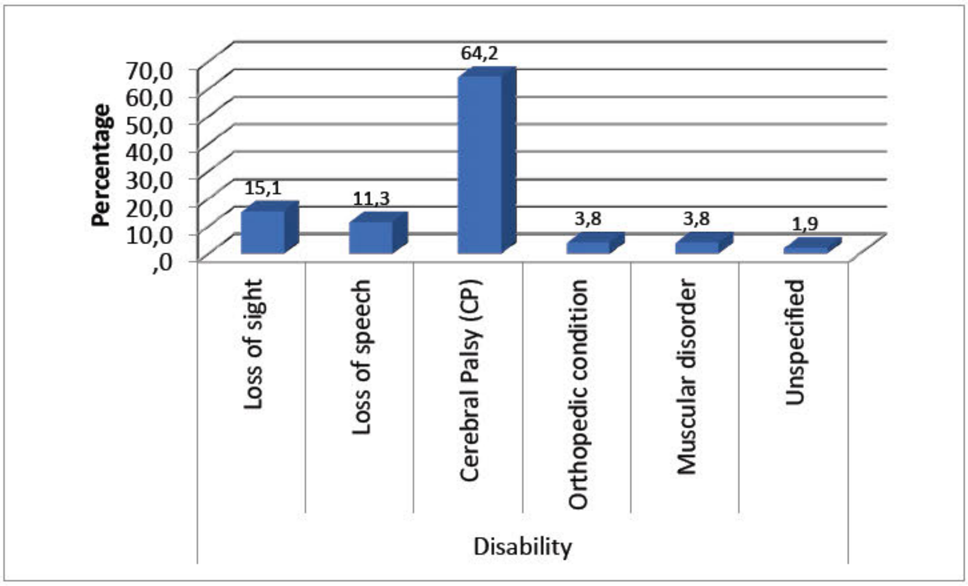


Figure 7: Various disabilities present in the sample

Physical Activity Questionnaire Data

For each of the questions in the questionnaire, various statistical analyses were completed.

The answers were divided into the following options when answering the questions; Never, Seldom (1-2 days), Sometimes (3-4 days) and Often (5-7 days) per week. All questions are based on the participants activity for the previous 7 days prior to completing the questionnaire.

Table 4 describes how often activities were performed weekly according to the questions in the questionnaire using the chi-square goodness-of-fit test for the sample (n=53).

Table 1: Results to show how often the different activities were performed weekly

	Never (%)	Seldom (%)	Sometimes (%)	Often (%)	Sig.	Chi-Square
How much time did you spend on quiet activities such as reading, TV, computer games or handcrafts?	0	17	41.5	41.5	.041	6.377[a]
How often did you walk, or any other activity other than specifically exercising) such as walking the dog, walking around the mall or other similar activities? (applicable to those not in wheelchair only n=34)	17.1	29.3	46.3	7.3	.003	13.927[a]
How often did you do light sport activities, or fun activities such as bowling, fishing, therapeutic exercise, stretching or other similar activities?	0	100	0	0	<.0005	20.547[a]
How often do you do moderate sport and fun activities such as tennis, golf, dancing, or other similar physical activities?	0	100	0	0	<.0005	20.547[a]
How often do you do strenuous(hard) sport and fun activities such as jogging, wheelchair racing, swimming, cycling (hand or arm), walking with/without help?	0	100	0	0	<.0005	20.547[a]

How often do you do exercise specifically to increase muscular strength and endurance?	81.1	18.9	0	0	<.0005	20.547[a]
How often do you do physical education (PE) at school?	81.1	18.9	0	0	<.0005	20.547[a]
On the weekend, how often do you participate in physical activity, including sports, dancing, playing games/adapted games and sport?	13.2	30.2	45.3	11.3	.001	16.208[a]

Friedman's test was done on the results and showed that the frequency with which these activities are done, differs significantly, p<.0005.

Table 5 shows statistics which are used to compare how often the different activities were done. It can be seen that quiet activities are done most often in the participants weekly schedules. At school muscular strengthening activities and Physical education are done the least. There is no difference in amount of time spent on doing light, moderate or strenuous intensity physical activity.

Table 2: Statistics comparing how often the various activities are done

	Mean	Median	SD
How much time did you spend on quiet activities such as reading, TV, computer games or handcrafts?	3.25	3.00	.731

How often did you walk, or any other activity other than specifically exercising) such as walking the dog, walking around the mall or other similar activities? (applicable to those not in wheelchair only n=34)	2.11	2.00	.974
How often did you do light sport activities, or fun activities such as bowling, fishing, therapeutic exercise, stretching or other similar activities?	2.00	2.00	.000
How often do you do moderate sport and fun activities such as tennis, golf, dancing, or other similar physical activities?	2.00	2.00	.000
How often do you do strenuous(hard) sport and fun activities such as jogging, wheelchair	2.00	2.00	.000

racing, swimming, cycling (hand or arm), walking with/without help?			
How often do you do exercise specifically to increase muscular strength and endurance?	1.19	1.00	.395
How often do you do physical education (PE) at school?	1.38	1.00	.790
On the weekend, how often do you participate in physical activity, including sports, dancing, playing games/adapted games and sport?	2.55	3.00	.867

Table 6 describes the number of hours per day of which the different activities were performed weekly according to the questions in the questionnaire using the chi-square goodness-of-fit test for the sample (n=53)

Table 3: Results to show number of hours weekly the various activities were performed

	<1 hour per day (%)	1-<2 hours per day (%)	2-4 hours per day (%)	>4 hours per day (%)	Sig.	Chi-Square
Quiet activities	3.8	34	52.8	9.4	<.0005	32.811[a]
Walking activities	24.4	53.7	4.9	0	<.0005	17.882[a]
Light intensity sport/activities	81.1	18.9	0	0	<.0005	20.547[a]
Moderate intensity sport/activities	81.1	18.9	0	0	<.0005	20.547[a]
Strenous intensity sport/activities	81.1	18.9	0	0	<.0005	20.547[a]
Exercise to increase muscular strength and endurance	18.9	0	0	0	<.0005	20.547[a]

Figure 8 shows the various activities which were reported to be done most for quiet activities done weekly for the sample

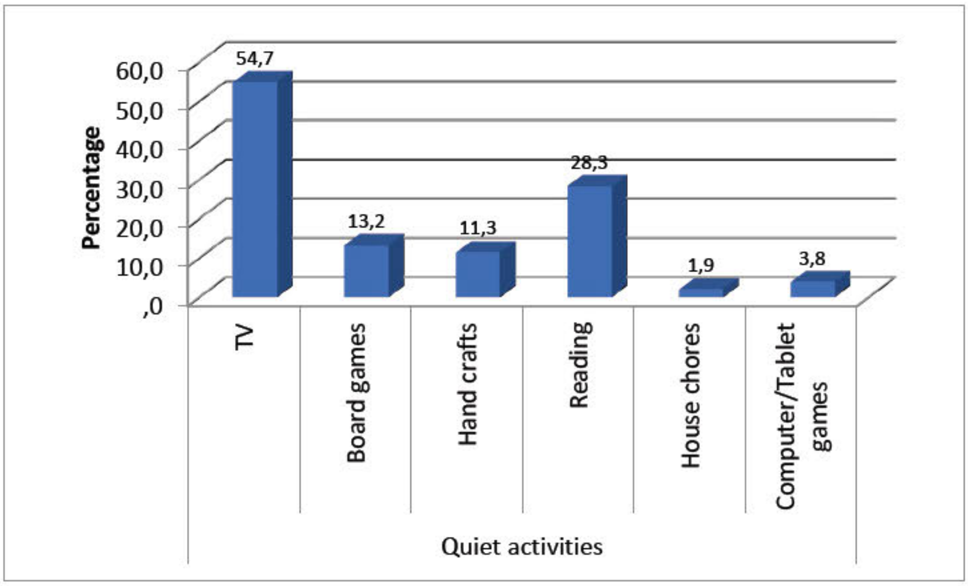


Figure 8: Types of quiet activities

The light sport/activities which were reported done weekly included Physiotherapy and Occupational therapy at both of the schools, one school also had hydrotherapy sessions with the children.

Figure 9 shows the various types of moderate intensity activities reported being done weekly

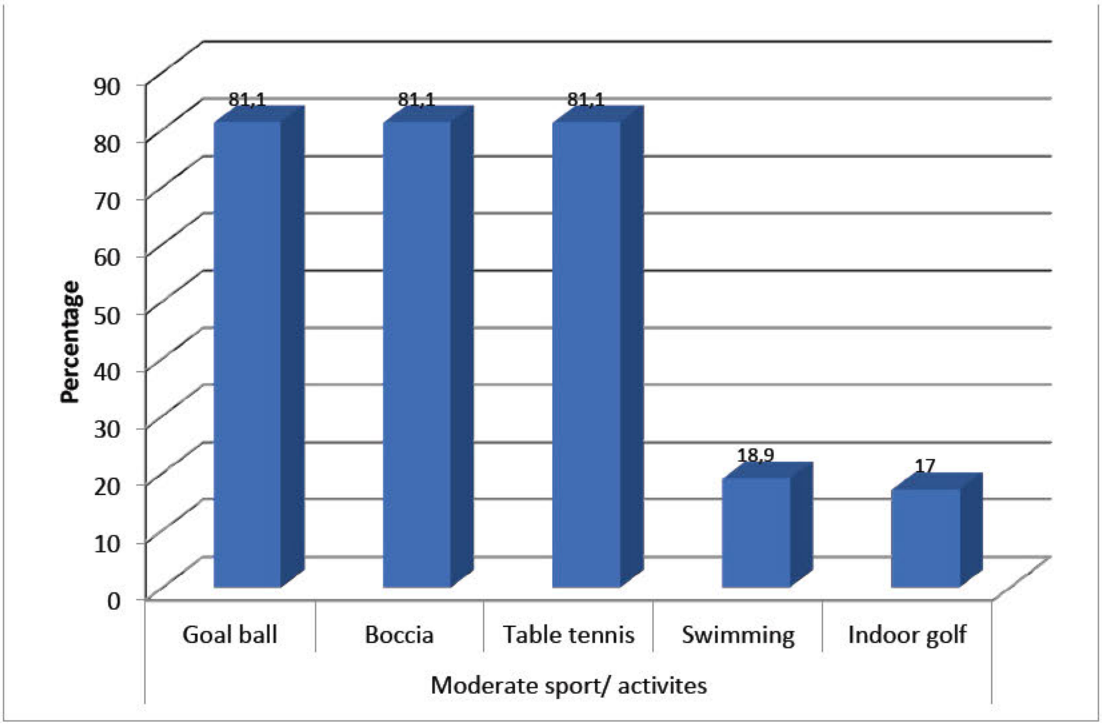


Figure 9: Types of moderate intensity sporting activities

Figure 10 shows the various types of strenuous intensity sport/activities reported being done weekly

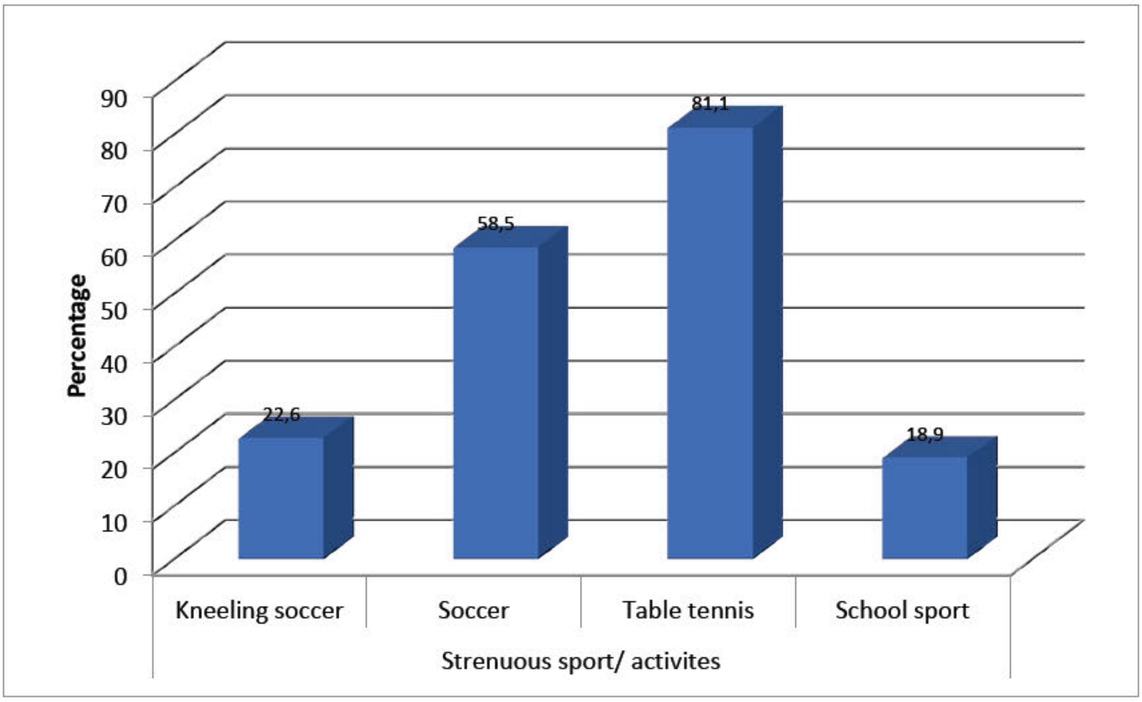


Figure 10: Types of strenuous intensity sporting activities

Only one of the schools had Biokinetics sessions for less than 1 hour weekly to increase muscular strength and endurance. The same school that had Biokinetics sessions weekly also had physical exercise sessions weekly for 1-<2 hours.

Figure 11 shows the results for what the participants spent their time doing in recess breaks at school

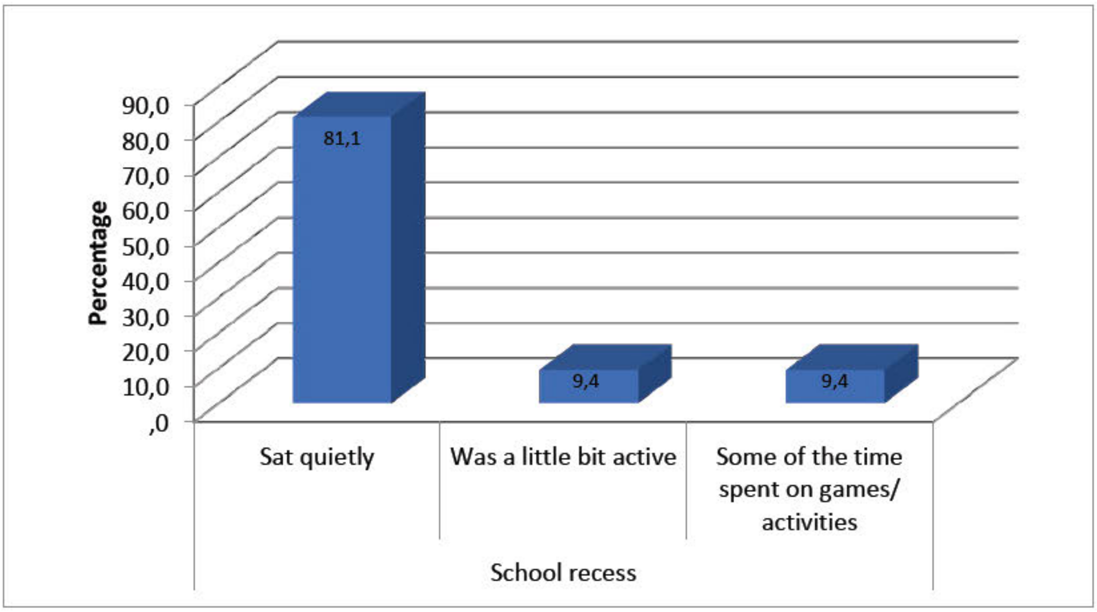


Figure 11: Activities done during school recess

13.2 % of the participants reported to do no physical activity on the weekend, but the rest reported be partake in physical activity over the weekends. Different activities reported on included; Ball sports, boccia, table tennis, volleyball, running, boccia and wheelchair racing.

Table 7 describes the response to how the participants (n=53) described their free time in the 7 days prior to testing ($p<.0005$) (chi-square= 26.019[a])

Table 4: Results of activities performed in free time

	Percent
All or most of the time spent on things that involves little effort	17
Sometimes (1-2 times) did physical activity in their free time	49.1
Quite often (3-4 times) did physical activity in their free time	32.1

Often (5-6 times) did physical activity in their free time	1.9
Very often (7 or more times) did physical activity in their free time	0

Only 1 participant reported to be sick in the week prior to testing which prevented them in partaking in their normal activity.

If there were no barriers to physical activity or if activities could be adapted so children with physical disability could be included the participants stated what activities they would partake in. These included; athletics, cycling, cricket, netball, golf, competitive soccer, swimming and tennis. Only 2 of the participants stated that they do not like sport so they would not want to partake in any physical activity by choice.

4.4 Anthropometric Data

Table 1 shows the anthropometric data of the sample (n=53). Including Height, Weight, BMI, Waist circumference, Hip Circumference, WHR, BF%, Fat Mass and LBM.

Table 5: Anthropometric data of the sample

	Height (cm)	Weight (kg)	BMI (kg/m2)	Waist circumference (cm)	Hip Circumference (cm)	WHR	BF%	Fat Mass (kg)	LBM
Mean	139.73	36.46	19.08	64.49	75.82	.83	22.79	9.25	27.83
Standard Deviation	13.05	13.79	7.05	12.04	15.79	.078	10.66	7.44	8.22
Minimum	100.20	12.00	11.53	45.70	.78	.63	5.10	1.20	9.20
Maximum	165.50	77.00	55.80	108.80	105.50	1.03	45.90	33.90	49.00

Hand grip strength

The hand grip strength is divided into results from the hand grip dynamometer and from the PAB®. The results are also according to hand dominance.

The participants were listed as either right hand or left hand dominant from the sample (n=53). The sample consisted of 9 (17%) participants being left hand dominant and 44 (83%) participants being right hand dominant.

Table 2 displays the hand grip strength results from the hand grip dynamometer for the dominant and non-dominant hands of the sample (n=49). 49 participants had valid results for this and 4 were missing data due to hand contractures or weakness leading to the inability to perform the test.

Table 6: Hand grip strength results from the Hand Grip Dynanometer

	Dominant Hand (kg)	Non-dominant Hand (kg)
Mean	12.6531	12.2245
Std. Deviation	10.08628	10.04690
Minimum	2.00	.00
Maximum	46.00	39.00

Table 3 displays the hand grip strength results from the PAB® for the dominant and non-dominant hands of the sample (n=53).

Table 7: Hand grip strength results from PAB®

	Max strength (kg/force) D	Max strength (kg/force) ND	Relative strength (kg/force) D	Relative strength (kg/force) ND	Total work (kg/force) D	Total work (kg/force) ND
Mean	4.0600	4.7278	37.3006	46.7180	1246.6592	1621.9092
Std. Deviation	2.56668	2.75380	33.18518	33.94476	1045.44693	1127.06579
Minimum	.08	.51	.49	2.32	19.97	46.44
Maximum	10.41	10.73	171.27	157.49	4624.26	4252.29

Data to show the relationships between the testing items with disability type

Data to show the relationship between disability type and physical activity

To test the relationship between disability type and physical activity, a chi-square test was applied and where needed a Fisher's exact test.

There was no significant relationship between the type of disability and amount of quiet activities one participated in.

There was a significant relationship between disability and frequency of walking, Fisher's exact = 22.532, p=.003. A significant number of those with sight loss sometimes walk, a significant number of those with an orthopaedic condition often walk; and a significant number of those with a muscular disorder never walk. There was a relationship between disability and amount of time spent daily on these walking activities, Fisher's exact=15.422, p=.002. Those with loss of speech who had reported to walk, reported for performing this activity for less than

1 hour per day. Those with an orthopaedic condition who did walk often, did so more frequently for 2-4 hours per day.

There was no significant difference between type of disability and participation in light, moderate and strenuous sporting activities. However, a significant number of those with loss of speech reported to perform all these different intensity sporting activities for longer hours per day than the other disabilities, completing 1-<2 hours per day of light sporting activities on average. Fisher's exact=20.969, p=.000.

There was a significant relationship between type of disability and participation in exercise to specifically increase muscular strength and endurance as well as participation in school Physical education. A significant number of those with loss of speech reported to perform these activities seldom compared to those with other disabilities who never performed them, children with CP also reported to perform these activities seldom weekly compared to other disabilities but this was not significant. There were no significant results in the number of hours spent daily on these activities between those with loss of speech and CP. Fisher's exact=20.969, p=.000.

There was a significant relationship between type of disability and what time during recess was spent doing, Fishers exact= 22.474, p=.001. Children with loss of speech were found to be either a little bit active, or spent some of their time on games or activities, and none reported to have sat quietly. Children with CP mostly sat quietly during their recess lunch time breaks while not a significant number spent time being a little bit active or spending time on games/activities. All other disability types reported to have sat quietly during their recess breaks.

There was no significant difference between type of disability and participation in physical activity on the weekends, all reported disabilities reported to be somewhat active over the weekends whether it be seldom, sometimes or often. Children with CP had the highest number reported to fit into the sometimes category for being active on the weekends, however this was not significant.

There was a significant relationship between type of disability and different statements describing activity during free time for 7 days prior to testing, Fishers exact= 19.132, p=.044. Children with loss of sight had the highest number (12.5%) fitting into the category "I often (5-6 times) did physical activity in my free time over the last 7 days", compared to other disabilities of which none fitted into this category. Children with an orthopaedic condition all answered “I quite often (3-4 times) did physical activity in my free time over the last 7 days”. And all of the children with loss of speech answered “I sometimes (1-2 times) did physical activity in my free time over the last 7 days”.

Data to show the relationship between disability type and anthropometric characteristics

To test the relationship between disability type and anthropometric characteristics ANOVA was used, when ANOVA’s conditions were not met, the Welch test was used.

For the different anthropometric characteristics, the only values which showed significantly different between the disability groups were differences in height, weight and LBM.

There was a significant difference in height depending on the disability, $F(4, 48) = 3.868$, $p=.008$. Those with loss of speech (mean height=153.72, SD=5.822) are significantly taller than those with CP (mean height=136.39,SD=12.835).

There was a significant difference in weight depending on disability, $F(4,48) = 3.892$, $p=.008$. Those with loss of speech (mean weight=53.06, SD=15.855) have a significantly higher weight than those with CP (mean weight=33.59, SD=12.650)

There was a significant difference in LBM depending on disability, $F(4,45)=6.026$, $p=.001$. Those with loss of speech (mean LBM= 37.88, SD=8.303) had a significantly higher LBM than CP (mean LBM=25.80, SD=25.806), Orthopaedic conditions (Mean LBM= 20.55, SD=2.616) and muscular disorders (mean LBM=19.25, SD= 3.88)

Data to show the relationship between disability type and hand grip strength results

To test the relationship between disability type and hand grip strength ANOVA was used.

The results from both the hand grip dynamometer and the PAB® revealed no significant differences in results between hand grip strength and different types of disabilities.