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DEVELOPMENTAL DIFFERENCES BETWEEN PRE-TERM AND FULL-TERM 18 MONTH OLDS

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

As the medical world advances, there is an ever increasing survival rate of children that are born prematurely and of a low birth weight. For this reason more and more research is being done to investigate the consequences of being born pre-term and underweight. Research has shown that children who are born prematurely may show signs of developmental delay later on in life (Johnson, 2007). Motor development has been shown to be more affected by prematurity than any other causative factor of prematurity (Goyen and Lui, 2002).

The main aim of the study was to establish the differences in global development between pre-term and full-term infants at eighteen months.

The Bayley Scales of Infant Development II (BSID II) were used to determine performance in both the pre-term and the full-term group. These results were statistically analysed in greater detail in the mental and the motor section. The Mental and Psychomotor Developmental Indices (MDI and PDI) of the BSID II were used to determine the extent of the mental and motor delays in this sample.

The Household Economic and Social Status Index (HESSI) was used in order to ascertain if the socioeconomic status of a family had any bearing on the development of the child in both the mental and the motor categories. This was statistically analysed. The socio-economic factors assessed in this study did not show any statistical significance but did confirm that these children come from similar backgrounds.

The results of this study showed that there is a delay in the pre-term group when compared with the full-term group. The mean MDI for the full-term group was 105.25, this is compared with the pre-term group of 81.9, which is statistically significant ($p<0.001$). The PDI for the full-term group showed a mean score of 109.6. The mean score for the pre-term group was 86.8. This also showed a statistical significance ($p<0.001$).

The pre-term infants in this study showed a significant delay both in the mental and the motor domains. The cognitive delays may be linked to an under-developed corpus callosum due to the premature birth. The motor delays may be caused due to a decreased motor control and developmental dyspraxia.

Infants that are born prematurely are at a higher risk to suffer from developmental delays in the cognitive, language and the motor developmental domains. This study confirms what has been found in previous studies showing cognitive development to be the developmental domain most affected by prematurity. The results of this study are important as they support policy change to ensure that these children are followed-up to allow the at-risk children to reach their full potential.

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The caregivers and children who participated in the study

DECLARATION

I declare that this research report is my own unaided work, except to the extent indicated in the reference citation and acknowledgements. It is being submitted in partial fulfillment of the requirements of the degree of Master of Science (Physiotherapy) at the University of the Witwatersrand. It has not been submitted before for any other degree or examination in any other University.

Diana Brown

……day of……2009

LIST OF ABBREVIATIONS

ADHD	-	Attention-deficit hyperactivity disorder
AIDS	-	Acquired Immune Deficiency Syndrome
AIMS	-	Alberta Infant Motor Scale
BSID	-	Bayley Scales of Infant Development
CNS	-	Central nervous system
CP	-	Cerebral palsy
DCD	-	Developmental Coordination Disorder
DOH	-	Department of Health
EI	-	Early intervention
ELBW	-	Extremely low birth weight
EMG	-	Electromyography
GABA	-	Gamma-aminobutyric acid
HESSI	-	Household Economic and Social Status Index
HIV	-	Human Immunodeficiency Virus
IQ	-	Intelligence quotient
LBW	-	Low birth weight
MDI	-	Mental Developmental Index
MRI	-	Magnetic Resonance Imaging
NICU	-	Neonatal intensive care unit
PDI	-	Psychomotor Developmental Index
PDMS-2	-	Peabody Developmental Gross Motor Scale 2
PEDI	-	Pediatric Evaluation of Disability Inventory
PMA	-	Postmenstrual age
PVHI	-	Periventricular haemorrhagic infarction
PVL	-	Periventricular leukomalacia
RDS	-	Respiratory distress syndrome
ROP	-	Retinopathy of prematurity
VLBW	-	Very low birth weight

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Chapter 1: INTRODUCTION

We are living in times where there are new medical, technological advances all the time. This is leading to children with lower gestational ages being kept alive, but at what cost? Infants who have extremely low birth weights are being kept alive until they are able to cope on their own. For this reason more and more research is being done into the effects of being born pre-term and of a low birth weight.

Prematurity is defined as a gestational age of less than 37 weeks (Swamy et al, 2008). There are differences in statistics between developed and developing countries. It has been shown that in developing countries such as South Africa the premature birth rate is as high as 25% of all live births. This is a vast difference to the 5% pre-term birth rate in developed countries (Steer, 2005). Male infants have been shown to be at greater risk of pre-term birth than females. Researchers attribute this to the fact that males are usually smaller for their gestational age than females (Di Renzo et al, 2007). In contrast to this there has been shown to be a greater number of female infants born between 37 and 39 weeks gestation (Ingermarsson, 2003).

Research has been conducted to show that pre-term infants are at risk for developmental delay later on in life (Johnson, 2007). Infants born within the 22-26 week group are at a higher risk for neonatal morbidity and neurodevelopmental delay at the 18 month mark than children born in the 27-37 week group (Vohr et al, 2005). Infants who are born at less than 26 weeks gestational age have been shown to suffer from Grade III/IV intraventricular haemorrhage and periventricular leukomalacia, both of which can result in the child suffering from cerebral palsy (Anderson and Doyle, 2008).

There are many predisposing factors that can cause prematurity and each pregnancy comes with its own problems. It has been reported that the greatest cause of pre-term labour is that of infections. These include HIV and malaria (Steer, 2005). There is

evidence that poor socio-economic status, poor nutrition and poor prenatal care are factors causing premature birth (Khadia et al, 1995).

Cognitive developmental delay has in previous studies been linked to prematurity (Wood et al, 2000). It has been reported that difficulties with tasks such as reading and spelling increase with a decrease in gestational age (Allen, 2008).

The Bayley Scales of Infant Development II (BSID II) is an assessment tool that is used to measure the individual child's current developmental status. It consists of three scales: the Mental and Motor Scales, and Behaviour Rating Scales. The scale was first published in 1969, where the age range was between two and 30 months. The second edition, which was used in this study, was published in 1993. The age range for the BSID II is between one and 42 months (Bayley, 1993). The BSID II has long been considered a criterion standard for assessing development in children. The BSID has been described as the most widely used assessment tool that measures developmental status (Harris et al, 2005). The child's developmental score, once the test has been conducted, is placed in a category of significantly delayed (raw score <70), mildly delayed (70-85), within normal limits (85-115), or accelerated development (115>) (Bayley, 1993).

The Household Economic and Social Status Index (HESSI) is a socioeconomic questionnaire. This tool was developed in Soweto, South Africa, and was therefore suitable to use on this population groups (Barbarin and Khomo, 1997).

Problem Statement

Children that are born prematurely have been shown to demonstrate long-term developmental delay. Secondary hospitals, such as Dr Yusuf Dadoo in Gauteng, do not provide a follow-up service for children being born prematurely. This study is of importance to ascertain whether such services are needed.

The Aims and Objectives of the study were:

General Aim of the Study:

To establish the differences in global development between pre-term and full-term infants at eighteen months.

Study Objectives:

I. To establish if there is a level of developmental delay of children born prematurely
II. To establish if there is a level of developmental delay of children born full term
III. To compare developmental scores between the two groups.
IV. To determine what socioeconomic and demographic factors impact on socioeconomic status

Significance of the Study:

This study aimed to investigate if there is a difference in global development between pre-term and full-term children. If a problem is discovered a follow-up service can be initiated at secondary hospitals to optimise the care of any pre-term children. In this manner, a multi-disciplinary team can be used for the treatment of these patients to ensure that they reach their optimal developmental potential (Blauw-Hospers and Hadders-Algra, 2005).

Definition of Terminology:

- Global development: "Refers to the changes in an individual's level of functioning over time" (Gallahue and Ozmun, 2006).
- Developmental delay: "Delay of milestone attainment in accordance to a standardised developmental screening test" (Campbell et al, 2000).
- Prematurity: "Gestational age of less than 37 weeks" (Swamy et al, 2008).

Chapter 2: LITERATURE REVIEW

Knowledge of the central nervous system and development thereof is vital in allowing us to gain an understanding into how the various aspects can be affected by prematurity. This literature review will discuss the normal development of the domains of cognitive, motor and language development. This will then be considered in regard to affects of prematurity. The socioeconomic factors that have been found to play a role will also be discussed.

Through comprehensive database searches that were done the literature was obtained (Pubmed, Medline, and PEDro). Keywords used in the searches included: Prematurity, Normal Development.

2.1 Development of the Central Nervous System

The central nervous system begins developing in the fifth week postmenstrual age (PMA) with the formation of the neural tube. This development continues for two decades before the central nervous system obtains its adult formation. Neural proliferation has been shown to have its peak development between weeks five and 25 PMA but continues into adulthood. Neural proliferation is the where the neural tissue differentiates forming the major sub-divisions being: forebrain, midbrain and spinal cord. This continues until the child is five years old. Axonic and dendritic sprouting peaks between weeks 25 and one year of age. This sprouting only occurs during this part of the development as the central nervous system cells need to have reached their final position prior to this sprouting occurring (de Graaf-Peters and Hadders-Algra, 2006).

The corticospinal tracts have been shown to be the last of the major tracts to enter the spinal cord with dendritic formation begins early in foetal life but is slow in the first and second trimester. It accelerates during the third trimester and remains very active until one year of age. It then slows down again until five yeas of age. The length of both axons and dendrites increases five to ten

times in the first six months of post-natal life (de Graaf-Peters and Hadders-Algra, 2006).

Synapse formation continues slowly until the 26th week where it accelerates resulting in a six-fold increase of synaptic density from 28 weeks PMA till 16 months of age. It then slows down again until adulthood. The first synapses have been found in the spinal cord at eight weeks PMA and in the cerebral cortex at nine to ten weeks PMA (de Graaf-Peters and Hadders-Algra, 2006; Girarda et al, 2007).

Glial cells encompass the remainder of the cells, apart from the neurones in the central nervous system. They are responsible for the formation of myelin, clearance of excessive neurotransmitters and regulation of the surrounding extracellular environment. Glial cell proliferation peaks between weeks 20 and 40 also continues into adulthood. Myelination peaks from 40 weeks to one years of age and continues till an average of 40 years of age with the intracortical connections amongst the last for myelination (de Graaf-Peters and Hadders-Algra, 2006; Girarda et al, 2007). In a study conducted in 1993, Magnetic resonance imaging (MRI) done on pre-term and term infants at the same PMA showed differences in myelination. It found that the white matter in the pre-term group was of a lower density than that of the full-term control group (Konishi et al, 1993).

Sulcation of the brain changes dramatically between weeks 18 to 34. The parieto-occiptal fissure is present at 18 weeks and is well-shaped. The calcarine fissure starts to fold at 24 weeks but is only definite at week 30. The central sulcus is seen at the brain surface at weeks 24 but only shows its normal orientation at week 35. The post-central sulci are seen on the surface at week 27 but only deep at week 35 (Girarda et al, 2007). This shows that there is an increased risk of neurodevelopmental problems that can occur up to those specific ages.

Chemical neurotransmitters such as acetylcholine, catecholamine, gamma-aminobutiryc acid (GABA) and glutamate are present from on average eight weeks PMA. The main periods of over-expression has been shown to be between weeks 12 to two month's postnatal age. GABA has been shown to be an excitatory neurotransmitter in early foetal development and then switches to the adult version as an inhibitory neurotransmitter during the last trimester. Electromyography (EMG) studies in pre-term children have suggested that the disruption in the monoaminergic systems may explain part of the motor dysfunction often experienced by low-risk pre-term infants. Stress during the pre-term stage may be one of the explanations as to why low risk pre-term infants may suffer from motor cognitive and behavioural problems. Stress is a condition where there is tension placed on the infant. Stress can be caused by factors bright lights and noise in an intensive care setting or by painful medical procedures being performed. Due to the over-expression of the catecholamine system until 44 weeks PMA it is suggested that therapeutic intervention be restricted until then to diminish the stress effects on the infants (de Graaf-Peters and Hadders-Algra, 2006). The effects of early intervention will be discussed later.

The above shows that gestational age at birth can cause disruption in central nervous system development. This can lead to various neurodevelopmental problems such as developmental delay and cerebral palsy (CP).

2.2 Prematurity

Prematurity is defined as a pregnancy where gestation is less than 37 weeks. The percentage of males born pre-term in a study conducted in 2008, reported to be at 5.6% as opposed to 4.7% of females (Swamy et al, 2008). It has also been reported that females have a better outcome over males if born prematurely. The reason for which remains unknown (Di Renzo et al, 2007).

The United States of America has premature birth rates reported at 12.5% (Ananth and Vintzileos, 2006). Steer (2005), reported that developed countries have a preterm birth rate of 5 % whereas developing countries such as South Africa, have rates as high as 25%.

A study conducted in 2005, has shown that there is a higher rate of prematurity in black mothers as opposed to white mothers. The researcher attributes this to an accelerated rate of maturity in the black neonate (Steer, 2005). Research has proven that in the United States the level of black women giving premature birth was at 18.4% as opposed to 11.7% for white women (Messer et al, 2008). As a result of a black baby maturing faster in-utero there is a greater chance of premature delivery. The body systems in a black infant begin to function independently faster than a white infant's allowing premature delivery.

There are numerous causes of prematurity. The most significant cause has been shown to be infection. There are two primary infections that cause prematurity being malaria and Human Immunodeficiency virus (HIV) (Steer, 2005). This is a pertinent issue in South Africa, as it was estimated that number of HIV positive women over the age of 15 is 13.3 million in Sub-Saharan Africa (UNAIDS, 2006). This statistic shows how relevant HIV is for women of child-bearing age.

In 2006, there were 12098 reported cases of malaria in South Africa. Of those, 87 resulted in death (South African Department of Health Malaria statistics; accessed 4 August 2009). Pregnant women are more likely than non-pregnant women to contract malaria and also suffer from a more severe infection this is due to the decreased immune response during pregnancy. Maternal placental malaria can cause low birth weight, premature delivery and intrauterine growth retardation and therefore decreases the infants' survival chances (Lagerberg, 2008; Briand et al, 2009).

2.2.1 Common Complications of Prematurity

Being born prematurely places the infant at a higher risk of complications that are specific to a pre-term infant. The shorter the length of gestation the greater the risk is for complications and the greater the risk is for more severe complications (Allen, 2008).

Low birth weight is a common complication of prematurity. There are various categories of low birth weight. These are as follows: low birth weight (LBW) of between 2500g and 1500g; very low birth weight (VLBW) as between 1500g and 1000g and lastly extremely low birth weight (ELBW) of less than 1000g (Eichenwald and Stark, 2008). Being born with a low birth weight has the potential for adverse side-effects. In the United States 40% of the cerebral palsy rate is due to children born with a low birth weight (Eichenwald and Stark, 2008). In developing countries it has been shown that 15% of all live births are of a low birth weight as compared to six to seven% in developed countries (Mokhachane et al, 2006).

Mothers who received less than appropriate prenatal care have also been shown to deliver infants with a low birth weight (Zeka et al, 2008). The risk of both prematurity and low birth weight were increased with a decrease in the number of ante-natal visits (Raatikainen, 2007).

Periventricular leukomalacia (PVL) is another complication of prematurity. PVL is an infarction of the white matter of the brain which leads to demyelination (Dubowitz et al, 1985). PVL is said to be the most common cause of cerebral palsy in pre-term infants. Two of the most likely causes of PVL include intrauterine infection and hypoxemia. It has been found that PVL is caused by a sequence of events. These two causes have been shown to induce an inflammatory response syndrome which activates a cascade of cytokines. These can cause pre-term labour. The greatest vulnerability is between 24 and 34 weeks PMA (Bauer et al, 2009).

Periventricular haemorrhagic infarction (PVHI) is defined as a grade four germinal matrix haemorrhage. It is thought to be caused by pressure of the germinal matrix haemorrhage on the periventricular terminal vein that drains the cerebral hemisphere. This leads to venous congestion in the periventricular white matter and this causes ischemia and haemorrhage. Mortality in PVHI ranges from 38% to 60%. Survivors are at an increased risk of cerebral palsy and for neurological problems after 12 months of age. There are several other factors that have been linked to PVHI. These include low APGAR scores, need for respiratory resuscitation, pneumothorax and pulmonary haemorrhage (Roze et al, 2008).

Another common complication of prematurity is retinopathy of prematurity (ROP). Retinopathy of prematurity is defined as a disorder of retinal vasoprofliferation that occurs mainly in extremely pre-term infants. According to Dammann et al (2009), 20% of infants born below 37 weeks gestational age will develop ROP. Among infants born below 34 weeks gestational age the risk increases to 56%. Risk factors for the development of ROP include: excessive oxygen exposure, oxygen-related disturbance of angiogenic growth factor availability, oxygen radicals, and *Candida* sepsis. Genetic factors are also investigated (Dammann et al, 2009).

Respiratory distress syndrome (RDS) is caused by a lack of pulmonary surfactant. Surfactant is a phospholipid, which stabilises surface tension in the alveolus, and prevents alveolar collapse on expiration. Small quantities are produced at weeks 23-24 of gestation and the amount gradually increases until a surge at week 30. The birthing process and the onset of respiration stimulate surfactant production. When an infant is born prematurely, their lungs do not produce enough surfactant and the alveoli collapse, preventing the infant from breathing properly. Babies born full term rarely develop RDS. Most cases are seen in premature babies under 28 week's gestation (Pryor and Prasad, 2003).

Symptoms of RDS include: apnea, cyanosis, grunting, inspiratory stridor, nasal flaring, poor feeding and tachypnea. RDS occur in approximately seven percent of infants. It is more prominent in male infants. The pathophysiology of RDS is as follows: the immature type II alveolar cells produce less surfactant, causing an increase in compliance. The resultant atelectasis causes pulmonary vascular constriction, hypoperfusion and lung tissue ischemia. Hyaline membranes form through the combination of sloughed epithelium, protein and oedema (Hermansen, 2007).

2.3 Motor Development

Motor development has been used as the best indicator of a child's developmental status (Santos et al, 2001). Motor development is a continuous change throughout an infant's growth. It is a descriptive form of assessing a child's development. Motor development is used as an indicator for a child's development as untrained people can see the changes in the child. The motor aspect of a child's development is keenly watched by parents and is often the first sign that there is developmental delay. Motor development in any child is divided into gross and fine motor aspects. Gross motor movement involves movement of the large muscles of the body. Fine motor movement involves limited movements of parts of the body in performing precise movements (Gallahue and Ozmun, 2006).

In normal gross motor development, children gain stability in each position and then locomotion. The sequence of stability tasks are developed in order from the head and neck, trunk, sitting and then standing. Locomotion occurs in horizontal movements such as crawling and then upright gait in the various walking stages of development (Gallahue and Ozmun, 2006). Locomotion is one of the major milestones that is keenly awaited by parents. It is divided into two components. The phasic component is responsible for the alternating contractions of the limb and trunk muscles. The tonic phase is associated with the postural muscle tone that is required for locomotion (Vinay et al, 2005). At

18 months of age all major motor milestones should have been obtained. From this age onwards there is a refinement in the quality of movement (Edwards and Sarwark, 2005). The developmental profiles of 18 months pre-term children have been shown to be comparable to that of their full-term counterparts. At this age the nervous system should have matured sufficiently for this comparison to be possible (Cooper and Sandler, 1997; Bayley, 1993).

The general theory of motor control state that there are many systems in the human body that function together to allow for balance. The primary systems involved in balance are the sensory system giving feedback, the motor system creating the movement and the biomechanical system including the bones and joints allowing for the frame to be held. Postural stability is defined as the ability to maintain the centre of mass in relation to the base of support to prevent falls and complete the desired movement. Balance is the process by which postural stability is maintained. Static balance is whilst in a stationary position while dynamic balance is in a mobile position. Postural control is classed as an important and necessary motor ability. Children with many types of disabilities, ranging from learning disabilities with mild motor problems to cerebral palsy with more severe motor problems have been shown to suffer from poor postural control. This ability has been said to reach maturity by age ten years (Westcott et al, 1997).

Independent gait is shown to develop at 12 months of age with a standard deviation of three months. The initial movement is characterized by short and quick steps with the toes pointing outwards. Associated with this is the trunk oscillating. The upper limbs are held in a rigid high-guard position allowing the toddler a wider base of support. There is also flat-footed contact with the ground unlike in adults where there is a heel-strike (Ivanenko et al, 2007). Gait pattern has been shown to reach adult-like maturity by age ten years (Westcott et al, 1997).

As with gross motor, fine motor development also occurs in various stages. The three main stages are reaching, grasping and releasing. The development of reaching and grasping occur simultaneously from birth up till the sixth month for reaching and the eighteenth month for grasping. Releasing only starts developing from the twelfth month and continues up till the eighteenth month (Gallahue and Ozmun, 2006). Postural muscle control is important in the development of fine motor ability. The development of trunk stability and central axis control is considered to be a necessity for upper limb function and hand usage (Rosenblum and Josman, 2003). It has been shown that the index finger plays an active role in grasping from as young as three months. The index finger usually contacts the object first and initiates the grasp reflex. This dominant role of the index finger becomes clearer with increasing age. After the initial index finger contact the remaining digits close together being controlled by the central nervous system for grasping and finger manipulation (Lantz et al, 1996).

Another factor affecting motor development is that of HIV infection. This has been attributed to HIV affecting the central nervous system causing abnormalities in tone, muscle strength and co-ordination. In a study conducted in Cape Town, South Africa using the Bayley Scale of Infant Development II (BSID II), they showed 66.7% of their sample size of HIV sufferers were significantly delayed. The mean age of their group was 15.8 months with a standard deviation of 7.5. This study did only have a sample size of 55 infants (Ferguson and Jelsma, 2009). In a study conducted by Potterton, (2009), a reported 72% of HIV-positive children showed severe motor delay. The mean age of this study was 18.5 months (± 8.1) and 122 children were assessed. This study also used the BSID II and was conducted in Soweto, South Africa (Potterton et al, 2009). These results correlate to other studies conducted showing developmental delay in HIV positive children (Potterton and Eales, 2001; Foster et al, 2006; Willen, 2006; Baillieu and Potterton, 2008).

Another factor affecting motor development is that of under-nutrition. Under-nutrition can cause stunting and delay or regression of motor milestones. Walker et al (2007), showed that children who received iron and zinc supplements benefited motor performance in Jamaican children. To combat this there are food supplementation programmes in place (Walker et al, 2007).

An important aspect that needs to be mentioned is that of the precocious development of African infants. This is not a very well researched area. A study was done on 320 Nigerian children at 12 months in 1991. This study showed that these children obtained motor milestones earlier than their first world counterparts that are used to norm standardized tests (Iloeje et al, 1991). This was confirmed by a study conducted using the Bayley Scales of Infant Development I (BSID). They reported on a group of 64 Kenyan children showing that their results were higher than the American norms in the BSID I (Super, 1976). Another comparative study showed that at nine months black African infants were three times less likely to show signs of gross motor delay than white infants (Kelly et al, 2006).

2.3.1 Impact of Prematurity on Motor Development

Pre-term infants are more likely to suffer from more motor co-ordination problems than a full-term infant. This again is documented to affect males more than females (Gallahue et al, 2006). Studies have shown that pre-term infants perform lower on the gross motor standardized tests than full-term infants (Goyen and Lui, 2002).). Fine motor development has been proven to show lower scores in pre-term infants when a standardized test has been conducted on the infant (Goyen and Lui, 2002). Fine motor scores have been shown to be lower in those pre-term infants who were born prior to 32 weeks; suffered from hyaline membrane disease or required longer periods of ventilation (Goyen et al, 1998).

With the increased knowledge of pre-term infant care, the survival rate of these children has increased. With this increase has come a group of what are being referred to as ‘clumsy’ children. These children do not have a major disability but often suffer from deficits in motor control or developmental dyspraxia. These deficits do not always occur in the smallest or most pre-term child. It varies across the board (Foulder-Hughes et al, 2003). The findings were also true for a large proportion of children that were born pre-term to have perceptual-motor difficulties which can lead to the child being classed as ‘clumsy’. There were high numbers of infants displaying this problem but at a school-age level (Jongmans et al, 1997).

Being born prematurely often necessitates admission to a Neonatal Intensive Care Unit (NICU). Most often pre-term infants are nursed in prone position in the NICU. This is a good position for improving respiratory system function. This continued position has been shown to cause muscle imbalances. It leads to trunk extensor muscle dominance resulting into hyperextension of the trunk. In the lower limbs this consistent prone position causes a delay in functional milestone obtainment such as hands to knees and feet. This is disadvantageous for weight bearing and can cause delay in crawling and walking (Monterosso et al, 2003).

Pre-term infants are often classed as ‘clumsy’ children later on in life. There is often a diagnosis of developmental coordination disorder (DCD) for these children. DCD is defined as “‘impairment of motor performance sufficient to produce functional performance not explicable by the child’s age, intellect, or other diagnosable neurological or psychiatric disorders” (Foulder-Hughes, 2003). DCD is also often found to be accompanied by attention-deficit-hyperactivity disorder (ADHD). Pre-term children are found to be at a higher risk for developmental dyspraxia, perceptual-motor dysfunction and deficits in motor control (Foulder-Hughes, 2003).

One school of thought is that the positioning of the pre-term neonate in incubators has a lot to do with the future problems with the postural control and motor control (Vaivre-Douret et al, 2004). Postural control or balance is the ability to maintain the centre of body mass over a stable or moving base of support (Rosenblum and Josman, 2003). The norm is for pre-term infants to be nursed in prone. The following abnormalities were found with this position: scapula retraction, hyperextension of the trunk and the head, arms in flexion/abduction, external rotation of the legs and orthopaedic deformity of the feet. These positions have been shown to lead to the following motor abnormalities: head control by the neck extensors exclusively, late sitting, early standing, and behavioral hyper excitability with resistance to postural change (Vaivre-Douret et al, 2004). In this study there was 55% of the pre-term group that were in incubators for various lengths of time following their births.

These changes are due to the fact that the pre-term neonates' musculoskeletal system is highly plastic and responsive to body changes during the first year of life. Differentiation of muscle tissue is incomplete until post-birth. It begins to differentiate after 20 weeks post conception. Flexor tone develops in a caudocephalad (lower to upper extremities) and centripetal (distal to proximal). This calls for a nursing position of semi-flexed midline position. This is where the full-term infant benefits from being in the cramped uterine environment for a longer period of time (Sweeny, 2002). These concepts can explain the risk of motor delay in pre-term infants.

2.4 Cognitive Development

Cognitive development in a non-handicapped child is reliant on various factors for a child to reach their full potential. A large proportion of brain development occurs in-utero and in the first two years of life and by this stage the brain is close to 80% of its adult weight (Casey et al, 2000). The pre-frontal cortex has been shown to mature last. The cognitive processes related to the pre-frontal cortex include memory and attention allocation. When there is interference in

development these developmental areas have been shown to suffer under-development. Interference can include attention deficit hyper-activity disorder or autism (Casey et al, 2000).

The second half of gestation and the neonatal period have been shown to be the most important for the development of the various cerebral pathways. The time before the 24th PMA is characterised by thalamocortical afferents forming. Between weeks 24 and 32, the thalamocortical afferent fibres grow into the cortical plate. By weeks 33 to 35 there is the growth of the cortico-cortical pathways into the cortical plate. In the neonatal period there is the cessation of the corpus callosum growth of interhemispheric fibres. In the first postnatal month there is an increased growth of synapses in the brain. This allows for cognitive development to occur in the infant (Kostovic et al, 2006).

The rate of maturation of the white matter in the developing brain cortex indicates an increased myelination of the axons. As the myelination increases it allows for more efficient neural transmission and thus faster information processing. By increasing the connections between the various cortex regions the brain increases the amount of fibres added to the white matter tracts (Paterson et al, 2006).

The cerebellum plays a role in cognition in the functions of executive, visuospatial and verbal processes. It has also been shown that the cerebellum plays a role in achieving new cognitive tasks prior to them being learned. This part of the brain would therefore play an important role in the cognitive development of infants, as the tasks they are learning are all new to them. Children who suffer from posterior fossa cerbellar malformations have been shown to display attention deficits and visuospatial problems. Cerebellar dysfunction from birth has been shown to cause cerebellar dyslexia leading to phonological, speed and literacy problems and presents with problems with articulation, language and memory. Children suffering from ADHD were shown

to have smaller vermal volume of the cerebellum as well as problems in the frontal lobe showing the cerebellar-frontal connections to be prominent (Steinlin, 2007).

The cerebellum has also been shown to have a role in learning and memory. Working memory is a cognitive function that allows the temporary storage of information used to perform complex everyday tasks, such as reasoning and language comprehension. This is thought to occur through the cerebellar-frontal connection through the dentothalamic fibre tracts (Ben-Yehudah et al, 2007). Memory has been shown to develop in two ways in infants. Firstly, retention becomes progressively greater. Secondly, memory retrieval improves (Hartshorn et al, 1998). Memory is the ability to store information, and is considered a basis of cognitive function. Areas of the brain related to memory include the hippocampus, prefrontal cortex and the cerebellum. Properties of the infant brain are shown to be too immature to encode, store and retrieve memories over a long term period. This memory capacity depends on brain structures that are not mature until the end of the first year of life. Infants who were observed were shown to be slower to learn and faster to forget when compared to adults. This shows that memory is a developing process (Rovee-Collier and Cuevas, 2009).

Object permanence is an important cognitive development milestone. Object permanence is the ability to keep track of an object when they disappear from site. It has been shown that infants are able to perform this task from 7.5 months, but it improves from ten months of age. It was shown that there were increased oxyhaemoglobin levels in the brain when the infant showed object permanence. These higher levels of neural activity occurred in the frontal lobes of the cortex. The maturation of the frontal lobe appears to be of importance in the development of object permanence. (Paterson et al, 2006).

Other factors that affect cognitive development include that of Iodine deficiency. It can lead to congenital hypothyroidism and irreversible mental retardation. Walker et al, 2007, conducted a review of 21 studies investigating if there is a link between iron deficiency and cognitive development. In 19 out of the 21 studies, anaemic infants showed poorer cognitive functioning regardless of the sample size and quality. Cognitive stimulation has also been shown to have a direct link to cognitive development. Four out of five studies in the same 2007 review, which were conducted in developing countries, reported beneficial outcomes of cognitive stimulation on infants and children (Walker et al, 2007).

2.4.1 Impact of Prematurity on Cognitive Development

Pre-term children have been shown to suffer from cognitive impairments and academic difficulties at a much greater degree than their full-term counterparts (Allen, 2008). The prevalence of this has been shown to be in the range of 30-40% for infants born prior to the 26 week gestation mark (Anderson et al, 2008).

One of the greatest areas that pre-term children have shown to be at a disadvantage is that on spelling and reading. As the gestational age of the infant decreases, the difficulty increases (Allen, 2008). Intelligent Quotient (IQ) scores have also been shown to decrease with prematurely born infants (Johnson, 2007). This study reports that these children have problems with mathematics, oral-motor skills, verbal working memory, perceptual and spatial organisation (Johnson, 2007). Studies have also shown that children who required longer periods of ventilation at birth show lower IQ scores than their peers that did not need such long periods of ventilation (Goyen et al, 1998).

Studies have shown that pre-term children are born with a smaller corpus callosum than that of full-term infants. This has been linked to lower cognitive scores (Allen, 2008). The corpus callosum is the main inter-hemispheric link between the left and right hemispheres of the brain. They transfer sensory and

higher processed information via more than 180 million fibres. The corpus callosum is the main interhemispheric commisure of the brain. These fibres integrate the activities of the two hemispheres by transferring sensory and higher processed information to allow for transferral to the opposite hemisphere. Pre-term infants show a thinning of the corpus callosum. This type of injury has been attributed to the vulnerability of the developing corpus callosum to hypoxic ischaemic damage and haemorrhage. Pre-term infants can present with learning disabilities and a poorer cognitive performance when compared with their full-term counterparts and this has been related to the reduction in the corpus callosum size. The damage is thought to occur due to hypoxic-ischaemic events or haemorrhages. The splenium of the corpus callosum has been strongly linked to IQ of a child. Studies have shown that a splenium of a preterm infant may lead to lower IQ scores in infants up to the adolescent age group (Narberhaus et al, 2007). The neurodevelopmental delay has been linked to the causes for the pre-term birth, the immature organ development and the adverse effects of the neonatal procedures that may have been required while the child was admitted in the Neonatal Intensive Care Unit (Allen, 2008).

Children born preterm have been shown to have cerebellar atrophy. Children born prior to 30 weeks are shown to suffer especially with injuries to the inferior hemisphere and vermis. Clinical features of cerebellar atrophy include: motor impairment, degrees of ataxia, athetosis or dystonia, significant developmental problem in the cognitive and speech domains. Pre-term birth also increases the risk of cerebellar haemorrhage, ADHD and behavioural problems all of which are common in pre-term infants (Steinlin, 2007).

Of the disabilities that have been shown to affect cognition that are associated with pre-term birth, the most prevalent is spastic diplegia. This is said to be caused by damage to the internal capsule, in which the fibres that supply the lower limbs are more prone to hypoxic-ischaemic injury (Fawke, 2007).

There is still hope for families with pre-term infants. Not all premature children will suffer from cognitive problems. The outcome of these children is largely related to genetic, brain injury presence and social factors (Anderson et al, 2008).

2.5 Language Development

Language development overlaps with both the cognitive and the motor aspects of development. Motor plays a role in the oral motor control (Alcock, 2006). If a child shows a cognitive delay it has been reported that the possibility of a language deficit is higher (Ortiz-Mantilla et al, 2008). It has been shown that female infants have superior language skill than males when born with an extremely low birth weight (Goyen and Lui, 2002). Children learn language from the people that surround them. Infant are sensitive to hearing sound patterns, grammatical arrangement and word patterns from adult speech. Infants tend to pick up nouns, verbs and adjectives first and then extend the range (Clark, 2004).

The processes involved in learning language are in a series of stages: additive, subtractive and re-organisation. The additive stages include the process of neuron proliferation and myelination formation. The subtractive stages include apoptosis, which is programmed cell death, of the overproduction of synapses that occurs pre-natally. The additive stage requires the brain to form its representation to allow adequate functioning (Bishop, 2000). Brain development has been linked to a maturation of other bodily organs which is driven by the genetics of the body but has been shown to be largely influenced by environmental factors which showed that people with low educational levels suffered from poorer spoken language as well as poor literacy levels (Bishop, 2000).

The most intensive time period for language development has been shown to be within the first three years of a child's life. As the speech mechanism and the jaw mature in a child, the child will be able to control the sounds they make. This will begin with 'cooing' noises and progress to forming actual words (Arshavsky, 2009).

Speech can be classed as the product of a complex series of processes. The formation of a simple phrase involves the formulation of a communicative goal, consideration of formality of speech, selection of vocabulary, the motor plan execution and intelligible articulation. This shows how involved the art of speech is. Due to this complexity in speech there are many areas where problems in speech can occur. These include the following: incorrect vocabulary, a hearing loss, a motor planning problem or a structural or neurological anomaly interfering with articulation (Powell, 2008).

The cerebellum controls up to 100 vocal tract muscles involved in the production of speech. It also controls the rhythm and quality of speech, including loudness and pitch. Children suffering from posterior fossa tumours of the cerebellum were shown to suffer from ataxic motor speech problems, showing the level of control the cerebellum has on the speech muscles. Resection of these tumours has shown a 15% rate of speechlessness in children. Disorders of the cerebellum lead to a reduced maximum speaking rate, disrupted co-ordination of the laryngeal and orofacial movements and problems with speech timing (Ackermann et al, 2007).

Rapid auditory processing has been shown to be of importance to language development. Auditory processing is when the central nervous system processes the auditory stimulation that it receives. It has been shown that children who struggled with auditory processing showed poor temporal lobe functioning. This was noted in the superior temporal gyrus, which houses

Heschl's gyrus which processes auditory information. Other areas of the brain involved are the thalamus, caudate and frontal lobe (Paterson et al, 2006).

Towards the end of a child's first year of life they begin to acquire words. Firstly, as a sequence of sounds and then later as meaningful words in their developing vocabulary. At the same time as this is developing speech perception is refined. Phonetic and vocabulary learning takes place in the first year shows an early learning capacity for speech. (Yoshida et al, 2009).

2.5.1 Impact of Prematurity on Language Development

Studies have shown that pre-term children have significant and consistent differences in expressive and receptive language abilities on a number of different measures (Ortiz-Mantilla et al, 2008). The same study showed how pre-term children were less efficient on both visual and auditory tasks. It was shown that the child's socio-economic status has an effect on language development (Ortiz-Mantilla et al, 2008). This aspect will be discussed under the socio-economic section.

Pre-term infants have been shown to experience poor development both in the receptive and expressive language in various stages of infancy. This has been linked to a global developmental delay in the cognitive area causing an impact on the language section (Briscoe et al, 1998).

2.6 Assessment of Development

Developmental assessments are used for various reasons and in various settings. Some assessment tools are used to identify high-risk infants for developmental disability. Others are used to plan an intervention strategy for treatment. Standardised assessment tools are useful in documenting a change in the child over a period of time (Majnemer and Snider, 2005).

These tests are administered to assess the child's ability in completing a certain task, the quality of the completed task and the motor planning involved in completing the task. Based on the results of the various tests the administrator is able to identify problems associated with the sensory, motor and musculoskeletal system (Tieman et al, 2005).

2.6.1 The Peabody Developmental Motor Scales 2

The Peabody Developmental Motor Scales-2 (PDMS-2) was developed by authors whose backgrounds are in education and physical education. The scales were developed to identify children whose gross and fine motor skills were delayed when compared to the normal. It also allows for comparison between the two groups and between the two motor domains and for change in time to be recorded. It is a test designed for infants from birth to 83 months. It was developed and normed on the western population of 2003 infants. The PDMS-2 has an interrater reliability of 0.96 and concurrent validity of 0.84 with the PDMS-1. The PDMS-2 is a norm-referenced and standardized motor test. Separate scores are obtained for fine and gross motor allowing problem areas to be highlighted (Tripathi et al, 2008; Kolobe et al, 1998; Tieman et al, 2005).

2.6.2 The Alberta Infant Motor Scale

The Alberta Infant Motor Scale (AIMS) is a measure of gross motor maturation in infants from birth to independent walking. It may not pick up subtle differences in test subjects. The test allows for observations in the following positions: prone, supine, sitting and standing. Standardisation of the scale was established on 2202 infants in Canada. Interrater reliability is 0.85 (Jeng et al, 2000).

2.6.3 The Pediatric Evaluation of Disability Inventory

The Pediatric Evaluation of Disability Inventory (PEDI) is designed to identify functional limitations and monitor progress in children with disabilities. It was designed to measure functional abilities in physically disabled children or a

combination of physical and cognitive disabilities. It has been used on traumatic brain injury sufferers, orthopaedic conditions patients and those with neurological conditions. It has aspects of mobility, self-care, transfers, eating, grooming, dressing and toileting. Test items were standardised on 412 children and a sample of 102 children with disabilities. The age range for the PEDI is six months to 7.5 years. It has an interrater reliability of 0.96 (Tieman et al. 2005).

2.6.4 Bayley Scales of Infant Development II

The Bayley Scales of Infant Development II (BSID II) is an assessment tool used to assess the individual development of a child. The tool ranges from one month to 42 months of age. It was revised in and published in 1993. Its predecessor, Bayley Scales of Infant Development (BSID), was published in 1969. It had an age range of two months to 30 months of age. The tool is diagnostic in value and allows for service planning for a child. It consists of three main areas: The Mental Scale, Motor Scale, and the Behaviour Rating Scale. The Mental and Motor Scales assess the cognitive, language, fine and gross motor skills of an infant (Bayley, 1993).

The primary aim of the BSID II is to identify children that suffer from development delay in one of the domains mentioned above. It is also used to ascertain progress in an intervention programme for a child. It is also used as a research tool (Bayley, 1993). The BSID II has long been considered a standard for the use in infant developmental research (Harris et al, 2005). Normative data has been obtained on many high-risk infant groups: Down-syndrome, prematurity and HIV. Construct validity has been established from the first edition. Concurrent validity has a value of r=0.85 – 0.97 for the motor section and 0.67 – 0.76 for the mental section. Content validity has been established by experts reviewing each of the items (Tieman, 2005).

In the Mental Scale, items were chosen to strengthen the assessment of cognition, language and social development. The Mental Scale consists of 178

items. In the Motor Scale, items were chosen to strengthen and extend the general content of motor development. The Motor Scale consists of 111 items (Bayley, 1993).

The raw scores that are obtained in the motor and mental domains are converted in index scores. These index scores indicate the extent of the infant's development. These are known as the Mental Developmental Index (MDI) and the Psychomotor Developmental Index (PDI) scores. These scores have a mean of 100 and a standard deviation of 15 (Bayley, 1993).

The BSID I was normed on children on a South African population. These children were from both urban and rural areas and for this reason this tool was suitable to be used on South African infants. The South African infants showed scores higher than the American infants up till the ten month group on both the Mental and the Motor Scales. From ten months onwards the scores obtained were very similar to the normative data obtained from the American infants (Richter and Griesel, 1992).

2.7 Management of Developmental Delay

Early intervention (EI) is provided for children who are classed as at risk for developmental disabilities. EI is a multidisciplinary approach provided for children from birth to five years to promote child health and minimise developmental delays. This is accomplished by individualised developmental and therapeutic services. This service is provided by physiotherapy, occupational therapy, developmental psychology and education specialists. The advantage of beginning early is that the brain is believed to be plastic. This means that the brain is able to remodel itself. This is especially true after the completion of neuronal migration during which the processes of dendritic outgrowth and synapse formation are highly active. This correlates to high plasticity levels between two and three months and six to eight months after term age (Blauw-Hospers and Hadders-Algra, 2005).

The study done by Blauw-Hospers et al (2005) was a systematic review conducted with 34 articles. Of those studies only 17 were carried out in a NICU. This makes it difficult for developing countries that do not always have NICU facilities. The studies ranged from sample sizes of 10 infants to that of 746. This is a vast range. All the studies were conducted in developed countries. This makes it difficult to apply the principles to that of a developing country. For this reason EI is the norm of practice in developed countries but not in developing countries (Blauw-Hospers and Hadders-Algra, 2005).

In a study conducted in Brazil in 2006, the effect of early positioning and kangaroo mother care on early neuromotor development in pre-term infants was investigated. Eighty infants between the gestational ages of 32 and 40 weeks were included in this study. The results showed a non-significant outcome (Barradas et al, 2006). This study highlights that there is a gap in the literature for EI in developing countries.

Research has shown that children should receive treatment based on their age. Evidence has been established that in pre-term infants the optimal EI is that of mimicking the intrauterine environment (Blauw-Hospers and Hadders-Algra, 2005). A popular form of treatment is that of Newborn Individualised Developmental Care and Assessment Program (NIDCAP). This program seeks to correct for the lack of stimulation due to the NICU environment. Benefits in motor, cognitive and speech development at three years of age in children born pre-term, which received NIDCAP therapy have been noted (Bonnier, 2008).

Both NIDCAP and individualised treatment in children have shown positive results in long-term cognitive improvements, motor skill improvement, and improved caregiver-child interaction. Reasons for this improvement include that of early stimulation programmes compensating for the lack of household stimulation in low socio-economic groups. Non-handicapped infants born

between 32 and 36 weeks gestational age often require help in learning the correct movement patterns (Bonnier, 2008).

2.8 Infection and the Effect on Development

Infectious disease rates are high amongst children under five in the developing world. These diseases have been shown to affect development either through a direct or indirect mechanism. Organisms invade the central nervous system parenchyma either during an infection or as a secondary complication. This is a direct mechanism. An indirect mechanism is when a child is malnourished for example and has low energy levels causing play and social interaction to decrease. It is reported that two million children under the age of 14 years are living with HIV/AIDS. Infection can lead to severe encephalopathy or developmental delay (Walker et al, 2007).

Gastroenteritis is an infectious disease that is related to poor socio-economic conditions largely due to dirty drinking water. Studies have shown that severe diarrhoea in the first two years of life is linked to impaired cognitive functioning in later childhood (Walker et al, 2007). Malaria is the cause of up to 40% of paediatric hospital admissions in Sub-Saharan Africa. Studies have shown that there are neurological and cognitive impairments in function related to malaria infection (Walker et al, 2007).

2.9 Socio-economic Factors and their effect on Development

This is an area of life that affects all children regardless of gestational age. Development of a child is largely dependent on genetic factors but also on environmental. Studies show that poverty, substandard housing, overcrowding, inadequate water and poor sanitation have a great impact on an infant's survival and quality of life. The lack of safe water and sanitation facilities increases the risk of intestinal infections and other communicable diseases. Overcrowding increases the risks of infectious diseases such as tuberculosis (Nair, 2004). Poverty is associated with under-nutrition, poor maternal

education and inadequate stimulation in the home (Grantham-McGregor et al, 2007).

The risk of delivering prematurely has been shown to be higher in mothers from a poor socio-economic background (Thompson et al, 2006). Studies show that maternal stress and smoking up to the first year of life has a detrimental impact on a child's development (Slykerman et al, 2007). The rate of pre-term birth increased with a decrease in maternal educational levels (Thompson, 2006). Reports state that higher levels of maternal education are a positive influence on a child's motor development. Maternal education is said to be of the utmost importance in third-world countries where pre-school education is not commonly available to everyone. This lack of education has also shown that parents may be over-protective of their children by thinking that by standing for long may cause damage to the infants' spines or legs (Santos et al, 2001).

As is in prematurity, low birth weight has also been linked to adverse socio-economic factors. Low birth weight has been linked to a representation of intrauterine growth retardation. In the same study, it was shown that low birth weight infants had a higher frequency of being born to mothers with a low education level (Zeka et al, 2008).

Another predisposing factor of prematurity is poor socio-economic status (Khadiga et al, 1995). Specific markers of poor socio-economic status that have been linked with premature birth are: low education levels, high unemployment rates and high poverty levels (Messer et al, 2008). A study conducted by Jansen et al (2009) showed that a low socio-economic status, indicated by a low level of education, has been shown to have a two-fold risk of giving birth prematurely. The researcher attributes this to the fact that women who have lower education levels are usually of a lower age and have an accumulation of adverse factors (Jansen et al, 2009). Research has shown that the rate of pre-term birth is also higher in the group that was either non-cohabitating or just

cohabitating but not married (Thompson et al, 2006). Studies have shown that the more disadvantaged the household is, the higher the rate is of a single parent (Delpisheh et al, 2006). This has been shown to be due to a lack of social stability (Thompson et al, 2006).

Child under-nutrition is a huge risk factor for developmental delay in infants. It has been reported that one third of the children under the age of five years in developing countries are malnourished (Walker et al, 2007). Stunting has been shown by a UNICEF report to be at a prevalence level of 26% out of the 79 participating countries (Grantham-McGregor et al, 2007). Iodine deficiency has been shown to cause mental retardation in children. Iodine aids in central nervous system regulation and physiological processes. Iodine is the leading cause of mental retardation that is preventable (Walker et al, 2007). Anaemia is a condition of iron depletion. It is estimated that in the developing world, children younger than four years, have a prevalence rate of 46-66% of anaemia sufferers. Iron deficiency alters brain metabolism, neurotransmission, myelination, and gene profiles. Studies show that children with iron deficiency show poorer mental, motor and neurophysiological functioning than infants without anaemia (Walker et al, 2007).

In their review, Walker et al show that children who receive cognitive stimulation from caregivers have higher levels of cognitive function later on in life (Walker et al, 2007). This is a problem in poorer socio-economic areas as caregivers are out at work during the day and in the case of migrant workers, work away from home. This leads to a cycle of lack of stimulation for the child, poorer cognitive functioning and then poorer socio-economic status as the child becomes an adult.

2.9.1 Household Economic and Social Status Index

The Household Economic and Social Status Index (HESSI) is a tool that was designed to assess the socio-economic status of a family. It was designed for

use in South Africa. This index was designed due to the growing amount of research indicating what a big factor socio-economic status is on the development of children (Barbarin et al, 1997).

The HESSI asks questions regarding the following areas: maternal education level, housing type, maternal occupation, toilet type, food adequacy, utilities, durable consumer goods, and family structure. This assessment identifies who falls in the poorest category: single mothers, low schooling levels, living in households of more than six people and who are unemployed. It has shown a link to poor education levels showing the hunger cycle of children (Barbarin et al, 1997).

2.10 Conclusion

As discussed above there are many areas where pre-term infants can suffer from insults to their developing brains. These are due to the stresses that the birthing process places on their CNS at varying gestational ages. There are gaps in the literature on the role that EI has to play in the developmental outcome of pre-term infants in developing countries. There are also limited studies showing whether pre-term infants who are given therapy in developing countries reach optimal developmental levels. This opens many areas for future research. The literature that has been reviewed confirms that there is a link between prematurity and developmental delay. It shows that there can be many causative factors for this delay in the various developmental domains but that prematurity is one of the leading causes of this possible delay.

Chapter 3: METHODS

In this chapter the methods used to conduct this research will be described. Demographic information will be presented first, followed by information on the assessment tools used.

3.1 Location

This study was conducted at the Dr Yusuf Dadoo hospital government clinic in Krugersdorp, Gauteng, South Africa. Children who fell in the age range of 17-19 months were recruited for the study when the children came for their 18 month measles two; oral polio virus four; and diphtheria, tetanus and pertussis four vaccinations. Patients who attend the clinics are from various social and cultural backgrounds.

3.2 Ethical Clearance

Prior to data collection commencement, ethical clearance was obtained from the Committee for Research on Human Subjects of the University of the Witwatersrand, Clearance certificate number M080954 (See Appendix II)

3.3 Sample Selection

The data for 40 consecutive infants who fell within the corrected ages of 17 to 19 months was analysed. Informed consent was obtained for the caregivers prior to assessment. (Appendix III).

3.3.1 Inclusion Criteria

- the children were within 17-19 months of age

3.3.2 Exclusion Criteria

- Any clinically apparent abnormality

3.4 The Study Population

The data from 40 infants who matched the inclusion and exclusion criteria was analysed. The children came from the Krugersdorp area. There was however a wide range of socio-economic status represented there. For this reason the Household Economic and Social Status Index was also administered.

3.5 Assessment Tools

3.5.1 Bayley Scales of Infant Development II

This assessment tool was chosen as it is used to detect any form of developmental delay. Construct, content, and concurrent validity have all been proven as well as reliability (Tieman et al, 2005). The BSID II can be used to assess infants between the age ranges of birth to 42 months (Tieman et al, 2005).

3.5.2 Household Economic and Social Status Index

Due to the varying of the socio-economic backgrounds of the children that were assessed the Household Economic and Social Status Index (HESSI) was used. This tool was developed in Soweto, South Africa, and is therefore suitable for use on this population (Barbarin et al, 1997).

3.6 Procedure

Training on the Bayley Scales of Infant Development was provided by Dr Joanne Potterton and Mrs Nicole Hilburn who are both experienced in the use of this tool. Five children were assessed using the tool for investigator training. These results were not included in this report.

Consecutive infants between the ages of 17 and 19 months corrected age, who attended the Krugersdorp vaccination clinics were assessed in order to obtain the data analysed in this study. The infant's date of birth, gestational

age, birth weight and, if any, birth complications were obtained from the child's Road to Health Chart. The infant and caregiver were approached and given a form which explained the study and requested participation (Appendix III). Nursing staff were available if translation was required. The study was fully explained to the caregiver. The investigator ensured that the caregiver knew that there was no obligation to participate in the study and if the caregiver denied permission it would not influence the treatment that they received at the clinic.

Once written consent had been obtained, the infant and caregiver were taken into an unused room in the clinic. This ensured that there were less distractions and disruptions during the testing procedure. The infant was first evaluated on the Motor Scale and then the Mental Scale. The infants were all assessed by the same examiner in order to standardise the procedure. The same room was used throughout the data collecting period to ensure that a standard was maintained for all test subjects.

The child was seated at a child-sized table and chair. There was a set of rehabilitation steps in the room to allow for aspects of the motor section of the BSID II to be standardised for each child. The test was started at the child's corrected age once the prematurity had been taken into account if necessary. The examiner moved back to a younger subset age only if the child obtained less than five credits within their specific age subset.

The HESSI was then done with the caregiver after the developmental test was conducted in order to decrease the risk of bias while testing took place (Appendix VII). The caregiver filled in the form independently if English was a known language for the caregiver. Help was given only if needed. The help was given by the examiner and the same nurse throughout the data collecting period to ensure standardisation of the procedure. This

information was used to obtain the caregiver's education level, housing type and safety of living area.

The data that was collected from 40 infants were then analysed as follows: The raw score was calculated from the assessment form. The Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) were calculated from the BSID II assessment book (Bayley, 1993). The HESSI information was used to ascertain any socioeconomic differences between the pre-term and the full-term group.

3.7 Statistical Analysis

A sample size of twenty children in each group was needed. This was calculated according to the Bayley Scales of Infant Development II by using a standard deviation of 15% and has a 90% power to detect a difference at the 0.05 level of significance.

Continuous data such as the BSID II test scores were summarized using mean, standard deviation, median range and 95% confidence intervals. The discrete data from the HESSI test scores were summarized in frequencies, percentages and cross-tables. Groups were compared with respect to mean BSID test score using student's two sample t-tests. Groups were compared with respect to their socio-economic data by using the Pearson's chi-square test. All testing was done at a 0.05 level of significance.

The results of this study will be presented in the following chapter.

Chapter 4: Results

In chapter four the results of the study will be presented. The data from 40 subjects were analysed.

4.1 Gestational Age

Table 4.1 Gestational age of subjects

Gestational age in weeks	Number of infants
30	2
31	2
32	1
33	0
34	1
35	6
36	8
37	4
38	7
39	6
40	2
41	1

Gestational age of the sample ranged from 30 weeks to that of 41 weeks (see table 4.1). The mean in the full-term group was 38.5 weeks (±1.1). The mean in the pre-term group was 34.3 weeks (±2.2).

4.2 Demographic Information

Table 4.2 Demographic Information

	Pre-term group	Full-term group
Male	10	13
Female	10	7
African	15	13
Indian	0	2
Coloured	1	1
White	4	4

The demographic details will be provided in the form of a table. In the gender section, the pre-term group had an even distribution between male and female. In the full-term group there were 13 males and seven females who were assessed. In the race section, there were predominately African children in both groups with very little spread between the Indian, Coloured and White section.

4.3 Birth Weight

Table 4.3 Birth weight

	Pre-term group Mean	Full-term group Mean
Birth weight (Kg)	2.2 (±0.78)	3.5 (±0.46)

Table 4.3 shows the mean values for the birth weight category. The full-term group had a mean birth weight of 3.5kg while the pre-term group came in at a mean value of 2.2kg.

4.4 Socioeconomic background

The Household Economic and Social Status Index (HESSI) questionnaire was used to obtain information related to the socioeconomic status of the participating infants (Appendix VII) (Barbarin O, 1997).

The areas that were determined were as follows: maternal marital status, number of adults living in the household, number of children living in the household, maternal educational level, house type, type of toilet, whether the child has gone hungry before and safety of living area.

4.4.1 Marital Status

Table 4.4 Marital Status of full-term and pre-term infants' mothers

	Full-term	Pre-term	p-value
Marital Status			0.77
Never married	3	3	
Married – not living with partner	1	0	
Widowed	5	4	
Never married – Living with partner	2	5	
Married living with partner	9	8	

Results for this section have been presented in tables 4.4. The p value was 0.77 showing no significance. The average result for both groups is that of the mother being married and living with their partner.

4.4.2 Number of Adults living in the Household

Table 4.5 Number of adults living in the household

	Full-term	Pre-term	p-value
Number of adults			1.0
1 adult	4	4	
2 adults	13	13	
3 adults	2	3	
4 adults	1	0	

This data group showed a p-value of one, showing no significance. The most frequent result for both groups is two adults living in the house with the child.

4.4.3 Number of Children living in Household

Table 4.6 Number of children living in the household

	Full-term	Pre-term	p-value
Number of children			0.91
1	10	8	
2	7	9	
3	3	3	

This data series was also shown to be non-significant with a p-value of 0.91. The most frequent result for the full-term group is that of one child living in the household. The most frequent result for the pre-term group is that of 2 children living in the household.

4.4.4 Maternal Education Level

Table 4.7 Maternal Education Level of Full-term and Pre-term group

	Full-term	Pre-term	p-value
Maternal Education Level			0.15
Less than Std 3	0	2	
Std 3-4	1	3	
Std 5-7	2	4	
Std 8-9	4	2	
Matric	10	7	
1-2 years College or Technikon	3	0	
3-4 years University	0	2	

This data series showed a p-value of 0.15, which is not significant. The most frequent result for both the pre-term and the full-term group is that of a matric education for the mother.

4.4.5 Housing Type

Table 4.8 Full-term and Pre-term Housing Type

	Full-term	Pre-term	p-value
Housing Type			0.38
Shack	2	7	
Hostel	1	1	
Room	3	1	
Flat	2	1	
Shared Home	1	0	
Own Home	11	10	

This data series showed a p-value of 0.38 when the two groups were compared. This is a value of no significance. The most frequent result for both the pre-term and the full-term group is that of a home that is not shared by other families.

4.4.6 Type of Toilet

Table 4.9 Toilet Type

	Full-term	Pre-term	p-value
Toilet Type			0.08
Pit	2	8	
Outside Flush	6	3	
Inside Flush	12	9	

The data series comprising the type of toilet that each infant has at their place of residence is of marginal significance. The data series showed a p-value = 0.08. The most frequent result for both groups showed an inside flush toilet.

4.4.7 Has the child gone hungry before?

Table 4.10 Has the child ever gone hungry?

	Full-term	Pre-term	p-value
Has the child ever gone hungry			0.25
No, never	15	10	
Rarely	2	6	
Often	3	3	
All the time	0	1	

This data series addressed the question of whether the child in question had ever gone hungry before. There was no significant difference between the groups (p-value=0.25). The most frequent result for both the pre-term and the full-term group is that of the child has never gone hungry before.

4.4.8 Safety of Living area

Table 4.11 Safety of Living Area of Full-term and Pre-term group

	Full-term	Pre-term	p-value
Safety of living area			0.5
Extremely dangerous	1	3	
Dangerous	2	4	
Safe	12	8	
Extremely safe	5	5	

This data series addressed whether the parent or guardian considered the living area safe in which they lived. There was no significant difference between the groups. The p-value= 0.5. The most frequent result is that of both the pre-term and full-term groups reporting that they live in safe areas with their children.

The overall comparison of the socioeconomic status between the two groups shows that there was no significant difference between the two groups. This demonstrates that the groups are well-matched for this aspect of the study.

4.5 Mental Developmental Index

This section of the results will document the scores obtained for the Mental Developmental Index (MDI) portion of the test. This score shows the cognitive development of the child based on the Bayley Scales of Infant Development II (BSID II). The MDI is a score that documents the child's performance on the cognitive aspect of the BSID II. The norm for the test is 100 with a standard deviation of 15. The mean MDI for the full-term group was 105.25 with a standard deviation of 18.8. The pre-term MDI mean was 81.9 with a standard deviation of 10.2. Hotelling tests of the scores showed a significance of $p<0.001$. This shows that pre-term children have significant cognitive delay when compared to their term counterparts. The MDI results are shown in figures 4.1 and 4.2.

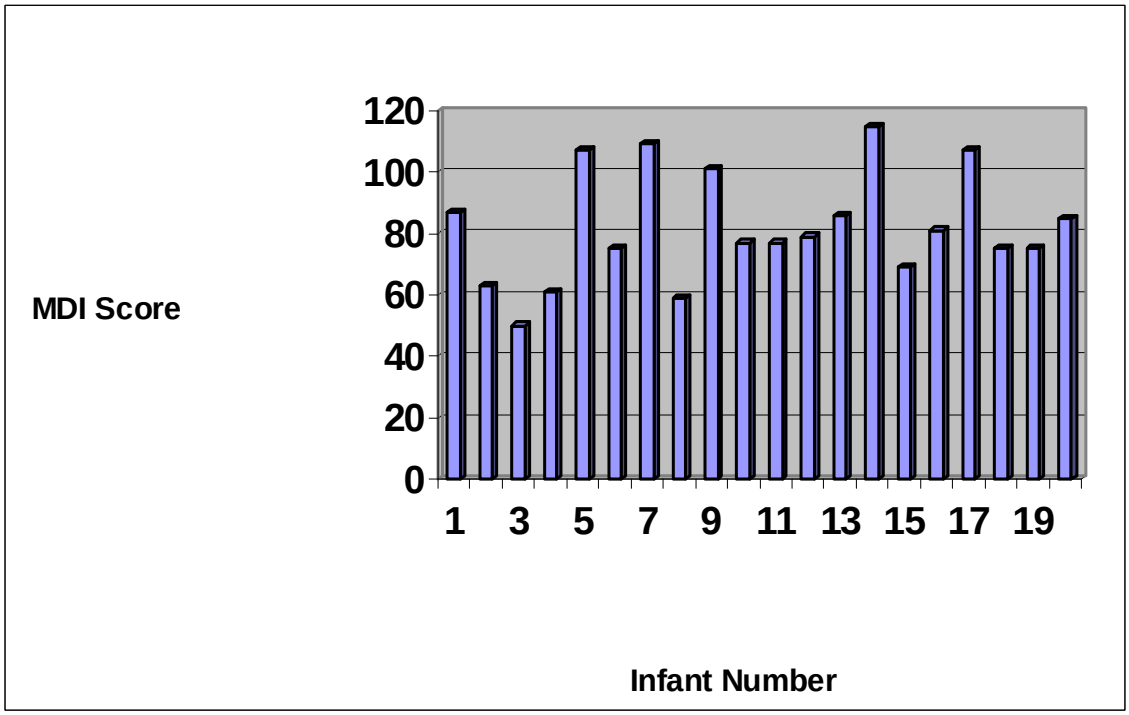

Figure 4.1 Full-term MDI Results

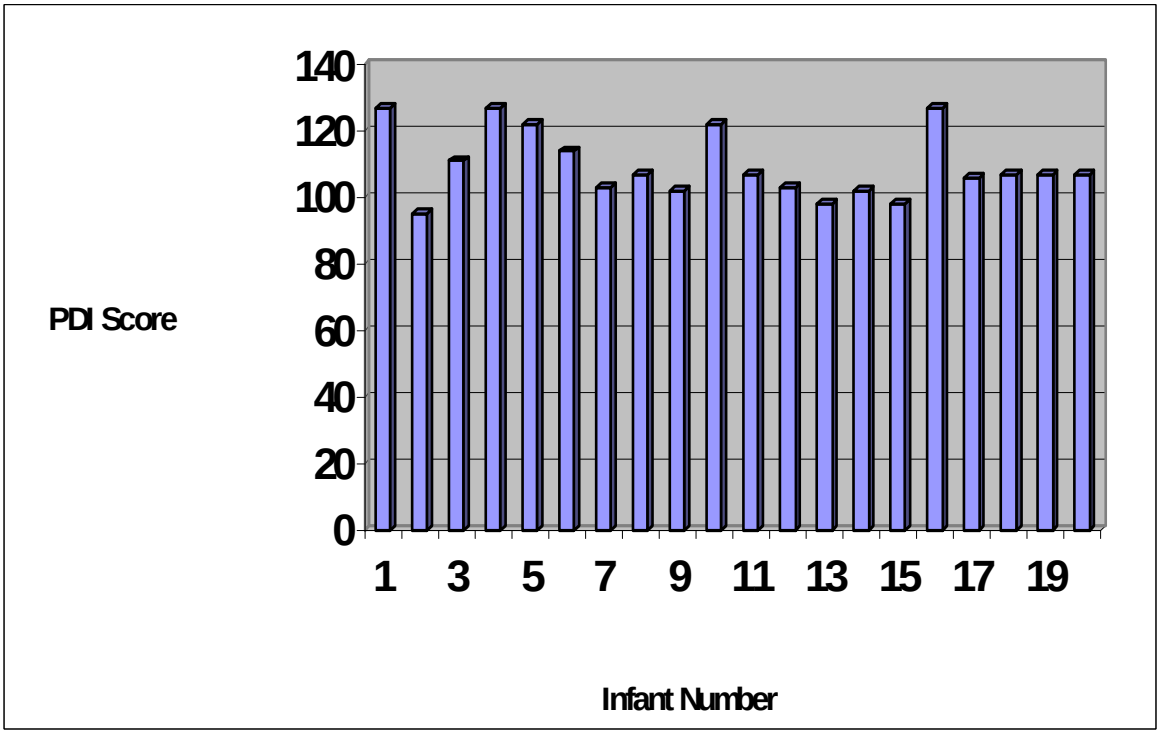

Figure 4.2 Pre-term Group MDI Results

MDI results were calculated from the raw score obtained by the infant on the Mental Scale of the BSID II. This was done by using Appendix A in the BSID II Manual (Bayley, 1993). The differences between the group scores can be found in table 4.3. The scores correlate to categories placing each child in a group based on their obtained score. The categories are as follows: Accelerated performance of a score of 115 or above; within normal limits is classed as a score ranging between 85 – 114; mildly delayed performance of a score range of 70 – 84; and significantly delayed performance with a score of below 69. As is shown there is a wide range of scores amongst the children in both groups. This can be accounted for by the various factors that affect development as will be discussed in chapter five.

Table 4.12 MDI categories

	Pre-term group	Full-term group
Accelerated performance	1	8
Within normal limits	7	7
Mildly delayed performance	7	5
Significantly delayed performance	5	0

4.6 Psychomotor Developmental Index

This section of the results will document the scores obtained for the Psychomotor Developmental Index (PDI) portion of the test. This score shows the gross and fine motor development of the child based on the Bayley Scales of Infant Development II (BSID II). The norm for the test is 100 with a standard deviation of 15. The mean PDI for the full-term group was 109.6 with a standard deviation of 10.2. The pre-term PDI mean was 86.8 with a standard deviation of 14.8. Hotelling tests of the scores showed a significance of $p<0.001$. This shows that pre-term children are significantly delayed in their motor development when compared to their term counterparts.

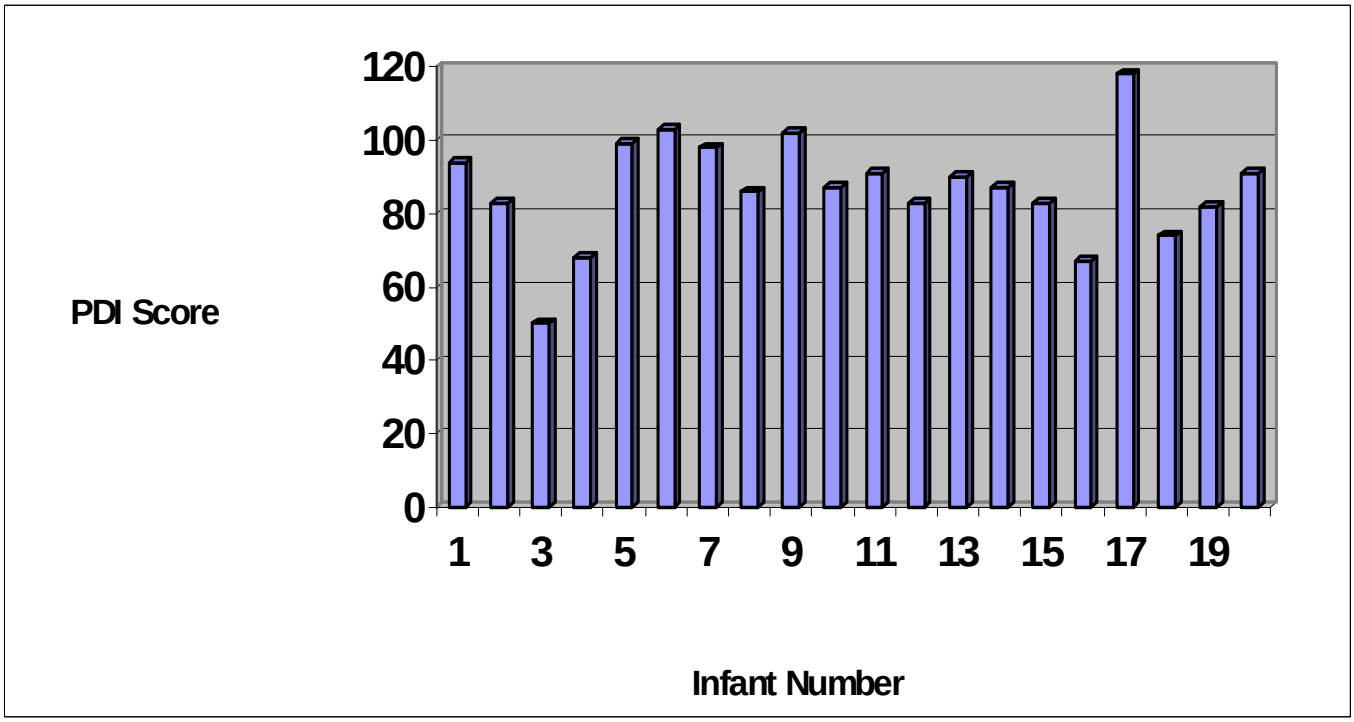

Figure 4.3 Full-term PDI Results

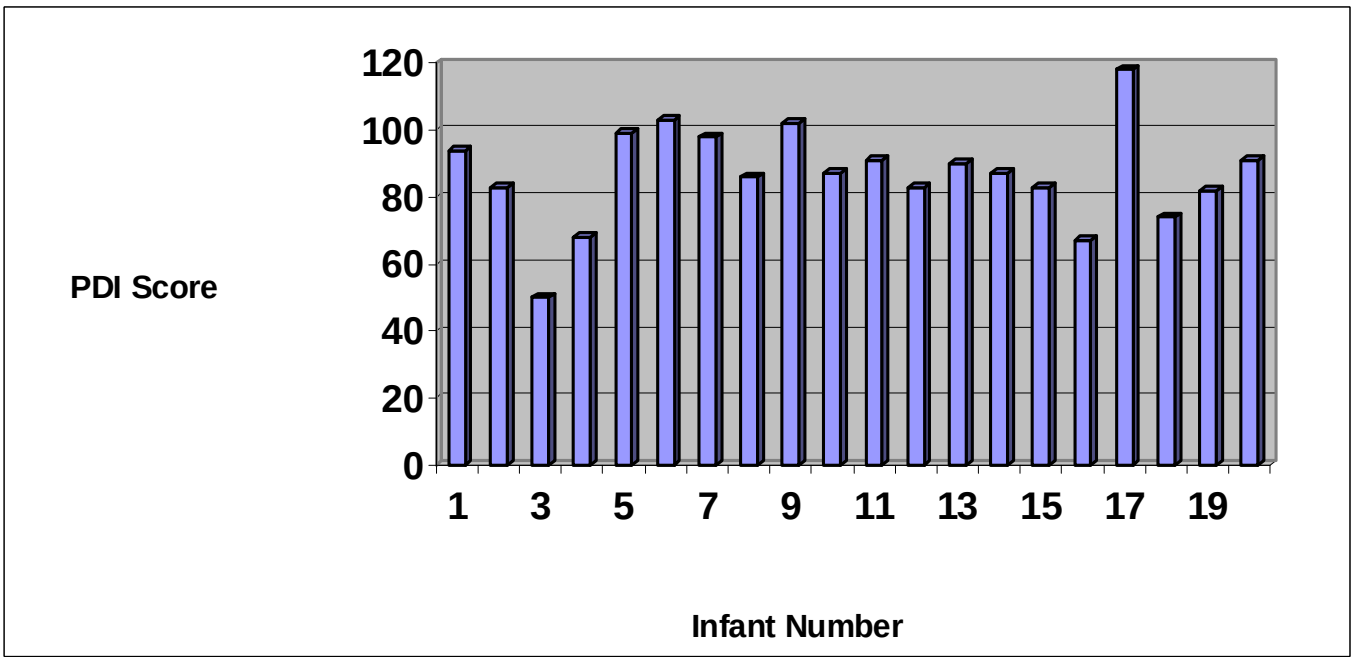

Figure 4.4 Pre-term PDI Results

PDI results were calculated from the raw score obtained by the infant on the Motor Scale of the BSID II. This was done by using Appendix A in the BSID II Manual (Bayley, 1993). The scores correlate to categories placing each child in a group based on their obtained score. The categories are as follows: Accelerated performance of a score of 115 or above; within normal limits is classed as a score ranging between 85 – 114; mildly delayed performance of a score range of 70 – 84; and Significantly delayed performance with a score of below 69. Results can be found in table 4.4. As is shown in figures 4.3 and 4.4, there is a wide range of scores amongst the children in both groups. This can be accounted for by the various factors that affect development as will be discussed in chapter five.

Table 4.13 PDI categories

	Pre-term group	Full-term group
Accelerated performance	1	5
Within normal limits	11	15
Mildly delayed performance	5	0
Significantly delayed performance	3	0

4.7 Conclusion

These results show that the sample of children obtained for this study were well-matched for socioeconomic and demographic variables but the pre-term group still showed significantly lower scores in both the MDI and the PDI portions of the BSID II assessment. This shows that at 18 months pre-term infants are at risk of suffering from developmental delay in comparison with their full-term counter-parts.

Chapter 5: DISCUSSION

In this chapter, the results that were obtained in this study will be discussed. The results will be compared to those recorded in previous studies. The implications and limitations of this study will be highlighted and recommendations will be made.

5.1 Effects of Prematurity on Development

5.1.1 Effects of prematurity on motor development

It was shown in this study that pre-term infants were delayed in the motor development domain. The pre-term group had a mean PDI of 86.8, (± 14.8), as opposed to the full-term group showing a mean PDI of 109.6, (±10.2). This was a statistically significant result ($p<0.001$). In the pre-term group 40% of the infants were delayed in the motor domain and 15% of the sample group were significantly delayed. The full-term group showed zero infants who had any form of motor developmental delay.

In a study conducted by Vohr et al, 2000, it was found that 57% of the pre-term group scored below the average range on the Psychomotor Index of the BSID II at 18 months. This is in line with the current study, except that the Vohr et al study included infants with major disabilities whilst the current study did not. The mean gestational age in the Vohr et al study was 26 weeks (±2). This is much lower than the current study of 34.3 weeks (±2.2). When this study is compared to a study conducted in the United Kingdom in the same year shows similar trends. The study also used the BSID II as the evaluation tool. A difference is that the study assessed children at a median age of 30 months. The mean gestational age was 25 weeks. The study also showed that there is a great prevelance of prematurity amongst children born prematurely (Wood et al, 2000). These results shows how there are definite lags in developing countries when neurodevelopment outcome of pre-term infants is looked at. With the gestational ages being lower than the current study's, it reinforces this fact. The

current study excluded children with significant disabilities as the investigator was interested in children with no previous history or diagnosis of developmental problems.

A study conducted in Austria looked at the effect of gestational age on neurodevelopmental status. In the less than 30 weeks group the mean age was 27.5 (±1.4). There were 116 infants in this group. The children were assessed using the BSID II at 12 months. In the group of 30 – 32 weeks gestational age the mean age was 30.5 (±05). There were 134 infants in this group. A total of 26.8% had a PDI of <85 indicating delayed development and 8.3% showing a PDI of <70 indicating severely delayed development. The median PDI in the lower gestational age group was 89 and in the higher gestational age group was 90. This is not a large difference between the two groups and between the current study's PDI of 86.8 (±14.8). The Austrian study showed a rate of 30.2% of their sample size suffering from developmental delay and the current study had a rate of 15%. The difference could be attributed to the difference in sample size or the precocious development of African infants as mentioned in chapter two as well as that the study having a sample size of lower gestational ages (Kiechl-Kohlendorfer et al, 2009).

An Australian study conducted in 1998, investigated whether pre-term infants suffered any fine motor delays. The Peabody Developmental Fine Motor Scale was used. Eighty-three children were included in the study with a mean gestational age of 28.5 weeks (±1.5). Sixty–five percent of the sample size displayed some degree of fine motor delay. The BSID II is unable to distinguish between gross and fine motor development. For this reason the current study cannot give the individualized scores for each domain. The delay in gross motor development in the current study was at 40% of the pre-term sample size. The mean gestational age of the current study was also higher than this Australian study (Goyen et al, 1998).

5.1.2 Effects of prematurity on cognitive development

The results of this study show that cognitive development in the pre-term group was delayed when compared with the full-term group. The mean MDI for the pre-term group was 81.9 (± 10.2), as opposed to 105.25 (±18.8), in the full-term group. This is statistically significant ($p<0.001$). The results show that 65% of the pre-term group had some form of cognitive delay, with 25% of the pre-term group showing significant delay. In the full-term group there were 25% showing a developmental delay.

Pre-term birth is defined is a gestation of less than 37 weeks (Swamy et al, 2008). Infants that are born prematurely have been shown to have an increased likelihood of suffering some form of cognitive delay (Foulder-Hughes et al, 2003; Khadia et al, 1995; Ozbec et al, 2005; Allen, 2008; Schirmer et al, 2006; Johnson, 2007; Anderson et al, 2008; Briscoe et al, 1998). This study also showed a risk of delayed cognitive outcome due to prematurity. Degree of delay has also been linked to lower gestational age of the infant. The earlier the delivery the greater the risk of cognitive delay as well as the greater the degree of delay (Gutbrod et al, 2000; Foulder-Hughes et al, 2003; Eichenwald and Stark, 2008; Allen, 2008). Studies have shown that there is an increased risk up to five years of age with late pre-term children being border-line for school readiness (Morse et al, 2009). Very young infants are referred for further treatment to larger hospitals. They are then referred back for follow-up to a clinic closer to their homes. Smaller hospitals, such as Dr Yusuf Dadoo, do not offer these follow-up services.

In this study the average gestational age of the pre-term group was 34.3 weeks gestation. This is higher than the average age in the articles for severe developmental problems that have been experienced. In a study conducted in Soweto the mean gestational age was 30 weeks (Cooper and Sandler, 1997). In a study conducted in Bangladesh the mean gestational age was 31.2 weeks (Khan et al, 2006). Then moving onto developed countries in a study conducted

by Wood et al (2000), their mean gestational age was 25 weeks (Wood et al, 2000). This shows a discrepancy between developed and developing countries. The developed countries pre-term infants show severe disability with gestational ages below 30 weeks while developing countries show the same result with ages above 30 weeks. This implies a difference in management of these pre-term infants. There are better equipped NICU facilities in first world countries and therefore very premature infants have a greater survival rate.

The youngest gestational age in this study was that of 30 weeks as the infants younger than this did not meet the inclusion criteria of the study. There were four children excluded from the study as they were displaying neurological fallout. Their gestational ages were 28, 29, 27 and 28 weeks. Studies have shown that infants born below 32 weeks gestational age have a greater risk of cerebral palsy (Anderson et al, 2008; Wood et al, 2000; Fawke, 2007; Oda et al, 2008). Studies have shown that infants born below this age have a greater risk of disability (Fawke, 2007; Bauer et al, 2009, Dubowitz et al, 1985, Oda et al, 2008, Badr and Purdey, 2006). This may explain the lack of infants younger than 30 weeks in this study. They may not have met the inclusion criteria as there may have been a disability present that was excluding them. The children that were excluded were immediately referred on for therapy.

There are various factors that could explain this result in this pre-term group:
1) The corpus callosum is the main inter-hemispheric commisure of the brain. It consists of approximately 180 million fibres. These fibres integrate the activities of the two hemispheres by transferring sensory and higher processed information to allow for transferral to the opposite hemisphere. MRI scans in pre-term infants show a thinning or anomalies of the corpus callosum. This has been shown to be most prominent in the posterior region. The corpus callosum growth rate is associated with poorer outcomes as the gestational age decreases. This problem has been shown to occur with infants born prior to 33

weeks gestational age. Research has shown that problems arising from this can persist into adolescence (Narberhaus et al, 2007).

2) The mean gestational age in this study was 34 weeks. At this stage of the central nervous system development the following are very active processes: dendritic formations, synaptic formations and Glial cell proliferation (de Graaf-Peters and Hadders-Algra, 2006; Girarda et al, 2007). Disruptions in these processes could cause delayed formation in any of the above. This could be a cause behind the cognitive delay that was noted.

3) A second factor that can occur is due to a periventricular leukomalacia (PVL). It primarily affects the regions around the lateral ventricles in the peritrigonal area, and is characterized by gliosis in the white matter and tissue loss with secondary ventricular dilatation (Pavlova et al, 2009). This is said to be the most common cause of spastic diplegia, which is a cerebral palsy (CP) subgroup. According to Fawke, 2007, spastic diplegia is a type of CP that is seen most common with pre-term infants. Spastic diplegia is said to be caused by an injury to the internal capsule in the brain. The fibres that supply the upper limbs are carried in this area and are more prone to hypoxic ischaemia, which is PVL as discussed already (Fawke, 2007; Bauer et al, 2009, Dubowitz et al, 1985, Oda et al, 2008). The incidence of PVL is said to be between 5% - 25% and risk decreases with an increasing gestational age (Badr and Purdey, 2006). No children were noted to have spastic diplegia.

4) Periventricular haemorrhage (PVH) and Intraventricular haemorrhage (IVH) are other factors that could be a cause of the cognitive delay. A PVH is described as a grade four germinal matrix haemorrhage. With both, the pathologies begin as a small rupture of the capillaries. In PVH, bleeding is limited to the subendymal germinal matrix. With IVH the bleeding extends into the ventricles. These lesions most often occur during weeks 24 and 28 of gestation as this is when the germinal matrix is at its highest developmental

stage. They have been associated with various forms of CP, such as hemiparesis and quadriplegia (Badr and Purdey, 2006; Fawke, 2007; Roze et al, 2008).

5) Another factor could be due to the poor socioeconomic backgrounds of the population group. Many of these children from both groups came from families were the mother or primary caregiver has to work to earn an income for the family. Often these children are left with older siblings all day without any stimulation. Studies have shown that without early childhood cognitive stimulation the cognitive ability of the child is decreased (Walker et al, 2007). An aspect noted while conducting the Mental Assessment on the children showed that the poorer the socioeconomic background of the child the less the ability of the child to perform the puzzle section of the tests. Many of the tasks in the BSID II are problem-solving based, and therefore, because the task is brand new, the infant does not have the skills to solve the problem. The effect of socioeconomic background on development is discussed in greater detail later on.

6) Another factor that has been looked into for poorer scores in developmental tests is that of inattention and poorer concentration in pre-term infants due to many suffering from ADHD. This has been said to have impacted on results both in the motor and cognitive section of testing (Foulder-Hughes and Cooke, 2003).

5.1.3 Effect of prematurity on language development

This study showed a significant difference between the two groups for the mental portion of the test. The results of which were discussed under the cognitive development section of the discussion. In the Mental portion of the entire test there are 54 items that assess language skills. Of that there were 17 language items in the 17 – 19 month age category. The BSID II is unable to discriminate between expressive and receptive language.

Language development overlaps with both the cognitive and the motor aspects of development. Motor plays a role in the oral motor control (Alcock, 2006). If a child shows a cognitive delay it has been reported that the possibility of a language deficit is higher (Ortiz-Mantilla et al, 2008). Studies have shown that pre-term children have significant and consistent differences in expressive and receptive language abilities on a number of different measures (Ortiz-Mantilla et al, 2008). The same study showed how pre-term children were less efficient on both visual and auditory tasks. It was shown that the child's socio-economic status has an effect on language development (Ortiz-Mantilla et al, 2008). This aspect will be discussed under the socio-economic section.

Language development is often considered a good sign of cognitive development in pre-term children. The lag has been shown to be significant between pre-term and full-term children with both receptive and expressive language. Studies have shown that there is an increase in words vocalized has a linear relationship to that of in gestational age (Marston et al, 2007).

A study conducted in New Jersey, United States, investigated the language outcomes in premature infants. The mean gestational age was 26.9 (±2.71). This is much lower than the current study. The Preschool Language scale test was administered to assess receptive and expressive language in children between the ages of birth to six years. They recorded significant and consistent differences between the two groups in both expressive and receptive language abilities. This is in line with the current study which also showed decreased cognitive scores. The Mental subscale of the BSID II included language items and can not differentiate between receptive and expressive language (Ortiz-Mantilla et al, 2008).

A study was done to investigate the impact of premature birth on reading and spelling abilities at eight years of age. The mean gestational age was 28

weeks. The Peabody Picture Vocabulary Test was used for this study. 38.1% of the sample size scored lower than the 25th percentile in the academic test. It was stated that 46% of the sample size had had some from of therapeutic intervention prior to the study. This is a study limitation as it does not reflect a true result between prematurity and the language delay. It does however highlight that even with therapy these children are still at some form of risk of delay (Wocaldo and Rieger, 2007).

5.2 Effect of Socioeconomic Status on Prematurity

The results of this study did not show any significant differences between the two groups with regard to socioeconomic status. This result illustrates that the groups were well-matched in that regard. This strengthens the result that pre-term infants are at a greater risk of developmental delay.

Sub-Saharan Africa has the highest number of disadvantaged children under the age of five in the world. This figure is 61%. It has been shown that disadvantaged children who do not reach their full potential will in turn become less productive adults. This in turn leads to a further perpetuation of the disadvantage cycle in future generations. This occurs by the fact that there are usually less years of schooling. This is caused by stunting and poverty. Stunting, causes health problems as the child does not develop in the normal manner and this decreases the child's attendance due to poor health. Poverty causes less school year attendance due to the fact that many of these disadvantaged families are child-headed households and finances are a problem to keep the child in an educational environment (Grantham-McGregor et al, 2007).

A higher family income has been associated with a more cognitively stimulating home environment and less maternal emotional stress which are both associated with higher cognitive outcomes (Linver and Brooks-Gunn, 2002). The more cognitively stimulating home environment bringing about a higher

cognitive outcome was reported by Walker et al, 2007, if done early on in life. In a study conducted in South Africa, it was reported that positive verbal stimulation techniques taught to mothers from low socioeconomic families, improved their child's cognitive scores in as little as a ten week intervention. These results remained improved at the one year follow-up as well. (Walker et al, 2007).

One aspect that this study did not take into account was that of human immunodeficiency virus (HIV) infection and its possible impact on the children's developmental status. The HIV status of the children was not known and it was not considered ethical to ask the caregiver, nor to require that all the children undergo testing for the purposes of this study. In December 2007, it was estimated that there were 2.5 million (range 2.2 – 2.6 million) children under the age of 15 years living with HIV globally. Of these, 90% of the HIV-positive children live in sub-Saharan Africa (UNAIDS Aids epidemic update, 2007). Studies have shown that HIV infection in children causes developmental delay (Foster et al, 2006; van Rie et al, 2008; Willen, 2006; Bailieu and Potterton, 2008; Potterton et al, 2009). This developmental delay ranges throughout the domains assessed in this study. It is said to affect the CNS due to the fact that it crosses the blood-brain barrier. This allows the HI- Virus to cause neurological damage. According to AVERT, which is an international AIDS charity there are 10.2% of the estimated population living with HIV that are between the ages of 2 and 4 years (AVERT, Accessed 07/08/2009).

5.3 Developmental Intervention

The children in this study have never received any form of developmental intervention or follow-up. Studies have shown that pre-term infants that receive intervention and follow-up are at a smaller risk for developmental delay (Kalia et al, 2009; Bonnier, 2008). The Kalia et al study, (2009), had a sample size of 127 infants and used EI as the form of intervention. It showed that pre-term infants should receive EI for the first year of life to improve developmental

outcome. The evaluation in this study included BSID II for major milestone assessment but the results of which are not given (Kalia et al, 2009).

The referral of a child for therapeutic intervention at the earliest sign of developmental delay is critical to maximize the benefits. Early therapy can improve a child's development and function and can prevent further delay from occurring. Early therapy can prevent deformity and encourage normal motor patterns (Edwards and Sarwark, 2005).

On the other side of the debate a study conducted by Cameron et al, (2005), shows no significant difference in infants who received intervention as those who did not. The mean gestational age in the intervention group was 29.6 weeks and had a sample size of 28 infants. The Alberta Infant Motor Screener assessment tool was used. This assessment is only scored on items observed during the testing period. It highlighted the need for further research in EI studies (Cameron et al, 2005).

5.4 Age

The age range of the subjects in this study is 17 – 19 months of age. The pre-term group had the test done using the corrected age and not the actual age. There have been other studies done at the same age range (Sonnander and Claesson, 1999; Goyen et al, 2002; Vohr et al, 2005; Stoelhorst et al, 2003). At this age the majority of the motor developmental milestones have been obtained. From this age onwards there is just refinement of the quality of movement (Edwards and Sarwark, 2005). The nature of this study was a once-off assessment format. This age range showed a statistical significance for pre-term children being at a risk for developmental delay both in the PDI and MDI sections.

5.5 Skill most adversely affected

Cognitive delay was the skill most adversely affected in the pre-term group in this study, which is in agreement with previous studies (Johnson, 2007; Anderson et al, 2008; Ortiz-Mantilla, 2008; Morse et al, 2009; Allen, 2008; Khan et al, 2006; Wood et al, 2000; Fawke, 2007; Gibson, 2007; Khadiga et al, 1995). The mean MDI for the pre-term group was 81.9 (±10.2) which falls into the mild delay classification range of the BSID II. As discussed above this could be attributed to the disruption in the normal central nervous system development.

The Anderson et al study conducted in 2008, looked at 30 month old children born prior to 26 weeks. The result showed a mean PDI of 87 and a mean MDI of 84, both giving results of significant delay. This study used an older sample size but it was much larger including 283 children whereas the current study only had a sample size of 40. The gestational age was also much lower than the current study's. It was carried out in the United States (Anderson et al, 2008). This is in contrast to the Khan et al study conducted in 2006 in Bangladesh. The mean gestational age was 31.2(±1.4). They assessed 85 pre-term children of 31 months of age. Their results showed 23% severely delayed in the MDI section and 21% severely delayed in the PDI section (Khan et al, 2006).

5.6 Bayley Scales of Infant Development II

The Bayley Scales of Infant Development (BSID II) is an individually administered standardised assessment tool that can be used to assess a child's current developmental status. The main aims of the BSID II are to diagnose any developmental delay. It can also be used in order to plan therapy sessions and to assess any progress that a child is making in their development. Another major use of the BSID II is that of research purposes (Bayley, 1993). This test has been stated as being the most widely used

assessment tool to measure infant cognitive and motor development (Harris et al, 2005).

In this study, the BSID II was used on a group of infants who suspected of being delayed, and the results confirm that they are delayed in cognitive, language and motor development. The BSID II is a sensitive, valid and reliable developmental assessment tool, and therefore was the most appropriate tool to employ in order to look at motor and mental development.

The BSID II has been successfully used in South Africa on a similar population group (Baillieu and Potterton; 2008; Cooper and Sandler, 1997). This made this choice of assessment tool a valid choice for this study.

The testing items of the BSID II were easy to administer. The children responded well to the test items. The language barrier was a problem with some of the children. This was overcome by having a Setswana speaking nursing sister to translate for the investigator if needed.

5.7 Household Economic and Social Status Index

The Household Economic and Social Status Index (HESSI), is an assessment tool used to assess socio-economic of a family. It is a tool that has been designed in South African on a similar population as that of the current study. This makes the HESSI an adequate tool for use in this study (Barbarin and Khomo, 1997).

Although the full questionnaire was administered only the most relevant questions were analysed descriptively. The questionnaire was not shortened as the fact that the investigator thought it best to administer it in its full capacity which had already been validated in South Africa. Those areas were: maternal marital status, number of adults living in the household, number of children living in the household, maternal educational level, house type, type of toilet,

whether the child has gone hungry before and safety of living area. Out of these parameters there was no significant difference found between the pre-term and the full-term groups when compared. This finding indicated that the delay that was evident in the pre-term group was not due to any of the socio-economic factors assessed. The various factors that were noted will be discussed later on in this chapter.

5.8 Limitations of the study

- Language barriers could affect some of the items and the child's understanding of what is being asked of them.
- The BSID II is not primarily a language assessment tool, and therefore it is not possible to assess the differences in receptive and expressive language.
- No neonatal records were available so there was no indication of any lesions sustained such as PVL.
- No heights were recorded so the level of stunting could not be recorded.
- There were no extremely pre-term infants in this study.
- Not all items of the HESSI were relevant. A shortened version of the tool should be developed and tested.
- HIV status of the children was not known.

5.9 Implications of the findings

The results of this study indicate that pre-term infants are delayed in at least three area of development: cognitive, language and motor. This indicates a need for early developmental assessment in this population. In the clinic where the data was collected there is no involvement of allied health professionals nor a screening programme for these children. These results indicate that physiotherapists as well as occupational and speech and language therapists should also be involved in order to facilitate motor and cognitive development in these infants. Due to the poor socioeconomic situations of many of the infants, parents cannot be expected to provide cognitively stimulating homes for these

children due to financial and educational constraints, and therefore they need support in this area.

5.10 Recommendations based on the study

- Infants born pre-term are known to be at risk for delay in cognitive, language and motor development and should therefore be screened early for signs of delay.
- Therapists, including educational psychologists, should be involved in neonatal follow-up clinics that these children should attend in order to provide assistance and education to the parents in gross motor, language and cognitive development. This indicates a need for government policy change, as at present there is no staffing requirement for allied health professional in these clinics. This indicates a lack of awareness in this regard.
- Simple home programmes could be effective in this population in making parents more aware of which milestone their infants should be reaching and assisting them in reaching them.

5.11 Recommendations in terms of future research

- A prospective study would be useful to determine the progression of the delay in a sample similar to this in a South African context.

Chapter 6: CONCLUSION

The purpose of this study was to examine motor, mental and language development in 20 pre-term infants at the age of 18 months and compare that information to that of 20 term counterparts. All subjects were from similar socioeconomic backgrounds, and attend the Dr Yusuf Dadoo Hospital government clinic in Krugersdorp. The factor of poor socioeconomic status encountered by this study population is also a factor. The assessment tools used were the motor and mental assessments of the Bayley Scales of Infant Development II and the Household Economic and Social Status Index.

The findings of this study support previous research which has shown that children born pre-term have significant delays in cognitive and motor development. In addition, cognitive outcomes are the highest delay found in pre-term children. Cognitive delay can be linked to disruption in the central nervous development brought on by the early labour as well as any other insults that could have been sustained. Problems with language delay have been linked to the delayed development in the overall cognitive area. One of the indications for poor motor development has been linked to the problem of positioning these infants in the neonatal intensive care incubators for extended periods of time. Other risk factors include the brain damage to which premature infants are susceptible as well as possible socio-economic factors.

These findings are in keeping with studies done in other parts of the world. Therefore, this indicates that developmental delay in pre-term infants is a global problem and early developmental assessment and intervention based on the results is of utmost importance in the management of these children. The results of this study are important for therapists, particularly those involved in paediatric rehabilitation, as an awareness of the potential problems in these children is needed for the best management possible to allow these children reach their full potential in life.

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APPENDIX I: Research Proposal

Developmental differences amongst pre-term and full-term 18 month olds.

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Introduction and rationale for the study:

As the medical world advances, there is an ever increasing survival rate of children that are born prematurely and of a low birth weight. For this reason more and more research is being done to investigate the consequences of being born pre-term and underweight.

Prematurity is defined as an infant being born prior to 37 weeks of gestational age (Swamy et al, 2008). Birth weight categories are defined as: low birth weight (LBW) of between 2500g and 1500g; very low birth weight (VLBW) as between 1500g and 1000g and lastly extremely low birth weight (ELBW) of less than 1000g. (Eichenwald and Stark, 2008).Research has shown that children who are born prematurely may show signs of developmental delay later on in life (Johnson et al; 2007). Motor development has been shown to be more affected by prematurity than any other condition (Goyen and Lui, 2002).

It has been shown that developmental outcome is related to gestational age. For example, infants born within the 22 – 26 week gestation period had a higher rate of neonatal morbidity and neurodevelopmental delay at 18 months than that of 27-37 week gestational age infants (Vohr et al, 2005). Children born at less than 26 weeks gestational age have been shown to suffer from Grade III/IV intraventricular

hemorrhage and periventricular leukomalacia which may result in cerebral palsy (Anderson and Doyle, 2008).

Infants that are born prematurely are also usually small for gestational age (SGA) and have also been shown to be at a higher risk of developmental delay (Slykerman et al; 2007). These children need to be followed-up later on in their developing life to optimize the development in all areas and ensure that appropriate milestone achievement is being obtained.

In developing countries such as South Africa, prematurity is estimated to be at 25% of all live births as opposed to developed countries at 5 % of all live births (Steer P; 2005). It has been shown that there is a greater prevalence of pre-term males than that of females which is due to the fact that most male children are born with a smaller birth weight than that of females (Di Renzo et al, 2007). Hediger et al (2002) also found that pre-term males had a delayed motor and social development when assessed.

There is no specific cause of prematurity. It has been reported that infection is the greatest cause of pre-term labour; these infections are mainly HIV and malaria (Steer P, 2005). There is evidence that poor socio-economic status, poor nutrition and poor prenatal care are factors causing premature birth (Khadiga et al; 1995). Social factors such as smoking, drug use and occupational hazards have also been shown to cause preterm birth (Weck et al, 2008). Occupational hazards such as lifting up heavy objects, prolonged sitting or standing and working with heavy machinery may also cause preterm labour (Weck et al, 2008). These are important concepts in the South African context as this encompasses most of the blue-collar workforce. Many women in South Africa are forced to take employment that requires them to put their own health and that of their unborn child at risk to earn a living to support their family. Pre-eclampsia and maternal hypertension are, another two of the major pathologies in causing pre-term labour (Steer P, 2005).

Cognitive developmental delay is also linked to prematurity (Wood et al, 2000). This study showed that half of the preterm infants, of a sample size of 283, that survived suffered from neurological delay. Further studies have also shown that cognitive delays are more common than motor delays in infants born preterm (Allen MC; 2008), and difficulties with reading and spelling increased with a decrease in gestational age (Allen MC; 2008). This study also showed that not only were their cognitive impairments due to the early gestational age and low birth weight but also due to the various types of brain injuries that may be associated with prematurity such as intraventricular haemorrhage and periventricular leukomalacia.

Delayed language development has been linked to prematurity (Briscoe et al, 1998) and children may experience difficulties with sentence comprehension. Poorer vocabularies are linked with varying degrees of brain injuries that were mentioned above. Further research showed that preterm children used less complex expressive language and demonstrated slower receptive language skills (Schirmer et al, 2006). A study conducted by Ortiz-Mantilla (2008), showed that the language delay in low birth weight infants could be linked to a global delay in the cognitive area (Ortiz-Mantilla et al, 2008).

Motor development consists of both fine and gross motor development. Studies have shown that prematurity has a role to play in delayed motor development. Ulrich Bucher et al, 2002, showed that 18% of their sample size was not able to walk at 18 months of age. Findings have also demonstrated that gross motor scores on various tests are below average for preterm children at various ages (Goyen and Lui, 2002). This study also showed that over 50 % of their pre-term sample size suffered from fine motor deficits at eighteen months of age. Motor developmental impairments have also been shown to occur in low-birth weight children that were born prematurely (Foulder-Hughes and Cooke, 2003).

By assessing the developmental differences between term and preterm children at eighteen months corrected age we can put a long-term program into place to ensure

adequate follow-up for children born preterm (Cooper and Sandler, 1997). If a child is classed as “at-risk”, an adequate physiotherapy programme can be put into place to ensure that the child reaches their full potential. (Leonard et al, 2001).

The Bayley Scales of Infant development Second version will be used for this study. This scale has long been considered a criterion standard for assessing development in children (Harris et al, 2005).

As shown above the literature has shown that there is a link between prematurity and global developmental delay. This study aims to do is to investigate if there is a difference in global development between pre-term and full-term children. Birth weights will also be established to ascertain if that has a bearing on the child’s development. In this manner a multi-disciplinary team can be used to ensure that these children reach their adequate potential in development (Blauw CH; Hadders M; 2005).

Problem Statement

Children that are born prematurely have been shown to demonstrate long-term developmental delay.

Aim

To establish the differences in global development between pre-term and full-term infants at eighteen months.

Objectives

- To establish if there is a level of developmental delay of children born prematurely
- To establish if there is a level of developmental delay of children born full term

- To compare developmental scores between the two groups.
- To determine what socioeconomic and demographic factors impact on socioeconomic status

Method

Study design

This is a cross-sectional study.

Ethical considerations

Ethical clearance will be applied for from the Committee for Research on Human Subjects of the University of the Witwatersrand. Informed consent will be obtained from the children's parent or guardian. All information will be treated as confidential and anonymous. Permission from the various clinics will be obtained prior to commencement of the study.

Statistical considerations

This study is to compare premature and full term 18 month old children with respect to developmental delay.

Sample size

From the literature, Bayley Scales of Infant Development test scores for full term infants at 18 months has a mean of around 97% and standard deviation of 15%. (Tieman et al, 2005). The suspected mean score for premature infants at 18 months is suspected around 80%, i.e. a difference of 17% which is also clinically relevant. Thus for a clinically relevant difference of 17% between groups using a standard deviation of 15% a sample size of 18 subjects in each group will have 90% power to detect this difference at the 0.05 level of significance.

In this way consecutive sampling will be used. Children are to be selected based on the fact that they are 18 months old (Hintz et al, 2005) and length of gestation will be established prior to the test being conducted.

- 37-Term (this will be the control group)
- <37 weeks gestational age

Children will be found at four various baby clinics in Krugersdorp. As children have measles 2; Oral Polio virus 4; and diphtheria, tetanus and pertussis 4 immunisations at eighteen months they will be recruited based on when they come in for their vaccinations at the various clinics (www.doh.gov.za ; accessed on the 2nd July 2008).

Inclusion criteria

The inclusion criteria are that the child must be eighteen months old.

Exclusion criteria

- The child is not eighteen months old.
- Any other clinically apparent abnormality.

Measurement Instruments

I will be using the Bayley Scales of Infant Development (BSIDII), second version. This scale is used to measure the motor as well as the language and cognitive development of children up to the age 42 months. (Tieman et al, 2005). The scale is used to identify if the child being assessed has any form of developmental delay and the child's need for early intervention strategies. Construct, content, and concurrent validity have all been proven as well as reliability (Tieman et al, 2005).

The Household Economic and Social Status Inventory (HESSI) assessment questionnaire will be used to assess the socio-economic status of the child. This tool was developed in Soweto, South Africa, and is therefore suitable for use on this population (Barbarin et al, 1997).

Procedure

Training of the researcher in the use of the Bayley Scales of Infant development II will be done by the University of the Witwatersrand Physiotherapy Department.

Parents of children who are 18 months old will be approached, and an information sheet stating the purpose of the study will be given to them. Should they agree to participate, they will be given an informed consent sheet to sign. The child will be assessed using the Bayley Scales of infant development in a quiet area of the clinic, and the HESSI will be given to the parent to fill out.

The results of the assessment will be made available to the parent, and if the child is experiencing significant delays in any area, the appropriate referrals will be made, and information regarding this will be given to the parent. This will also include any form of counselling that is needed either by the parent or the child.

If the child cannot be assessed completely on that day the child's information will be excluded to minimise the risk of recall bias.

The information will then be put into a confidential folder for analysis.

Data analysis

Continuous data, e.g., Bayley Infant Scales of Development test scores, will be summarized using mean, standard deviation, median range and 95% confidence interval, while discrete data, e.g., HESSI test scores, will be made of frequencies, percentages and cross-tables. Groups will be compared with respect to mean BSID test score using Student's two sample t-test or Wilcoxon's matched pairs signed ranks test if data is not normally distributed. Groups will be compared with respect to socio-economic categories using Pearson's chi-square test. To facilitate interpretation 95% confidence intervals will also be determined. All testing will be done at the 0.05 level of significance.

Conclusion

Prematurity is a growing problem in South Africa and has been shown to cause developmental delay. This study aims to analyse the extent of that delay.

APPENDIX II: Ethical Clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Brown

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M080954**
PROJECT	Developmental Differences amongst Pre-Term and full-Term 18 Month olds
INVESTIGATORS	Ms D Brown
DEPARTMENT	Physiotherapy Department
DATE CONSIDERED	08.09.26
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 08.11.26 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr J Potterton

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

.....

APPENDIX III: Informed Consent

INFORMATION DOCUMENT

Developmental differences amongst pre-term and full-term 18 month olds.

My name is Diana Brown, and I am a Physiotherapy Masters student at the University of the Witwatersrand. I am doing a study to investigate the developmental differences amongst pre-term and full-term children at the age of 18 months. Other research that has been done has shown that prematurity may affect development. This information will help to inform us as to what procedures and follow-up processes need to be put in place in order to allow these children to reach their full potential.

Invitation to participate

I would like your permission to include your child in this study, as he/she is 18 months old.

What is involved in the study?

Your child will be assessed by the researcher, using a standardised test of development. The test looks at all areas of development and will be fun for your child, as it involves toys and games. The test takes on average an hour to administer. The procedure will be done in the baby clinic that you regularly attend. You will also be asked to fill in a socio-economic questionnaire that will take about 10 minutes to complete.

Risks

There are no risks to being involved in the study.

Benefits

The results of the assessment will be discussed with you. If any developmental delay is picked up your child will be referred to the appropriate person.

Participation is voluntary

You may refuse permission for your child to be part of the study, and your child's treatment at the clinic will not be affected in any way.

Confidentiality

All your personal information will be kept confidential. No names will be used, and the researcher will be the only person with access to your information.

Contact details:

For further information please feel free to contact Diana Brown on 0845854044.

INFORMED CONSENT

I, _____, parent/ guardian of _____
Have read the information sheet attached and agree to allow my child to participate in the research study.

I agree for my child's information to be used I the study. I am aware of the fact that I may withdraw from the study at any time and that all information will be kept confidential.

_____ _____

Parent/Guardian Witness

_____ _____

APPENDIX IV: Household Economic and Social Status Index

Household Economic and Social Status Index (HESSI)

(Barbarin, et al, 1995)
Who provided the information below_____

I. Family Structure/Household Composition (Score 1-10)

a. Marital Status of Mother

1. Never married, not now living with a partner
2. Married, but not living now with a partner (e.g. divorced, separated)
3. Widowed
4. Never married, but now living with partner
8. Married and currently living with partner

b. Household Membership. How many people currently reside in the household? _____

Number 18 and older _____
Number 6 – 18 yrs old _____
Number under 6 yrs old _____

c. Are there adult relative now residing in the household? 0. No 2 Yes
If yes who are they in relationship to the child? _____

II. Social Status- (Education, Occupation, [2 – 18]

a. Mother's Education: What is the highest level of education attained by mother?

1. less than standard 3
2. primary school (standard 3-4)
3. junior secondary (standard 5-7)
4. senior secondary (standard 8-9)
5. matric/ High School graduate/ vocational training diploma
6. 1-2 yrs College, Technikon
7. 3-4 yrs of University
8. Ph.D., M.D., J.D., D.D.S., or other doctoral degree

b. education of Mother's Partner: What is the highest level of education attained?

1. less than Standard 3
2. primary School (Standard 3-4)
3. Junior Secondary (Standard 5-7)
4. Senior Secondary (Standard 8-9)
5. matric / High School graduate/ vocational training diploma
6. 1-2 yrs College, Technikon
7. 3-4 yrs of University
8. Ph.D., M.D., J.D., D.D.S., or other doctoral degree

What are the names, occupation and industry of the primary wage earners in the house?

	Name	Occupation	Industry
1.			
2.			
3.			

Access to Finances Who in the family earns money? Check all that apply.

____ BTT mother
____ Partner
____ Parent
____ Parent Pension
____ Sibling/ Aunt/ Uncle

III. **Housing Accommodation** In what type of housing do you live?

0. None, homeless
1. Shack
2. Hostel
3. Room, garage
4. Flat, cottage
5. home shared with other family (ies)
6. Home that is not shared with other families

B. Does your home have

1) A **Separate Kitchen?** 0. No 1. Yes
2) A **Separate Bathroom?** 0. No 1. Yes

a) In your home how many separate rooms are there just for sleeping?
(Circle one number) 0 1 2 3 4 or more

b) What type of toilet facilities does your home have:

0. None
1. Pit or Bucket
2. Outside flush toilet
3. inside flush

c) Do you own or rent a home.

0. neither
1. Rent
2. Purchasing on Bond
3. Own

d) How much do you pay monthly for rent or bond? R_____
For service charges R_____

e) for electricity:
(Highest in the last year) R_____
(The lowest) R_____

Does the place you live in have a …….?

a)	Refrigerator	0. No	1. Yes
b)	Television	0. No	1. Yes
c)	Telephone	0. No	1. Yes
d)	Car	0. No	1. Yes
e)	Video recorder	0. No	1. Yes
f)	Washing machine	0. No	1. Yes
g)	Microwave oven	0. No	1. Yes

h) In the past, have your children gone hungry because you did not have food?:
   3. No, never
   2. Rarely
   1. Often
   0. All the time

IV. **Savings:** (Score 0-3)

a) Do you have <u>savings</u> or Participate in a savings plan?	0. No	1. Yes
b) Do you have <u>life insurance?</u>	0. No	1. Yes

<u>Maternal Well-being</u>

Do you have any problems you might like to talk over with a doctor?
0. No
1. Yes (Specify)

During the past 3 months have you had any physical or emotional condition for which you have been receiving treatment or taking medication?
0. No
1. Yes (Specify)

During the past 3 months have you been anxious, worried or upset?
Extremely so – to the point of being sick or almost sick
Very much so
Quite a bit
Some – enough to bother me
A little bit
Not at all

During the past 3 months, have you felt so sad, discouraged, hopeless or had so many problems that you wondered if anything was worthwhile?

Extremely so – to the point that I have just about given up
Very much so
Quite a bit
Some – enough to bother me
A little bit
Not at all

In **any one year** have you had at least 12 drinks of any kind of alcoholic beverage?

Yes No

Have you ever had any serious physical handicap? 0. No 1. Yes

Have you ever been a patient (or outpatient) at a mental hospital, mental health ward of a hospital, or a mental clinic for any personal emotional, behaviour, or mental problem?:

Yes, during the past year
Yes, more than a year ago
No

Neighbourhood Safety

A. In general how safe is the area in which you live?

1. Extremely dangerous
2. Dangerous
3. Safe
4. Extremely safe

B. How much do you worry about your child getting hurt when s/he is outside of your home?

1. Never
2. Sometimes
3. Often
4. All the time

Satisfaction with family life (Support)

My family has a lot of problems:

1. Not true 2. Sometimes true 3. Often true 4. Always true

My family is always there for me when I need them.

1. Not true 2. Sometimes true 3. Often true 4. Always true

V. Gestational age: _____

VI. Birth weight: _____

VII. Birth complications:

_____
_____
_____