THE VALIDATION OF THE CANADIAN NORMS FOR THE ALBERTA INFANT MOTOR SCALE WITHIN THE CAPE METROPOLITAN

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DECEMBER 2009
I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it in at any university for a degree.

Signature: ……………………………………………………..

Date: …………………………………………………………

DECLARATION
ABSTRACT

BACKGROUND

Information on the normal gross motor skills in a healthy population is important since normative data provides a benchmark for health professionals to evaluate deviations from the norm. The Alberta Infant Motor Scale (AIMS) was developed to assist with the motor assessment of young infants from birth through to independent walking. The validation of the Canadian cohort for the AIMS needs to be done with regards to infants in South Africa (Cape Town), before it can be utilised by health professionals working in Paediatric Health Care.

OBJECTIVE

To determine if the Canadian norms for the AIMS are valid for infants aged 4 - 18 months within the Cape Metropole, South Africa.

METHODOLOGY

A prospective descriptive study was conducted to validate the AIMS. A total of 67 infants from one private and one public institution participated in the study. Infants were assessed at 4, 8, 12 and 18 months of age with the AIMS. Results were analysed using ANOVA and t-tests to determine the relationship between age, ethnicity, gender and clinics.
RESULTS

The AIMS gross motor scores of this sample of infants were not significantly different from the Canadian norms, bar at 4 months. Female infants performed significantly (p<0.05) better than males at four months. It was not possible to convert the 18 month old infants’ raw scores into percentile rankings and therefore it could not be compared to the Canadian norms.

CONCLUSIONS

The results yielded from this study indicate that the AIMS is a valid assessment tool for healthy infants from 8 - 12 months of age within the Cape Metropole, South Africa, however, care should be taken when infants’ scores at 4 months are compared to the scores of the normative sample. The AIMS can therefore be used by health care professionals at the Baby Well clinics in the Cape Metropole to assess gross motor development in infants for this age group and can consequently refer infants who may display delays in motor development to appropriate paediatric specialists. The results from this pilot study also make provision for future in-depth research on the AIMS with a larger cohort and with more ethnic diversity.
ABSTRAK

AGTERGROND

Informasie oor normale grof motoriese vaardighede in ’n gesonde populasie is van belang aangesien die normatiewe data ’n standaard verskaf waarteen gesondheids personeel afwykings van die norm kan bepaal. Die "Alberta Infant Motor Scale" (AIMS) is ontwikkel om te assisteer met die motoriese evaluering van die baba vanaf geboorte tot onafhanklike loop. Die geldigheid van die Kanadese kohort vir die AIMS ten opsigte van babas in Suid Afrika (Kaapstad) moet gedoen word, voordat die AIMS deur gesondheids personeel werksaam in die Pediatriese Gesondheids Sorg gebruik kan word.

DOEL

Om vas te stel of die Kanadese norms vir die AIMS geldig is vir babas vanaf 4 - 18 maande in die Kaapse Metropool, Suid Afrika.

METODOLOGIE

‘n Prospektiewe beskrywende studie is uitgevoer om die geldigheid van die AIMS te bepaal. ‘n Totaal van 67 babas van ’n privaat en ’n publieke instansie het deelgeneem aan die studie. Die babas is op 4, 8, 12 and 18 maande met die AIMS ge-evalueer. Resultate is geanaliseer deur gebruik te maak van die ANOVA en t-toets om die verhouding tussen ouderdom, etniese groepering, geslag en klinieke te bepaal.
RESULTATE

Die AIMS grof motoriese waardes van die babas wat aan die studie deelgeneem het, het behalwe by 4 maande, nie betekenisvol van die Kanadese norms verskil nie. Vroulike babas het betekenisvol beter (p<0.5) as die manlike babas op 4 maande presteer. Dit was nie moontlik om die data van die 18 maande oue babas om te sit in persentiel waardes nie en dit kon dus nie met die Kanadese norms vergelyk word nie.

GEVOLGTREKKING

Die resultate van die studie dui aan dat die AIMS ‘n geldige evaluerings instrument is om vir gesonde babas van 8 - 12 maande ouderdom in die Kaapse Metropool, Suid Afrika, te gebruik. Die AIMS kan dus deur gesondheids personeel by Baba Klinieke in die Kaapse Metropool gebruik word om die grof motoriese vaardighede van babas in die ouderdomsgroep te evaluer en babas met motoriese ontwikkelingsagterstande te verwys na toepaslike pediatriese spesialiste. Die resultate van die voorlopige studie maak voorsiening vir meer indiepte navorsing met die AIMS met ‘n groter kohort en meer uitgebreide etniese diversiteit.
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GLOSSARY

**Infant**: An individual between the ages of 1-23 months of age.

**Gestational weeks**: This is calculated from the first day of the last normal menstrual period to the date of birth, and is expressed in completed weeks.

**AIMS**: Alberta Infant Motor Scale
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CHAPTER 1

INTRODUCTION

Information on the normal gross motor skills in a healthy population is important since normative data provides a benchmark for health professionals to evaluate deviations from the norm (Piper & Darrah, 1994). In developing countries such as Canada, normal referenced values for gross motor development has been established in young infants, and the Alberta Infant Motor Scale (AIMS) was developed to assist with the motor assessment of young infants from birth through to independent walking (Piper & Darrah, 1994). Research to validate the AIMS in different infant populations across the world is currently underway in other countries like Australia (Dr Andrea Bialocerkowski: 2007, School of Physiotherapy, The University of Melbourne, Australia, personal correspondence), the Netherlands (Fleuren, Smit, Stijnen & Hartman, 2006) and Taiwan (Jeng, Yau, Chen & Hsiao, 2000).

Various screening methods have been developed for infants who are deemed healthy, to determine whether infants are at risk for motor delay, namely the Harris Infant Neuromotor Test (HINT)(Harris & Daniels, 1996); the Denver – II (Frakenburg, Dodds, Archer, Bresnick, Maschka, Edelman & Shapiro, 1992); the Ages and Stages Questionnaire (ASQ) (Bricker & Squires, 1999), Bayley Scales of Infant and Toddler Development (Bayley, 1993), and the Peabody Developmental Motor Scale (PDMS)(Folio & Fewell, 2000). The AIMS is the only screening tool to date that also evaluates the qualitative aspects of the infants’ acquired gross motor skills (Majnemer & Snider, 2005). These qualitative aspects of the AIMS assess the infants’ antigravity movements, postural control, weight bearing, balance and coordination as they move into and out of different positions. Therefore, the AIMS does not only focus on the achievement of motor milestones, but also assesses the quality of the newly acquired motor skills (Piper & Darrah, 1994).
The AIMS was developed in Alberta, Canada in the early 1990’s and assesses motor development from birth to eighteen months of age (Liao & Campbell, 2004). It also identifies infants with motor delay, differences in motor development in infants who are suspected to have neurological delay and it affirms normal development (Bartlett & Kneale Fanning, 2003). The AIMS was norm referenced and standardised on two thousand two hundred and two infants between one and eighteen months of age. This scale has 58 items, each accompanied with a photograph and a drawing of the infant in four different positions, namely; prone, sitting, standing and supine (Piper & Darrah, 1994). The biggest advantage of the AIMS is that it is an observational tool, hence it allows independent movement of the infant and thus allows the examiner to remain unobtrusive and distanced from the infant while assessing the infant’s performance (Piper & Darrah, 1994). Another advantage is that it is the least expensive of all screening tools and takes approximately 20 minutes to execute (Jeng et al., 2000). Since the AIMS is easy to learn and to administer, it can be used by a wide variety of health care professionals and even student physiotherapists, with a basic knowledge of infant motor development (Blanchard, Neilan, Busanich, Garavuso & Klimas, 2004; Lee & Harris, 2005).

Research has been done to investigate the AIMS’ reliability and validity (Piper & Darrah, 1994). The interrater, test-retest reliability and validity study consisted of a sample size of 506 normal infants and was performed in Canada in the early 1990’s (Piper & Darrah, 1994). Interrater reliability was about 96% and the test-retest reliability ranged from 86 to 99% (Piper & Darrah, 1994). Intra- and interrater reliability testing on preterm infants in Taiwan was also found to have high consistency scores (Jeng et al., 2000). The concurrent validity of the AIMS has also been tested against the Test of Infant Motor Performance (TIMP), the Bayley Scales of Infant Development (BSID) as well as the Peabody Developmental Motor Scales (PDMS) and the findings indicated a high correlation between these scales (Campbell & Kolobe, 2000; Blanchard et al., 2004). These studies indicate that the AIMS is a robust assessment tool, which is why it would be applicable for use in South Africa. Spittle, Doyle & Boyd (2008) conducted a
systematic review of nine infant motor assessment tools and concluded that the AIMS demonstrated the strongest psychometric properties and clinical utility.

Whether or not differences in culture affect the administration of the AIMS has not been tested extensively (Jeng et al., 2000). The high criterion validity between Canadian and Taiwanese infants suggests that the AIMS can potentially be used cross-culturally (Jeng et al 2000). The findings from recently published research revealed that no study has been conducted to state whether Canadian norms are valid for other countries (Fleuren, Smit, Stijen, Hartman, 2007). Therefore the validation of the Canadian cohort for the AIMS needs to be done with regards to infants in South Africa (Cape Town), before it can be utilised by health professionals working in paediatric health care.

Restricted funds in the South African Health care sector warrant the need for a reliable and easy-to-use tool to assess motor development of low and high risk infants (Bateman, 2006). The AIMS can easily be used in rural settings since it does not require expensive equipment or a large venue to assess the infants (Piper & Darrah 1994). The AIMS has the potential to address an important gap in the motor assessment of infants in developing countries. There is thus a clear need to firstly validate the AIMS in the Western Cape, South Africa and secondly to use this inexpensive, reliable and easy to use tool for the early identification of infants who present with motor development disorders.

Physiotherapists and occupational therapists specialising in paediatrics are often involved in screening and treating infants, especially those who have delays in motor development and who are at risk for delay in gross motor function (Provost, Heimerl, McClain, Kim, Lopez, Kodituwakku, 2004). Identifying these groups of infants is imperative as it will allow for early intervention (Bartlett, 1995). Intervention at an early stage in infant development is necessary especially in developing countries (Blanchard et al., 2004) because it prepares parent(s) or guardian(s) for the result of motor delay, it may also help to prevent secondary and long term impairments (Williams & Holmes,
2004) and improve the motor outcomes of the infant which in turn will lower costs of rehabilitation.

Paediatric therapists also make use of standardized gross motor assessment tools to guide decisions regarding rehabilitation and the referral of infants to specialised services. In order for paediatric therapists to make accurate conclusions and judgements, the tools used need to have sound psychometric properties, i.e. high levels of reliability and validity (Snyder, Eason, Philibert, Ridgway & McCaughey, 2008). Snyder et al., (2008) also conclude that all assessments used by clinicians should have acceptable levels of psychometric properties for infants and children who are with or without disability.

Paediatric therapists also need to be aware and understand the limitations of each assessment tool so as to make informed decisions as to which tool to use (Maring & Elbaum, 2007). If therapists are unaware of these limitations, assessments could be used incorrectly, this could lead to information being misinterpreted, over referral of infants to specialists and denial of treatment for the children in question (Provost, Crowe & McClain, 2000). According to Rosenbaum (1998), construction of a good assessment tool is conducted by robust research of its psychometric properties such as reliability and validity. Therapists have a wide variety of assessment tools to choose from, the best are tools that have excellent psychometric properties (American Academy of Paediatrics 2001). The following Chapter will present a Literature Review on the cross cultural validation of gross motor assessment tools as well as a Systematic Review comparing the reliability and the validity of the AIMS with that of other infant motor assessment tools in detecting gross motor patterns in infants between the ages of 0 – 18 months.
CHAPTER 2

2.1 LITERATURE REVIEW

2.1.1 INTRODUCTION

Physiotherapists who specialise in paediatrics use assessment of gross motor performance as an important tool in managing and treating infants. From these assessments information is obtained as to the infants’ developmental stage as well as the recommendations that need to be made regarding rehabilitation of the infant (Provost et al., 2004). The selection of an assessment tool should be based on the purpose of the tool as well as the therapist’s ability to critically appraise and review the information of the evidence of the tool (Palisano, Kolobe, Haley, Lowes & Jones, 1995).

2.1.2 PURPOSE OF ASSESSMENT TOOLS

Kirshner & Guyatt (1985) have developed a framework for assessing screening tools. They stipulate that the tool must be used for one or for various purposes. They are classified as discriminative (such as the AIMS, BSID, Denver Developmental Screening, and the PDMS), evaluative and predictive. Discriminative tools are used to differentiate between subjects who are with or without a particular characteristic. Evaluative tools are used to measure the amount of change in function after treatment or over time and predictive tools categorize subjects based on what is expected to be their future status. Assessment tools are designed specifically to meet these criteria (Rosenbaum, Russel, Cadman, Gowland, Jarvis, Hardy &1990).

2.1.3 NORMS

Most fine and gross motor assessment tools can be classified as norm referenced tests (Shoemaker, Ketelaar & Smit-Engelsman, 2000). Assessments that are norm referenced are developed using the average performance of subjects, who are without
disability and impairment to discriminate between high and low risk infants. These tests will thus give an indication if an infant’s motor performance is better, similar or worse than other infants of the same age group. Accurate conclusions about an infant’s stage of motor development should be made with an assessment tool involving standardised administration and a normative cohort that reflects the cultural background of the infants for whom the assessments are intended (Provost et al., 2000).

An assessment tool cannot be utilised on a population that it is not the same as that on which it was validated (Rosenbaum et al., 1990), since development of motor skills in everyday life is influenced by personal, social, cultural and environmental factors, in addition to the infant’s age and general development (Berg, Aamodt, Stanghelle, Krumlinde-Sundholm & Hussain, 2008). Assessment tools should be utilised to provide information on the motor performance of an individual infant relative to the performance of the infant in the context of his/her own environment (Mayson, Harris & Bachman, 2007). Most discriminative assessment tools have a normative sample to which infants being assessed can be compared to (Mayson et al., 2007). These normative samples however might not be ethnically diverse or might not represent all of the county’s ethnic groups (Mayson et al., 2007).

### 2.1.4 Validation of Assessment Tools

The most widely used gross motor assessment tools, i.e. the Denver II and PDMS, have been standardized on North American populations and have used ethnic minorities representative of the population, although small amounts of specific cultural groups were included (McClain, Provost, Crowe, 2000). Mayson et al., (2007) states that even if the normative sample of gross motor assessments have been standardized on different ethnic groups, they may not represent the motor performance of a specific group within the sample, i.e. if the majority of infants being assessed belong to one ethnic group, “then the mean comparison data will be skewed toward their results”. This means that infants from other ethnic backgrounds included in the normative sample may have
motor development typical of their ethnic grouping yet could be classified as delayed or performing better than the normative sample, which may lead to incorrect inferences about their gross motor development (Mayson et al., 2007).

Research dating back to the 1970’s has demonstrated that differences in motor development across cultures have been linked to environmental factors relative to the cultural group as well as child rearing practices (Solomons, Solomons, 1975; Ueda, 1978). McClain et al., 2000, also found that two year old typically developing Native American children scored significantly lower on the BSID-II motor scale and that these findings could be attributed to the children’s reactions to and the adjustment to the testing situation.

Health professionals working in paediatrics need to be aware of the differences in motor development across cultures especially when making use of assessment tools that are standardized on a population that is culturally different to the infant being assessed (McClain et al., 2000).

An extensive and systematic search was conducted using the following databases: Cinahl, Cochrane Library, Pubmed, PEDro, Science Direct as well as Google Scholar however, only a few studies were found on the cross cultural validation of infant motor assessment tools. A review of the cross cultural validation of four widely used gross motor assessment tools will be discussed, namely the, AIMS (Piper & Darrah, 1994), BSID II Motor Scale (Bayley, 1993), Denver II (Frankenburg, Dodds, Archer, Shapiro & Beverly, 1992)and the PDMS-2(Fewell & Folio, 2000). Most of the literature pertaining to the validation of these scales are not easily available as most of the research was published more than twenty years ago and is only available electronically in abstract format, hence details of how many infants were used and what statistical analyses were employed cannot be presented. The methods used during the cross cultural validation of these scales will be discussed in the following paragraphs.

Only one study could be found that analysed the cross-cultural validity of the AIMS Canadian normative data for a sample of 100 Dutch infants aged between 0 and 12 months (Fleuren, Smit, Stijnen, Hartman, 2007). The infants attended a health care
centre in a small town in the Netherlands. The authors purposely avoided studying a sample from one of the major cities in the Netherlands to ensure social and/or economical differences would not affect the results and chose a town representative for the majority of urban Dutch towns.

The authors state that a sample size of 99 infants was needed to obtain 80% power. There were no exclusion criteria and informed consent was obtained from the parents of the participants. The sample size consisted of 100 children of which 63% were boys, 37% girls and 4% non-Caucasian. The number of infants assessed between 1 and 12 months did vary considerable from the sample used in the Canadian validation of the AIMS by Piper and Darrah (1994) with a ratio of 1:18. The authors stated that it is not essential for the Dutch sample to resemble the original group used in the study by Piper and Darrah (1994), since normative data should be applicable to any sample size.

Student t test was used to establish whether group scores differed from the Canadian normative sample and a one way ANOVA was used to compare the group means. A p-value of 0.05 or less was considered to be statistically significant. The study found that Dutch children between the ages of 0-12 months scored significantly lower (p<0.001) on the AIMS when compared to the normative sample, whereby 75% of the Dutch children scored below the 50th percentile. Fleuren et al. (2007) concluded that new AIMS reference values need to be established for Dutch infants aged 0-12.

Norms for the BSID II Motor Scale were also validated on a convenience sample of 39 typically developing Native American children between the ages of 24-35 (McClain et al., 2000). Subjects were recruited with the help of the Child Day Care Program, Child Find program and the Pueblo Early Childhood Program. Financial incentive (albeit small) was given to the parents/caregivers of the participants. Parents signed a consent form. One tester examined all the children and the assessment took between 60 and 90 minutes. Student t tests were carried to identify differences as well as statistical regression analysis of the Motor Scale results. The study found that two year old Native American children scored significantly lower than the normative sample of the BSID II.
The Denver II was adapted for use in rural Malawi as the assessment tool was not culturally relevant for the population (Gladstone, Lancaster, Jones, Maleta, Mtitimila, Ashorn, Smyth, 2008). A prospective family cohort study was used and the researches looked at normal development, gestational health, growth, morbidity and mortality, for the validation of the Denver II norms for the Malawian population. Children between the ages of 3.5- 6.5 yrs and their younger siblings between 0-3.5 years of age were used for the study, which amounted to a study population of 1130. A quota sampling strategy was used with target numbers being sought for each of the 33 age groups. Informed verbal consent was obtained from the mothers of the participants. Logistic regression analysis was employed with decimal age and sex as explanatory variables. The ages corresponding to 25%, 50%, 75% and 90% of the subjects passing were determined for each item. This was then used to plot the age norms of achievement of each milestone in a box-type representation (Gladstone et al., 2008).

In a study by Tripathi, Joshua, Kotian, Shashidha, Tedla, (2008), the norms of the PDMS-2 was compared to 300 Indian children, between the ages of 0-60 months of age who were recruited from nursery and play schools as well as from door to door surveys. Children were excluded if they failed the screening test, the Denver Developmental Screening Test II, or if they had any medical conditions. Written and signed informed consent was obtained from parents. The raw scores obtained were converted into age equivalent percentiles as well as standard scores. These were converted to z scores and the means were used for comparison with the mean values in the PDMS 2 manual using the Student t test.

2.1.5 CONCLUSION

There is a wide variety of discriminative gross motor assessment tools available and with this search of the current literature not much exists pertaining to the cross cultural validation of the normative data. The systematic review published by Mayson et al., (2007) yields the same results, most literature and research was done more than 20 years ago and the majority of it are linked to the original Denver Developmental
Screening Tool (Mayson et al., 2007). This mirrors the lack of research available on the appropriateness of validating normative data for discriminative gross motor assessment tools across cultures (Mayson et al., 2007). Hence a huge gap in the literature exists as to the validation of norms for gross motor assessment tools especially across cultures.

Out of the literature presented all the studies used infants and children who were low risk, except for the AIMS Dutch study. The AIMS study determined a sample population of 99 subjects to achieve 80% power (Fleuren et al., 2007), the BSID II study used a sample of convenience (McClain et al., 2000), the Denver II employed the quota sampling strategy and the study validating the norms of the PDMS 2 for Indian children made use of an estimated cluster sample (Tripathi et al., 2008). Informed consent was obtained used in all studies. In all the studies Student t tests were used for statistical analysis.

In education and psychology the science of assessing is well established and it is fast becoming recognised and documented in clinical medicine (Rosenbaum et al., 1990). Paediatric assessment tools are selected more for practical reasons rather than theoretical knowledge, even though there are a wide range of tools that have specific purposes and measure specifics aspects of infant development (Ketelaar, Vermeer & Holders, 1998). Paediatric specialists have highlighted the importance and need for accurate assessment tools that will minimise confusion as to how and when to rehabilitate (Maring & Elbaum, 2007).

Mayson et al., (2007) advise caution when using discriminative gross motor assessment tools that are standardized on infants from different ethnic groupings until enough evidence exists as to the motor development of children of different backgrounds within one country.

As previously mentioned, a review of the literature has proved that there is not much research published on the validation of norms (especially across cultures). Only one article exists as to the validation of the norms for the AIMS. In light of this, it was decided to do a systematic review of the psychometric properties of the AIMS, as a lot of the research now published places great emphasis on an assessment tool having
high levels of reliability and validity (Fleuren et al., 2007). Wiart & Darrah, (2001), state that assessment tools also need to have good psychometric properties and that frequently used tools do not ensure that the reliability and validity are adequate. Health professionals working in paediatrics must be aware of all the limitations and not make the assumption that all published assessment tools have been tested rigorously (Wiart & Darrah, 2001).
SYSTEMATIC REVIEW

2.2 INTRODUCTION

The pursuit for a reliable, easy to use and inexpensive screening tool to predict neurodevelopmental outcome in the young infant has been an ongoing process since Saint-Anne Dargassies described the first concepts relating to the neurological examination of the newborn baby in 1955 (Mercuri, Ricci, Pane & Baranello, 2005). Since then numerous structured, age-appropriate assessment tools were developed to evaluate gross and fine motor development in newborn babies and infants (Campbell, Vander, Palisano, 2005). The first year of an infant’s life is a crucial period of motor development. Therefore early identification allows for early diagnosis and subsequent intervention, which will allow for optimal results with regards to therapy and may curb functional limitations at a later stage in development (Fleuren et al., 2007; Flegel & Kolobe 2002; Williams & Holmes, 2004).

Health professionals who make use of motor assessment tools to identify infants at risk for developmental delays must be aware of the limitations and strengths of the specific tool being used (Provost et al., 2000). If an assessment tool is used inappropriately, it could result in over referral or denial of services for infants (Provost, et al., 2000). For example, assessment tools used in a clinical setting, with a low positive predictive value can result in over referral and a waste of the assessor’s time and resources which could be used to treat or assess an infant with a legitimate delay in motor development (Flegel & Kolobe, 2002). Identifying and treating infants with delays in motor development are on the increase within the first year of life (Cameron, Maehle & Reid, 2005). Physiotherapists are among the group of health professionals who assess and provide the necessary treatment for these infants; hence they need to be knowledgeable of which assessment tools are practical, efficient and psychometrically sound (Jeng, Yau, Chen & Hsiao, 2000).
The Committee on Children with Disabilities of the American Academy of Paediatrics on developmental screening and surveillance of infants and young children, state that screening tools must have excellent psychometric properties; that is, good levels of validity, reliability, sensitivity and specificity (American Academy of Paediatrics 2001).

One of the numerous structured age appropriate assessment tools that has enjoyed widespread publication and has been reported to have excellent psychometric properties is the AIMS (Tse, Mayson, Leo, Lee, Harris, Hayes, Backman, Cameron & Tardiff, 2008; Jeng et al., 2000). Unlike other infant motor assessment tools, the AIMS does not only assess the infants acquisition but also the quality of movement such as weight bearing, postural control and anti gravity movements (Piper & Darah, 1994). The AIMS demonstrates ease of administration and scoring (takes approximately 20 minutes to complete an assessment), which makes it easy to use by health professionals and students (Blanchard et al., 2004; Lee & Harris, 2005). In addition to this the AIMS has shown to be the least expensive gross motor infant assessment tool available today (Jeng et al., 2000).

To date there has been no systematic review undertaken to compare the validity (concurrent and predictive validity) and reliability (interrater and test-retest reliability) of the AIMS with other infant motor assessment tools. The two fold aim of this systematic review will first be to compare the psychometric properties of the AIMS with other infant gross motor assessment tools and secondly; a comparison of the cross cultural validity of the AIMS. Cross cultural validity of the AIMS is needed, so as to detect the influence of culture on the administration of the AIMS (Jeng et al., 2000). The psychometric properties which include; validity (predictive and concurrent validity) and reliability (interrater and test-retest reliability) of the various infant motor assessment tools were compared with the AIMS to determine if this scale is effective in detecting gross motor patterns in infants between the ages of 0-18 months of age.
2.2.1 List of Definitions

- **Validity** is the extent to which an assessment tool tests what it purports to test (Portney & Watkins, 2000).

- **Concurrent validity** is the degree to which scores on one assessment scale correlate with scores on another more established assessment scale, the so-called golden standard, when both scales are applied concurrently (Portney & Watkins, 2000). Concurrent validity is the most common type of validity assessed when a new assessment tool is produced (Campbell & Kolobe, 2000) and is therefore key in establishing the credibility and efficacy of a new assessment tool (Tse et al., 2000).

- **Predictive validity** (which will include sensitivity and specificity) is important to evaluate the accuracy of standardised screening tests used to assess the gross motor skills of infants (Darrah, Piper & Watt, 1998). Predictive validity is describing how accurate an assessment tool can predict future outcome in an infant. Sensitivity is the percentage of infants who are correctly identified as having a neurodevelopmental disorder and specificity is the ability of a test to correctly identify those infants without a neurodevelopmental disorder (Spittle, Doyle & Boyd, 2008). A highly specific test is unlikely to misclassify healthy infants with the presence of a neurodevelopmental disorder (low false positives), while a highly sensitive test is important for confirming a diagnosis of a neurodevelopmental disorder (low false negatives).

- **Reliability** is defined as the consistency of scores when a test is applied to the same individual more than once (Piper & Darrah, 1994).
2.3 OBJECTIVES
The specific review questions to be addressed were:

- How does the concurrent validity of the AIMS compare with that of other infant gross motor assessment tools?

- How does the predictive validity (sensitivity and specificity) of the AIMS compare to other infant gross motor assessment tools?

- How does the interrater reliability and the intrarater reliability of the AIMS compare with that of other infant gross motor assessment tools?

- Are the Canadian norms for the AIMS valid across cultures?

2.4 REVIEW METHOD
The following criteria, with respect to the types of studies, participants, search strategy, study selection and assessment of methodological quality, were applied to this review.

2.4.1 TYPES OF STUDIES
The types of study designs included for the review were descriptive studies of infant gross motor assessment tools. The articles included in the review had to meet the following criteria:

- Only studies published in English language.
- Studies that compared the concurrent validity of the AIMS with other infant gross motor assessment tools.
- Studies that compared the predictive validity of the AIMS with other infant gross motor assessment tools.
- Studies that reported on the inter- and intra rater reliability of the AIMS.
- Studies that reported on the cross-cultural validity of the AIMS.
The following studies were excluded:

- If a population sample of infants with physical and or mental disabilities were included in the study.

### 2.4.2 Type of Participants

Participants included low-risk and/or high risk preterm or full term infants between the ages of 0-2 years of age, irrespective of gender, nationality and race.

### 2.4.3 Type of Outcomes

The types of outcomes included were concurrent validity, predictive validity, cross cultural validation as well as reliability of the infant motor assessment tools.

### 2.4.4 Search Strategy

In order to commence the systematic review an extensive search of the Cochrane Library, Google Scholar and Pedro was conducted for a review of a similar aim. To date no review has been found.

The following Stellenbosch University Library computerized databases were searched using specifically developed search strategies during the end of February 2008 through to the beginning of March 2008:

- CINAHL (01/1994 – 2008)
- The Cochrane Library (2008)
- Lippincott, Williams and Wilkins
- Medline (01/1994- 2008) via Ebsco Host
- Pubmed
- Pedro
- Proquest
- Science Direct
- Biomed Central

The databases were searched from 1994, since 1994 is the year that the AIMS was developed and the AIMS manual was published. The search strategy was developed for Pubmed, but was adapted for each of the databases. Searches were limited where possible to humans only and infants from birth to two years of age. The complete search strategy has been included in Appendix I. Apart from this, another search method was used, where authors’ names were searched within the same databases as mentioned above. The search process also included additional searching such as
pearling, that is reviewing reference lists of the included articles for added relevant material.

2.4.5 ASSESSMENT OF METHODOLOGICAL QUALITY

The methodological qualities of the study were appraised using the critical appraisal tool by Williams, Schmuck, Allwood, Sanchez, Shea & Wark, (2007). This appraisal tool can be used for all studies that evaluate the psychometric properties of a measurement tool (Appendix II). Uncertainties were solved by the help of the study supervisor.

2.4.5.1 Scoring

The psychometric properties of each study were critically appraised and marked with a ‘+’ if the study met the criteria or a ‘+/-’ if methods used were doubtful; or a ‘–’ if the criteria were not met or a ‘?’ if the criteria were not found in the study.

2.4.5.2 Data extraction

Data extraction was done by the principal researcher. A description of the studies was completed and the following information was captured onto the Excel spreadsheet:

- Author reference, publication year, country where study was conducted, title of study, journal in which study was published.
- Number of participants and information on participants, such as age range, gender and whether or not they were classified as low risk or high risk.
- Assessment tool used and at what age the tool was used to assess the infants.
- Concurrent validity of the Alberta Infant Motor Scale (AIMS) and when compared to other assessment tools.
- Inter-rater and intra-rater reliability of the AIMS.
- Cross cultural validity of the AIMS.
2.5 RESULTS

2.5.1 DESCRIPTION OF THE STUDIES

The results of the search strategy are presented in a flow chart (Figure 2.1). A total of 15010 hits were found, out of these studies 8 full text articles were initially accepted and then 1 article was excluded. This systematic review is consequently an analysis of 7 studies. These studies were conducted in the following countries: USA (1) (Campbell & Kolobe, 2000), Canada (4) (Darrah, Piper & Watt, 1998; Piper & Darrah, 1994; Tse, Mayson, Leo, Lee, Harris, Hayes, Backman, Cameron & Tardif, 2008; Blanchard, Neilan, Busanich, Garavuso & Klimas, 2004) Netherlands (1) (Fleuren et al., 2007) and Taiwan (1) (Jeng et al., 2000).
<table>
<thead>
<tr>
<th>COMPUTERISED SEARCHES</th>
<th>SEARCH STRATEGY 1</th>
<th>SEARCH STRATEGY 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial Hits</td>
<td>Accepted</td>
</tr>
<tr>
<td>Biomed Central</td>
<td>145</td>
<td>0</td>
</tr>
<tr>
<td>CINAHL via Ebscohost</td>
<td>2586</td>
<td>1</td>
</tr>
<tr>
<td>Cochrane Library</td>
<td>2171</td>
<td>0</td>
</tr>
<tr>
<td>Lippincott, Williams and Wilkins (Journals @ Ovid)</td>
<td>3639</td>
<td>5</td>
</tr>
<tr>
<td>Medline via Ebscohost</td>
<td>3734</td>
<td>1</td>
</tr>
<tr>
<td>Pedro</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>Proquest</td>
<td>475</td>
<td>0</td>
</tr>
<tr>
<td>Proquest</td>
<td>475</td>
<td>0</td>
</tr>
<tr>
<td>Pubmed</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Science Direct</td>
<td>1014</td>
<td>0</td>
</tr>
<tr>
<td>Motor Assessment of the Developing Infant Piper and Darrah, 1994 AIMS manual</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total:</td>
<td>n=15010</td>
<td>n=8</td>
</tr>
</tbody>
</table>
2.5.2. METHODOLOGICAL QUALITY OF THE STUDIES

The methodological scores of the identified studies are reported in Appendix III. All but one study included in the review did not have information on content, construct and responsiveness and therefore scored a (?). All studies scored (+) for internal consistency.
2.5.2.1 Participants
There were a total of 971 infants that participated in the studies. Of these a total of 653 infants were classified as low risk because these infants were born at term (> 36 weeks gestation), with no congenital abnormalities and were typically developing infants. Thirty three infants were considered medium risk because they were born prematurely (<36 weeks gestation), weighing more than 1500 grams, with no significant medical problems. There were 285 infants classified as high risk, either due to being born preterm with significant medical problems or exposed to cocaine and or alcohol in utero. Two studies included in the review used infants who were classified as high risk (Jeng et al., 2000; Piper & Darrah, 1994). Two studies made use of a combination of infants that were classified as high risk or low risk (Fleuren et al., 2007; Tse et al., 2008). Two studies made use of a mixture of infants ranging between high, medium or low risk (Campbell et al., 2000; Darrah et al., 1998). Two studies only used low risk infants (Blanchard et al., 2004; Piper & Darrah, 1994).

2.5.3 Psychometric properties evaluated in the studies
2.5.3.1 Concurrent validity of the AIMS when compared to other gross motor assessment tools.

Four studies evaluated the concurrent validity of the AIMS with other infant gross motor scales: the concurrent validity of the AIMS compared to the Test of Infant Motor Performance (TIMP) (Campbell & Kolobe, 2000); the concurrent validity of the AIMS compared to the Harris Infant Neuromotor Test (HINT) (Tse et al., 2008) and the studies by Piper & Darrah (1994) and Jeng et al.(2000) tested the concurrent validity of the AIMS with the Bayley Scales of Infant Development (BSID); study by Piper & Darrah (1994) tested the concurrent validity of the AIMS with the PDMS.

The AIMS demonstrated good to high levels of concurrent validity when compared to two well standardised and used scales, namely the BSID and PDSM (Jeng et al., 2000 and Piper & Darrah, 1994). The intraclass correlation coefficients (ICC) range between
0.78-0.98, this is when low risk or high risk infants are used at different age groups namely at 6 and at 12 months of age (Jeng et al., 2000; Piper & Darrah, 1994). The concurrent validity of the AIMS with the PDSM depicts even higher correlation coefficients, the ICC’s range from 0.98 to 0.99 (Piper & Darrah, 1994).

When the concurrent validity of two newer scales are compared to the AIMS the ICC’s are moderate to good. In the study by Campbell & Kolobe (2000), the ICC’s for a combination of infants from low, medium and high risk between the AIMS and the TIMP are 0.64 between the raw scores and 0.60 between the raw scores of the TIMP and the percentile ranks of the AIMS.

The HINT when concurrently compared to the AIMS show higher ICC’s of 0.809-0.867 when low risk and at risk infants were used respectively and 0.831 for the entire sample between the ages of 4-6.5 months are assessed (Tse et al., 2008). The ICC’s when 10-12.5 month old infants were used ranged from 0.596-0.928 for typical and at risk respectively and 0.849 for the entire sample of at risk and low risk infants (Tse et al., 2008) (Table 2.1).
Table 2.1  The concurrent validity of the AIMS during different age periods in correlation to other more established assessment scales.

<table>
<thead>
<tr>
<th>Scales</th>
<th>Authors</th>
<th>Pearson product moment Correlation Coefficients</th>
<th>No. of infants</th>
<th>High risk and low risk infants</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIMS &amp; BSID</td>
<td>Jeng et al. (2000)</td>
<td>0.78</td>
<td>41</td>
<td>Infants at risk 6 months of age</td>
</tr>
<tr>
<td>AIMS &amp; BSID</td>
<td>Jeng et al. (2000)</td>
<td>0.90</td>
<td>41</td>
<td>Infants at risk 12 months of age</td>
</tr>
<tr>
<td>AIMS &amp; PDSM</td>
<td>Piper &amp; Darrah (1994)</td>
<td>0.99</td>
<td>103</td>
<td>Normal infants 0-13 months of age</td>
</tr>
<tr>
<td>AIMS &amp; BSID</td>
<td>Piper &amp; Darrah (1994)</td>
<td>0.97</td>
<td>103</td>
<td>Normal infants 0-13 months of age</td>
</tr>
<tr>
<td>AIMS &amp; PDSM</td>
<td>Piper &amp; Darrah (1994)</td>
<td>0.98</td>
<td>48</td>
<td>Infants at risk</td>
</tr>
<tr>
<td>AIMS &amp; BSID</td>
<td>Piper &amp; Darrah (1994)</td>
<td>0.98</td>
<td>48</td>
<td>Infants at risk</td>
</tr>
<tr>
<td>AIMS &amp; TIMP</td>
<td>Campbell &amp; Kolobe (2000)</td>
<td>0.64 Between raw scores of scales.</td>
<td>90</td>
<td>Combination of low, medium and high risk infants</td>
</tr>
<tr>
<td>AIMS &amp; TIMP</td>
<td>Campbell &amp; Kolobe (2000)</td>
<td>0.60 Between raw scores on TIMP and percentile ranks on AIMS.</td>
<td>90</td>
<td>Combination of low, medium and high risk infants</td>
</tr>
<tr>
<td>AIMS &amp; HINT</td>
<td>Tse et al. (2008)</td>
<td>0.831- entire sample</td>
<td>121;72;49</td>
<td>Typical and at risk infants 4 -6.5 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.809 at risk group</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.867 typical group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIMS &amp; HINT</td>
<td>Tse et al. (2008)</td>
<td>0.849 entire sample</td>
<td>109;64;45</td>
<td>Typical and at risk infants 10 - 12.5 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.928 at risk group</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.596 typical group</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.5.3.2 Predictive Validity

Only one study reported on the predictive validity (sensitivity and specificity) of the AIMS (Darrah et al., 1998). One hundred and sixty four infants were used in the study, at the 18 month evaluation, 128 infants were classified with typical motor development, 14 were classified as suspicious and 22 infants were classified as atypical in their motor development.

Two cut off points are accepted to identify infants at risk for developmental delays on the AIMS namely the 5th and 10th percentile. The best balance between specificity and sensitivity on the AIMS was the 10th percentile at 4 months of age. An additional infant was classified as high risk when the 10 percentile is used at 8 months and an additional 10 infants were classified as typical when the 5th percentile is used at 8 months.

The study suggests that the 5th percentile should be used at 8 months when wanting to identify typically developing infants and the 10th percentile should be used at 8 months when wanting to identify atypical infants. The AIMS and the MAI (Motor Assessment of Infants) have similar sensitivity values for the 4 month age category (AIMS 77.3%; MAI 72.7%), but the MAI had better specificity values for the same age (4 months) (MAI 93.0%; AIMS 81.7%). At 8 months the AIMS and the MAI sensitivity values are (AIMS 86.4%; MAI 95.5%) and the specificity values are (AIMS 93.0%; MAI 80.3%) (Table 2.2).

<table>
<thead>
<tr>
<th>Author</th>
<th>Assessment at 4 &amp; 8 months of age</th>
<th>Best cut off points for the AIMS</th>
<th>No. of infants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darrah, Piper &amp; Watt(1998)</td>
<td>AIMS, MAI &amp; PDGMS</td>
<td>10th percentile @ 4 months of age; and the 5th and 10th percentile@ 8 months of age</td>
<td>164 infants: 128 typical, 14 suspicious and 22 atypical (classified @ 18 months of age)</td>
</tr>
</tbody>
</table>
2.5.3.3 Inter-rater reliability

All of the studies used in this review showed high levels of interrater reliability for the AIMS (Jeng et al., 2000; Fleuren et al., 2007; Campbell & Kolobe, 2000; Tse et al., 2008; Blanchard et al., 2004; Piper & Darrah, 1994). The correlation coefficients ranged from 0.72-0.99 and are illustrated in Table 2.3.

Table 2.3  The interrater reliability of the AIMS

<table>
<thead>
<tr>
<th>Authors</th>
<th>Amount of training time</th>
<th>Interrater score</th>
<th>No. of raters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeng et al. (2000)</td>
<td>32 hours</td>
<td>ICC &gt;0.95 across all age groups; ICC’s for most subscales &gt;0.90 across most subscales</td>
<td>2</td>
</tr>
<tr>
<td>Fleuren et al. (2006)</td>
<td>Not specified</td>
<td>Spearman rank correlation coefficient for each item 0.93-0.99 and total scores 0.99.</td>
<td>2</td>
</tr>
<tr>
<td>Campbell &amp; Kolobe, (2000)</td>
<td>1 day</td>
<td>Raters passed the reliability test with the reliability criteria of less than 5% of inappropriate ratings.</td>
<td>11</td>
</tr>
<tr>
<td>Tse et al. (2008)</td>
<td>6 training sessions</td>
<td>ICC of 0.72-0.98 for 6 training sessions; ICC &gt;0.93</td>
<td>22</td>
</tr>
<tr>
<td>Blanchard et al. (2004)</td>
<td>1.5 hours</td>
<td>ICC from 0.98-0.99</td>
<td>8</td>
</tr>
<tr>
<td>Piper &amp; Darrah, (1994)</td>
<td>Not specified</td>
<td>ICC = 0.9967</td>
<td>2</td>
</tr>
</tbody>
</table>

2.5.3.4 Intra-rater reliability

Only one study reported on the intrarater reliability (Jeng et al., 2000) of the AIMS, with an ICC of 0.95 for the total scores and intraclass coefficients ranging between 0.85-0.99 for the subscales (Table 2.4).
Table 2.4 The intrarater reliability of the AIMS

<table>
<thead>
<tr>
<th>Authors</th>
<th>Intrarater score</th>
<th>No. of raters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeng et al. (2000)</td>
<td>ICC &lt;0.95 total score; 0.85-0.99 subscales</td>
<td>1</td>
</tr>
<tr>
<td>Piper &amp; Darrah, (1994)</td>
<td>0.9925</td>
<td>1</td>
</tr>
</tbody>
</table>

2.5.3.5 Cross cultural validity

One study examined the cross cultural validity of the AIMS. The study was conducted in the Netherlands where 100 infants between the ages of 0-12 months were assessed using the AIMS (Fleuren et al., 2007).

The cross-cultural study conducted in the Netherlands concluded that new reference values on the AIMS are needed for Dutch children between the ages of 0-12 months. Seventy five percent of the Dutch children, who participated in the study, scored less than the 50th percentile. These scores were not explained by congenital disorders, race or differences in sex (Fleuren et al., 2007).

2.6 SUMMARY POINTS

- The AIMS demonstrated high concurrent validity with the PDMS and the BSID.
- Good values for predictive validity were found on the AIMS but only one study reported on this.
- High correlation coefficients were reported for the studies that involved interrater and intrarater testing.
- Only two published studies were aimed at cross-cultural validation of the AIMS.
- Overall the AIMS demonstrates that it is a useful and effective tool in identifying and monitoring infants with gross motor delay and who are at risk for developmental delay.
CHAPTER 3

METHODOLOGY

The methodology of the study will be presented in this chapter. Firstly, the research aim, research question, objectives, study design and population will be reported. This will be followed by a detailed description of the instrumentation, procedure, data analysis and ethical considerations. The study consisted of four assessment phases at different age periods of the subjects and the methodology of these phases will be presented simultaneously. This research project is a preliminary study for a future AIMS validation study on a larger sample of infants from all socioeconomic groups within the Western Cape.

3.1 AIM OF THE STUDY

The main aim of the study was to validate the Canadian norms for the AIMS for infants aged four to eighteen months within the Cape Metropolitan region.

3.2 RESEARCH QUESTION

Are the Canadian norms for the AIMS valid when assessing the normal gross motor function of infants, at 4, 8, 12 and 18 months of age within the Cape Metropolitan region?

3.3 OBJECTIVES

The objectives of the study were:

- to gain normative AIMS data on a cohort of full term infants at 4, 8, 12 and 18 months of age.
• to gain demographic data on a cohort of full term infants at 4, 8, 12 and 18 months of age.
• to compare the normative Cape Town AIMS data (the public and private Baby Well clinics) to that of the Canadian AIMS norms.
• to compare the normative AIMS data between infants from Baby Well clinics in the public and private sector.
• to compare the normative Cape Town AIMS data between the different race groupings.
• to establish intrarater reliability of the principle researcher as well as the interrater between the principle researcher and the Researcher A when assessing the gross motor function of infants at 4, 8, 12 and 18 months of age with the AIMS.

3.4 STUDY DESIGN

A prospective descriptive study was conducted to answer the research question and the objectives.

3.5 POPULATION

The population consisted of normal infants residing in the Cape Metropolitan region.

3.5.1 SAMPLING METHOD

A convenient successive sampling method was used to recruit the infants from two Baby Well clinics within the Cape Metropolitan region. Since the study had to be conducted within a 2 year period (due to financial constraints) and infants had to be followed up till 18 months of age, only infants born during June through to November 2007 were recruited. The assessments were conducted at both private and public institutions to ensure that all levels of socioeconomic groups were represented. The assessments at the private institution took place at the Pikanini Baby Well Clinic (Louis
Leipoldt Baby Well Clinic). The clinic is situated in Bellville, and is attached to a large secondary hospital and caters for infants from all races in the middle to upper socio economic population with approximately forty newborn infants during the month of June 2007 (Geraldine Ponsetti, 2009, head nurse, Pikanini Baby Well Clinic, personal correspondence, 2 May). The assessments at the public institution took place at the Hanover Park Clinic, situated in the Hanover Park area which caters predominantly for infants in the lower to middle class socio-economic population within the black, coloured and Indian communities. Seventy nine newborn infants visited the clinic for the month of June 2007 (Judy Hendricks 2009, head nurse, Hanover Park Clinic, personal correspondence, 2 May).

3.5.2 Sample Description

The sample consisted of infants aged 4-18 months from all levels of socioeconomic groups at a public (Hanover Park Clinic) and a private clinics (Pikanini Baby Well clinic).

3.5.2.1 Inclusion criteria

- Infants of all races, representative of the infant population within the Cape Metropolitan region, namely, Black, Coloured, Indian and White.
- Infants at four months of age, since this was the age when the first assessment was conducted.
- Infants born at full term (>37 weeks of gestation), since infants born prematurely may have motor developmental delays (Allen, 2000).
- Birth weight of > 2500g, since small for gestational age infants may have a delay in their motor development (do Espírito Santo, Portuguez, Nunes, 2009).
- Nurses managing the Baby Well Clinics were asked to only give names of infants who were HIV negative.
3.5.2.2 Exclusion Criteria

- Infants with congenital and genetic disorders, as this would have impaired normal motor development.
- Infants who do not display any normal movement patterns/milestones on the day of testing due to any illness and/or medication that made the infant irritable and/or causes depression of the central nervous system.
- Current diagnosis of Kwashiorkor or Marasmus, since this could have temporarily delayed normal motor development.
- Extended hospitalization (more 25% of their lives), as prolonged hospitalization would have temporarily delayed normal motor development.
- Parents who intend to use baby walkers for their infants, as this may influence the development of milestones such as independent sitting and crawling (Burrows & Griffiths, 2002; Garret, McElroy & Staines, 2006).
- Infants without written consent by parents/or legal guardians.

3.6 INSTRUMENTATION

The AIMS was the only tool used in this study to assess the motor development of infants. The justification, items, scoring and the psychometric properties of the AIMS will be discussed in the following sections of this chapter.

3.6.1 THE ALBERTA INFANT MOTOR SCALE (AIMS)

The AIMS is a performance based, norm referenced, observational measure that is used by health professionals to record spontaneous movement abilities of infants from birth up to the age of eighteen months (Piper and Darrah, 1994). The AIMS was developed in Canada in the early 1990s (Piper & Darrah, 1994) in order to identify any early motor development problems in infants, so that early intervention could take place
(Long & Treman, 1998). The AIMS detects any deviation from normal movements and is also used to assess the quality of movement patterns (Majnemer & Snider, 2005). The assessor observes and records the infant’s abilities in four positions (supine, prone, sitting and standing). Testing procedures for the AIMS take approximately 15-20 minutes per infant, part of which can be used for the infant to adapt to its surroundings. The assessment does not require the assessor to handle the infant or to facilitate movement, but prompting may take place where necessary (Piper & Darrah, 1994).

### 3.6.1.2 Items of the AIMS

There are 58 items assessed in four starting positions i.e. 12 in sitting, 16 in standing, 9 in supine and 21 prone. Each item assesses the achievement of a new motor milestone as well as the quality of the newly acquired motor skills. The items are depicted in the AIMS Manual by a drawing and a photograph and the manual also provides more detailed descriptions, such as anti gravity movements, postural alignment and weight bearing (Piper & Darrah, 1994).

### 3.6.1.3 Scoring of the AIMS

The items of the AIMS are scored on a dichotomous scale as either observed or not observed. Observed items obtain one point and items not observed obtain no points, as according to the criteria set out in the AIMS manual. The sum of the positional scores for each of the four positions equals the total raw score. The scores range between zero and fifty eight and increases between these numbers as the infant’s motor repertoire develops with age. A graph is provided to plot the infant’s total AIMS score (see Appendix IV). The percentile ranking was determined by consulting the Table in Appendix II on page 204 in the AIMS manual. The column that contains the infant’s age was located. The infant’s score was located in the raw score column. The percentile rank was located at the intersection of the infant’s raw score and the age group (Piper & Darrah, 1994).
If a happy and active infant still failed to perform an item after a 30 minute assessment, it can be concluded that the item was not currently part of the infant’s gross motor repertoire. Piper and Darrah (1994) also recommended that the examiner should complete the score sheet at the end of the assessment, and not during the observational period. In this way, the examiner’s attention is focused on observing and analysing the infant’s movements, rather than identifying each skill separately in order to complete the score sheet.

3.6.1.4 AIMS Manual score sheet

The AIMS manual includes a score sheet, combining graphical presentations as well as descriptions denoting the motor pattern and sequence of each item. This score sheet was photocopied for each subject to be scored on (Appendix IV).

3.6.1.5 Psychometric Properties of the AIMS

Concurrent validity of the AIMS
Refer to Chapter 2 section 2.5.3.1 of the Systematic Review.

Reliability of the AIMS
Refer to Chapter 2 section 2.5.3.3 of the Systematic Review.

3.6.2 VIDEO CAMERA

A light sensitive digital video camera (JVC GR-DV4000) was used to record the infants’ gross motor repertoire on JVC digital compact videocassettes.
3.6.3 Subject Demographic Sheet

A subject demographic data sheet (Appendix VI) was compiled for this study by the principal researcher. The following information was collected:
1. Infants name and surname,
2. Identification number,
3. Date of birth,
4. Sex,
5. Gestation,
6. Birth weight,
7. Ethnic group,
8. Contact details of parents/legal guardians,
9. Dates of each of the assessments at 4 months, 8 months, 12 months and 18 months.

3.7 Study Procedures

The purpose for the subject demographic sheet was to capture information with the first assessment of the infant and this was updated with each visit. Parents/legal guardians were asked if their infant was hospitalised for more than 4 weeks during the past four months and if the infant was using a baby walker. The assessment data of infants who were hospitalised for more than four weeks and/or used a baby walker between any of the four assessments were not included in the study, but the parents/legal guardians were encouraged to bring their infants for the follow-up assessments to determine if the infants needed any form of therapeutic intervention.

3.7.1 Research Team and Training of Principal Researcher

The research team consisted of two researchers, the principal researcher and a research assistant (researcher A). The principal researcher, a registered physiotherapist, is the Master's candidate and researcher A has a Master's degree in
Physiotherapy (Paediatric Neurology), Stellenbosch University 2006. Researcher A was also the supervisor for this research project. The principal researcher was trained in using the AIMS by researcher A who had extensive experience with the AIMS during previous research projects in South-Africa and the Netherlands. Training took place one month before the commencement of the Pilot study. The principal researcher had to accustom herself with the AIMS manual. Video recordings for each age category were used to train the principle researcher, ensuring that the principle researcher acquired the necessary skills in performing observational assessments for each of the four age categories.

3.7.2 PILOT STUDY

The pilot study was conducted on five healthy infants, who were four months of age during November 2007, and on two infants each at 8, 12 and 18 months of age (prior to the 8, 12 and 18 months of age assessments), at both the Hanover Park and Louis Leipoldt baby clinics. These infants were recruited into the main study.

The aims of the pilot study were:

- to determine the practical arrangements, such as availability of information on the general health of the infants in the clinic files,
- to determine the venue availability and adequacy in terms of space, setting up the equipment and temperature for the test procedures of the main study,
- to determine how long it would take to complete the data capturing sheet and the AIMS assessment.
3.7.3 FINDINGS OF THE PILOT STUDY
3.7.3.1 Practical arrangements

If there was not sufficient information in the infants’ clinical files, then the parent(s) or legal guardians were contacted telephonically to obtain the necessary information.

3.7.3.2 Venue for data collection

Both clinics had adequate space for the assessments to take place. A heater was available at both venues and was used when necessary. An exercise mat was acquired for the Hanover Park Clinic and stored at the principal researcher’s home. The mat was a prerequisite for the 8, 12 and 18 month follow ups.

3.7.3.3 Proposed time limit

The proposed time limit (approximately 30 minutes per assessment) was sufficient for the AIMS assessment to take place and be completed at both clinics.

3.7.4 PROCEDURE OF THE MAIN STUDY

This section describes the procedure that was followed in the main study for the assessments of the infants at:

- 4 months of age
- 8 months of age
- 12 months of age
- 18 months of age
3.7.4.1 Recruitment of the sample

The principal researcher was responsible for recruiting and assessing the sample population. The sisters in charge of the Hanover Park and Louis Leipoldt Baby Well clinics were contacted, and asked to supply a list of all infants eligible for the study who were born during June through November 2007. The principal researcher consulted the infants’ clinical files to obtain the families’ contact details and to establish their home language. Information from the clinical files was also used to determine which infants met the inclusion and exclusion criteria. If the information was not available in the infants’ clinical files, the principal investigator obtained it from the parents telephonically. Lists of all the eligible infants born during June through to November 2007 were compiled by the principal researcher.

3.7.4.2 Invitation to participate

Parent(s) or legal guardian(s) were contacted telephonically by the principal researcher and invited to participate in the study. Standard information regarding the study was given to the parent(s) or legal guardian(s) over the telephone (Appendix VI.). The information sheet was translated from English, into Afrikaans. A Xhosa information sheet was not needed as the Xhosa speaking parent(s) and or legal guardian(s) could understand and comprehend English.

Researcher A requested the parent(s) or legal guardian(s) to bring their infant to the clinic for four assessments over a 14 month period, when the infant was 4, 8, 12 and 18 months old respectively. The participants were not financially remunerated for their participation in the study, but a transport reimbursement of R20 was paid for each visit. Researcher A explained to the parent(s) and/or legal guardians(s) that their infants should not use baby walkers since this may have a negative affect on the development and acquisition of motor skills, like independent walking, sitting as well as crawling...
(Burrows & Griffiths, 2002; Garret, McElroy & Staines, 2006). This information was also included in the consent form.

Once permission to participate in the study was given telephonically by the parent(s) or guardian(s), the first appointment was made when the infant was 4 months old. During the first appointment, the study purpose and procedures were explained to the parents and they were asked to sign a consent form (Addendum VI). The consent form was available in both English and Afrikaans. The infants were assigned an identification number by the principal researcher for analysis. The parents were encouraged to contact the principal researcher to discuss any questions regarding the neurodevelopmental progress of their infant throughout the study.

3.7.4.3 Venue for data collection

At both clinics, the assessments took place in a private room with a 1x1 metre soft mat, toys and a low examination table. An assessment room at Hanover Park Clinic was made available on Mondays, Wednesdays and Thursdays. A room used for administering injections was made available at the Pikanini Baby Clinic on Mondays, Wednesdays and Fridays.

3.7.4.4 Gross motor assessments and video recordings

At four months of age the infants were placed on an examining table and at 8, 12 and 18 months of age the infants were placed on a padded exercise mat on the floor. A digital video camera was used to record the infants’ gross motor repertoire on JVC digital compact videocassettes. The infant was videotaped in four different positions, namely sitting, standing, supine and prone. The infants were dressed lightly and comfortably to avoid restriction of movements. The infants were also encouraged by the principal researcher who used toys to encourage them to move in and out of the positions mentioned above. Fifteen to twenty minutes of the infants’ gross motor pattern
was recorded. If the infant started crying, the video recording was stopped to allow for the infant to be consoled or fed by their parent(s) or legal guardian(s). If the infant did not settle down in this period the mother was asked to bring the infant back on another day (within a week of the assessment that was interrupted).

3.7.4.5. Storage of the video recordings

The video recording of the infant were edited by the principal researcher, so that optimal recordings could be transferred from video cassette to compact disc. The infants' assessments were stored under their identification numbers on compact discs.

3.7.4.6. Assessment of video recordings

The recordings of each infant’s gross motor repertoire (at 4, 8, 12 and 18 months) were assessed, analysed and scored on individual AIMS score sheets (Addendum IV) by the principal researcher. The raw scores were converted into a percentile ranks (See 3.6.1.3 for scoring of the AIMS).

3.7.4.7 Assessment at 4, 8, 12 and 18 months of age: interrater reliability

In order to determine the interrater reliability, researcher A assessed and scored the recordings of a sub-sample of infants in each age category. A random sub-sample of 80% of each age group was assessed to accommodate for dropouts in follow-up groups.
3.8 ASSESSMENTS AT 8, 12 and 18 MONTHS OF AGE

The same procedure for the AIMS assessment at 4 months of age was completed for the assessments at 8, 12 and 18 months. The only difference was that the infants were placed on a padded exercise mat on the floor for the assessments at 8, 12 and 18 months, whereas at 4 months the infants were placed on an examining table. The principal researcher was responsible for contacting the parent(s) and or legal guardian(s) and making all follow-up appointments and giving feedback to the parent(s) and or legal guardian(s) on the progress of the infant. Parents/ caregivers were paid R20 for each assessment and were telephonically contacted in advance to notify them about the assessment dates.

3.9 DATA ENTERING AND STATISTICAL ANALYSIS

The infants’ demographic data and their raw scores and percentile rankings were entered on an Excel spreadsheet. For inter rater reliability intra-class correlations (ICC) were calculated. For comparison of percentile ranks against a fixed 50% percentile, t-tests were conducted. Repeated measures ANOVAs were done to compare 4, 8 and 12 month rankings, taking into account gender and the clinic from which the infants came. Statistica version 9 were used for all analyses except the ICC’s which were calculated using the R programming language.

3.10 ETHICAL CONSIDERATIONS

- Confidentiality:
  The infant’s parent(s) or guardian(s) were assured that all information obtained was treated as confidential.
- **Consent:**
  Following ethical clearance and registration with the Research Committee of the Faculty of Health Sciences, Stellenbosch University (Ref number: N07/09/196), informed written consent was obtained from the parent(s) or legal guardian(s) of all infants who participated in the study.

- **Voluntary participation:**
  The infants and their parent(s) or guardian(s) took part in the study on a voluntary basis. The parent/caregiver could withdraw their child at any stage during the study.

- **Advice and referral:**
  The results were made available to all subjects and their parents/legal guardians. If any motor delays were identified at any of the four assessments, the parent(s) or guardian(s) were given advice and the infant was referred for intervention as deemed appropriate by the principal researcher. The assessment data of these infants were excluded from the study.

- **Financial benefits:**
  No financial benefits were paid to the participants of the study. A transport reimbursement of R20, 00 was paid for each visit to the clinics.

- **Video recordings:**
  All video recordings were destroyed upon completion of the study.
CHAPTER 4

RESULTS

The results of the study are presented in this chapter and are documented under the headings of sample size; demographic information regarding sample; AIMS score results and interrater reliability. A significance level of 5% (p< 0.05) was used as guidance for determining significant differences. Numbers are rounded off to two decimal points.

4.1 SAMPLE SIZE

The sample size during the first assessment, at four months, consisted of 67 infants from both private (Pikanini Baby Well Clinic) and public (Hanover Park Baby Clinic) institutions. In June through to November 2007, 40 newborn infants visited the private clinic and 79 newborn infants visited the public clinic, this meant that 119 infants were eligible for the study. Of these, 20 infants participated in the study from the private clinic and 47 infants participated from the public clinic. A total of 67 infants were recruited for the study and 52 parents/caregivers declined to participate in the study. At the 8 month AIMS assessment 50 infants were assessed, 17 infants were lost to follow up; 9 infants were lost to follow up at 12 months with 39 infants assessed and a further 12 infants were lost to follow up at 18 AIMS assessment resulting in 27 infants assessed for the 18 month AIMS assessment (Figure 4.1).
119 newborn infants eligible for AIMS research project

Private clinic
- 40 newborn infants attended clinic in June through to November 2007

AIMS assessment at 4 months:
- 20 infants participated in study

AIMS assessment at 8 months:
- 11 infants participated.
- 9 infants lost to follow up

AIMS assessment at 12 months:
- 9 infants participated in study.
- 2 infants lost to follow up

AIMS assessment at 18 months:
- 5 infants participated in study.
- 4 infants lost to follow up

Public clinic
- 79 newborn infants attended clinic in June through to November 2007

AIMS assessment at 4 months:
- 47 infants participated in study

AIMS assessment at 8 months:
- 39 infants participated.
- 8 infants lost to follow up

AIMS assessment at 12 months:
- 30 infants participated in study.
- 9 lost to follow up.

AIMS assessment at 18 months:
- 22 infants participated in study.
- 8 infants lost to follow up

AIMS assessment at 18 months
- 27 infants assessed
- End of study May 2009

Figure 4.1 CONSORT diagram indicating lost to follow-up
4.2 DEMOGRAPHIC PROFILE OF THE SAMPLE

4.2.1 GENDER AND ETHNIC GROUP

More female infants were assessed than male infants throughout all assessments. The majority of infants at four months were coloured (79%) followed by white infants at (12%), with black infants (7%) and Indian (1%) (Table 4.1).

Table 4.1 Characteristics of infants at 4, 8, 12 and 18 months of age

<table>
<thead>
<tr>
<th>4 Month Sample</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>37</td>
<td>30</td>
<td>67</td>
</tr>
<tr>
<td>Ethnic Group: Black</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Ethnic Group: Coloured</td>
<td>30</td>
<td>23</td>
<td>53</td>
</tr>
<tr>
<td>Ethnic Group: Indian</td>
<td>1</td>
<td>/</td>
<td>1</td>
</tr>
<tr>
<td>Ethnic Group: White</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>8 Month Sample</td>
<td>Female</td>
<td>Male</td>
<td>Total</td>
</tr>
<tr>
<td>Gender</td>
<td>32</td>
<td>18</td>
<td>50</td>
</tr>
<tr>
<td>Ethnic Group: Black</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Ethnic Group: Coloured</td>
<td>25</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>Ethnic Group: Indian</td>
<td>1</td>
<td>/</td>
<td>1</td>
</tr>
<tr>
<td>Ethnic Group: White</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>12 Month Sample</td>
<td>Female</td>
<td>Male</td>
<td>Total</td>
</tr>
<tr>
<td>Gender</td>
<td>24</td>
<td>15</td>
<td>39</td>
</tr>
<tr>
<td>Ethnic Group: Black</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ethnic Group: Coloured</td>
<td>20</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>Ethnic Group: Indian</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Ethnic Group: White</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>18 Month Sample</td>
<td>Female</td>
<td>Male</td>
<td>Total</td>
</tr>
<tr>
<td>Gender</td>
<td>16</td>
<td>11</td>
<td>27</td>
</tr>
<tr>
<td>Ethnic Group: Black</td>
<td>/</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ethnic Group: Coloured</td>
<td>14</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>Ethnic Group: Indian</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Ethnic Group: White</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
4.3 AIMS SCORE RESULTS AT 4, 8, 12 MONTHS OF AGE

4.3.1 PERCENTILE RANKINGS AT 4, 8 AND 12 MONTHS OF AGE

The infants’ percentile rankings for both the private and public institution at 4, 8 and 12 months of age are shown in Figure 4.2. The percentile rankings are slightly higher at 4 months when compared to the percentile rankings at 8 and 12 months.
Figure 4.2  Percentile rankings of infants at both Private and Public Baby Well clinics at 4, 8 and 12 months of age
4.3.2 MEANS TEST AT 4, 8 AND 12 MONTH PERCENTILE RANKINGS

Table 4.2 represents the test of means with only the 4 month percentile rank demonstrating statistical significance (p=0.015).

Table 4.2 Test of means against reference constant

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std.Dv.</th>
<th>N</th>
<th>Std.Err.</th>
<th>Reference Constant</th>
<th>t-value</th>
<th>Df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>4mnth Percentile rank</td>
<td>56.97</td>
<td>22.80</td>
<td>67</td>
<td>2.79</td>
<td>50.0000</td>
<td>2.50</td>
<td>66</td>
<td>0.01</td>
</tr>
<tr>
<td>8mnth Percentile rank</td>
<td>50.22</td>
<td>23.98</td>
<td>50</td>
<td>3.4</td>
<td>50.0000</td>
<td>0.06</td>
<td>49</td>
<td>0.95</td>
</tr>
<tr>
<td>12mnth Percentile rank</td>
<td>48.38</td>
<td>26.68</td>
<td>40</td>
<td>4.22</td>
<td>50.0000</td>
<td>-0.39</td>
<td>39</td>
<td>0.70</td>
</tr>
</tbody>
</table>
4.4 THE RELATIONSHIP OF THE AIMS PERCENTILE RANKINGS AND VARIOUS VARIABLES


Albeit infants at 4 months of age scored higher on the AIMS when compared to infants at 8 and 12 months of age, no statistical significant difference was found between assessments (p=0.38)(Figure 4.3).

Figure 4.3 Relationship of percentile rankings of the AIMS at 4, 8 and 12 months of age
4.4.2 Gender and Percentile Rankings

Figure 4.4 illustrates female infants scoring higher percentile rankings overall when compared to their male counterparts, however no statistical significant difference was found (p=0.68).

Figure 4.4 Relationship between percentile rankings of the AIMS and gender
4.4.3 Public and Private Institution and Percentile Rankings

Figure 4.5 demonstrates infants at Pikanini Baby Well Clinic (private institution) scoring higher percentile rankings on the AIMS when compared to infants at Hanover Park Baby Clinic (public institution). No statistical significant difference was found (p=0.18).

Figure 4.5  Relationship between percentile rankings and infants attending Hanover Park and Pikanini Baby Well Clinics
4.4.4 **Age and Percentile Rankings of Female and Male Infants**

At the 4 month percentile rank, female infants scored significantly higher than their male counterparts ($p=0.03$), however at 8 and 12 month percentile rankings the male infants were scoring slightly higher.

**Figure 4.6** Relationship between age and percentile rankings of female and male infants
4.4.4.1 Tests for statistical significant differences between age and the percentile rankings of male and female infants

Various statistical significant differences were found between the percentile rankings of male and female infants. They are highlighted in red (Table 4.3).

Table 4.3 Tests for statistical significant differences between age and the percentile rankings of male and female infants

<table>
<thead>
<tr>
<th>Comparisons Cell(1)–(2)</th>
<th>1st Mean 4mth Percentile rank*F</th>
<th>2nd Mean 4mth Percentile rank*M</th>
<th>Mean Differ. 16.18</th>
<th>Standard Error 6.35</th>
<th>P 0.01</th>
<th>-95.00% Cnf.Lmt 3.55</th>
<th>+95.00% Cnf.Lmt 28.82</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)–(2)</td>
<td>4mth Percentile rank*F</td>
<td>4mth Percentile rank*M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)–(3)</td>
<td>4mth Percentile rank*F</td>
<td>8mth Percentile rank*F</td>
<td>14.89</td>
<td>5.23</td>
<td>0.01</td>
<td>4.48</td>
<td>25.29</td>
</tr>
<tr>
<td>(1)–(4)</td>
<td>4mth Percentile rank*M</td>
<td>8mth Percentile rank*M</td>
<td>9.17</td>
<td>8.39</td>
<td>0.28</td>
<td>-7.51</td>
<td>25.82</td>
</tr>
<tr>
<td>(1)–(5)</td>
<td>4mth Percentile rank*F</td>
<td>12mth Percentile rank*M</td>
<td>16.16</td>
<td>5.78</td>
<td>0.01</td>
<td>4.66</td>
<td>27.66</td>
</tr>
<tr>
<td>(1)–(6)</td>
<td>4mth Percentile rank*M</td>
<td>12mth Percentile rank*M</td>
<td>12.95</td>
<td>8.5</td>
<td>0.13</td>
<td>-3.9</td>
<td>29.8</td>
</tr>
</tbody>
</table>
### 4.4.5 Age and Percentile Rankings of Infants Attending the Private and Public Institutions

Figure 4.7 shows that infants attending the private institution (Pikanini Baby Well Clinic) scored higher percentile rankings at 4, 8 and 12 months when compared to infants at the public institution (Hanover Park Baby Clinic), but no statistical significant difference was found (p= 0.90).

![Graph showing percentile rankings over age for infants attending different clinics.](image)

**Figure 4.7** Relationship between age, and the percentile rankings of infants attending Hanover Park and Pikanini Baby Well Clinics
### 4.4.5.1 Test for statistical significant differences between age and percentile rankings of infants attending the different clinics

One statistical significant difference was found between the 4 month percentile rank at Pikanini Baby Well Clinic and the 12 month percentile at Hanover Park Clinic (p=0.04) (Table 4.4).

**Table 4.4** Tests for statistical significant differences between age and percentile rankings of infants attending the different clinics

<table>
<thead>
<tr>
<th>Comparisons Cell(1)-(2)</th>
<th>1st Mean</th>
<th>2nd Mean</th>
<th>Mean Differ.</th>
<th>Standard Error</th>
<th>P</th>
<th>-95.00% Cnf.Lmt</th>
<th>+95.00% Cnf.Lmt</th>
</tr>
</thead>
<tbody>
<tr>
<td>{1}-{2}</td>
<td>4mnth Percentile rank*Hanover Park</td>
<td>4mnth Percentile rank*Pikanini</td>
<td>-5.5</td>
<td>6.4</td>
<td>0.39</td>
<td>-18.13</td>
<td>7.14</td>
</tr>
<tr>
<td>{1}-{3}</td>
<td>4mnth Percentile rank*Hanover Park</td>
<td>8mnth Percentile rank*Hanover Park</td>
<td>5.48</td>
<td>4.3</td>
<td>0.21</td>
<td>-3.1</td>
<td>14.1</td>
</tr>
<tr>
<td>{1}-{4}</td>
<td>4mnth Percentile rank*Hanover Park</td>
<td>8mnth Percentile rank*Pikanini</td>
<td>-3.96</td>
<td>8.45</td>
<td>0.72</td>
<td>-19.91</td>
<td>13.71</td>
</tr>
<tr>
<td>{1}-{6}</td>
<td>4mnth Percentile rank*Hanover Park</td>
<td>12mnth Percentile rank*Pikanini</td>
<td>-1.3</td>
<td>8.72</td>
<td>0.1</td>
<td>-18.5</td>
<td>16.2</td>
</tr>
<tr>
<td>{2}-{3}</td>
<td>4mnth Percentile rank*Pikanini</td>
<td>8mnth Percentile rank*Hanover Park</td>
<td>11</td>
<td>6.6</td>
<td>0.1</td>
<td>-2.06</td>
<td>24.00</td>
</tr>
<tr>
<td>{2}-{4}</td>
<td>4mnth Percentile rank*Pikanini</td>
<td>8mnth Percentile rank*Pikanini</td>
<td>2.4</td>
<td>8.14</td>
<td>0.77</td>
<td>-13.8</td>
<td>18.6</td>
</tr>
<tr>
<td>{2}-{5}</td>
<td>4mnth Percentile rank*Pikanini</td>
<td>12mnth Percentile rank*Hanover Park</td>
<td>14.05</td>
<td>6.8</td>
<td>0.04</td>
<td>0.61</td>
<td>27.5</td>
</tr>
</tbody>
</table>
4.4.6 Gender and Percentile Rankings of Infants at the Two Institutions

Female infants had higher percentile rankings than their male counterparts at Hanover Park Baby Clinic and male infants had higher percentile rank at Pikanini Baby Clinic. No statistical significant difference was found (p=0.12) (Figure 4.8).

Figure 4.8  Relationship between gender and the percentile ranks of infants attending private and public clinics
4.4.7 **Age and Gender at the Public and Private Institutions**

At Hanover Park Baby Clinic, female infants scored higher percentile rankings at 4, 8 and 12 months when compared to male infants. At Pikanini Baby Well Clinic, female infants only scored higher percentile rankings at 4 months and male infants had higher percentile ranks at 8 and 12 months, however no statistical significant difference was found (p=0.20)(Figure 4.9).

**Figure 4.9** Relationship between age and gender at both private and public clinics
4.4.7.1 Tests for statistical significant differences between age, gender and percentile rankings of infants attending the different clinics.

Various statistical significant differences were found between the variables and they are highlighted in red below (Table 4.5).

Table 4.5 Tests for statistical significant differences between age, gender and percentile ranks of infants attending the different clinics

<table>
<thead>
<tr>
<th></th>
<th>1st Mean</th>
<th>2nd Mean</th>
<th>Mean Differ.</th>
<th>Standard Error</th>
<th>P</th>
<th>-95.00% Cnf.Lmt</th>
<th>+95.00% Cnf.Lmt</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)-(3)</td>
<td>4mnth percentile rank<em>F</em>Hanover Park</td>
<td>4mnth percentile rank<em>M</em>Hanover Park</td>
<td>17.36</td>
<td>7.08</td>
<td>0.02</td>
<td>3.29</td>
<td>31.44</td>
</tr>
<tr>
<td>(1)-(7)</td>
<td>4mnth percentile rank<em>F</em>Hanover Park</td>
<td>8mnth percentile rank<em>M</em>Hanover Park</td>
<td>20.2</td>
<td>7.6</td>
<td>0.01</td>
<td>5.08</td>
<td>35.31</td>
</tr>
<tr>
<td>(1)-(9)</td>
<td>4mnth percentile rank<em>F</em>Hanover Park</td>
<td>12mnth percentile rank<em>F</em>Hanover Park</td>
<td>14.73</td>
<td>5.71</td>
<td>0.01</td>
<td>3.38</td>
<td>26.09</td>
</tr>
<tr>
<td>(1)-(11)</td>
<td>4mnth percentile rank<em>F</em>Hanover Park</td>
<td>12mnth percentile rank<em>M</em>Hanover Park</td>
<td>19.74</td>
<td>7.94</td>
<td>0.01</td>
<td>3.95</td>
<td>35.54</td>
</tr>
<tr>
<td>(2)-(3)</td>
<td>4mnth percentile rank<em>F</em>Pikanini</td>
<td>4mnth percentile rank<em>M</em>Hanover Park</td>
<td>21.68</td>
<td>9.3</td>
<td>0.02</td>
<td>3.17</td>
<td>40.18</td>
</tr>
<tr>
<td>(2)-(6)</td>
<td>4mnth percentile rank<em>F</em>Pikanini</td>
<td>8mnth percentile rank<em>F</em>Pikanini</td>
<td>21.65</td>
<td>9.08</td>
<td>0.02</td>
<td>3.56</td>
<td>39.71</td>
</tr>
<tr>
<td>(2)-(7)</td>
<td>4mnth percentile rank<em>F</em>Pikanini</td>
<td>8mnth percentile rank<em>M</em>Hanover Park</td>
<td>24.51</td>
<td>9.7</td>
<td>0.01</td>
<td>5.21</td>
<td>43.81</td>
</tr>
<tr>
<td>(2)-(9)</td>
<td>4mnth percentile rank<em>F</em>Pikanini</td>
<td>12mnth percentile rank<em>F</em>Hanover Park</td>
<td>19.05</td>
<td>9.12</td>
<td>0.04</td>
<td>0.91</td>
<td>37.18</td>
</tr>
<tr>
<td>(2)-(11)</td>
<td>4mnth percentile rank<em>F</em>Pikanini</td>
<td>12mnth percentile rank<em>M</em>Hanover Park</td>
<td>24.06</td>
<td>9.97</td>
<td>0.02</td>
<td>4.22</td>
<td>43.9</td>
</tr>
</tbody>
</table>
4.4.8 AIMS AND ETHNICITY

4.4.8.1 The relationship between race and percentile rankings of infants

Figure 4.10 depicts the relationship between race and percentile rankings of the infants who participated in the study. No statistical difference was found (p=0.4).

---

Figure 4.10  Relationship between race and percentile rankings
### 4.4.8.1.2 Test of means for race groupings

Table 4.6 indicates the percentile means for the different race groupings.

**Table 4.6** Table of percentile means for the different race groups.

<table>
<thead>
<tr>
<th>Cell No.</th>
<th>Race</th>
<th>Percentile mean</th>
<th>Percentile Std. Err.</th>
<th>Percentile - 95.00%</th>
<th>Percentile +95.00%</th>
<th>N (= amount of assessments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>coloured</td>
<td>50.85</td>
<td>2.67</td>
<td>45.51</td>
<td>56.19</td>
<td>124</td>
</tr>
<tr>
<td>2</td>
<td>white</td>
<td>56.78</td>
<td>6.83</td>
<td>43.13</td>
<td>70.44</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>black</td>
<td>42.04</td>
<td>8.6</td>
<td>24.86</td>
<td>59.23</td>
<td>12</td>
</tr>
</tbody>
</table>

### 4.4.8.1.3 Tests for statistical significant differences between race groupings

Table 4.7 indicates that no statistical significant differences were found between race groupings.

**Table 4.7** Test for statistical significant difference for race

<table>
<thead>
<tr>
<th>Comparisons Cell[#1]-[#2]</th>
<th>1st Mean</th>
<th>2nd Mean</th>
<th>Mean differ.</th>
<th>Standard Error</th>
<th>P</th>
<th>-95.00% Cnf.Lmt</th>
<th>+95.00% Cnf.Lmt</th>
</tr>
</thead>
<tbody>
<tr>
<td>{1}-[2] coloured White</td>
<td>-5.96</td>
<td>7.34</td>
<td>0.421</td>
<td>-20.6</td>
<td>8.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>{1}-[3] coloured Black</td>
<td>8.81</td>
<td>9.01</td>
<td>0.33</td>
<td>-9.19</td>
<td>26.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>{2}-[3] White Black</td>
<td>14.74</td>
<td>10.18</td>
<td>0.18</td>
<td>-7.21</td>
<td>36.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.4.8.2  Relationship between race and percentile rankings on the AIMS

Figure 4.11 demonstrates that white infants scored higher percentile ranks when compared to the black and coloured infants that participated in the study.

![Graph showing relationship between race, age, and percentile rankings](image)

**Figure 4.11**  Relationship between race, age and percentile rankings on the AIMS
4.4.8.2.1 Tests for statistical significant differences between age and race

Table 4.11 demonstrates the various statistical significant differences between the race groupings and age of infants at assessments.

Table 4.8 Test for statistical significant difference between age and race.

<table>
<thead>
<tr>
<th></th>
<th>1st Mean</th>
<th>2nd Mean</th>
<th>Mean Differ.</th>
<th>Standard Error</th>
<th>P</th>
<th>-95.00% Cnf.Lmt</th>
<th>+95.00% Cnf.Lmt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4mnths*coloured</td>
<td>8mnths*black</td>
<td>27.25</td>
<td>11.86</td>
<td>0.02</td>
<td>3.66</td>
<td>50.84</td>
</tr>
<tr>
<td>2</td>
<td>4mnths*coloured</td>
<td>12mnths*coloured</td>
<td>10.47</td>
<td>4.23</td>
<td>0.02</td>
<td>2.05</td>
<td>18.89</td>
</tr>
<tr>
<td>3</td>
<td>4mnths*white</td>
<td>8mnths*black</td>
<td>32.65</td>
<td>14.06</td>
<td>0.02</td>
<td>4.7</td>
<td>60.61</td>
</tr>
<tr>
<td>4</td>
<td>4mnths*coloured</td>
<td>8mnths*black</td>
<td>31.25</td>
<td>12.45</td>
<td>0.01</td>
<td>6.48</td>
<td>56.01</td>
</tr>
</tbody>
</table>

4.5 AIMS SCORE AT 18 MONTHS

At the 18 month AIMS assessment 27 infants were assessed from both Pikanini and Hanover Park Clinic. The raw scores cannot be converted to percentile ranks at 18 months (Piper & Darrah, 1994). Out of these, seventeen (62.96%) infants scored 58, seven (25.93%) infants scored 57, two (7.41%) infants scored 56 and one (3.7%) infant scored 51. Data could not be statistically analysed as the AIMS reaches a ceiling effect from the 12 month age category and not much variability is seen in the data. (Refer to Appendix V for details on correspondence with the AIMS authors).
4.6 INTERRATER RELIABILITY

4.6.1 INTERRATER RELIABILITY AT THE 4 MONTH AGE ASSESSMENT

Figure 4.12 depicts the interrater reliability between the two assessors at the 4 month age assessments, with ICC (agreement) =0.995, Spearman r = 0.9949 and p=0.0000.

Figure 4.12 Interrater reliability between assessors at 4 month age assessments
4.6.2 Interrater Reliability at the 8 Month Age Assessment

Figure 4.13 depicts an ICC (agreement) =0.998, Spearman r=0.9977 and p=0.0000, between the two assessors at 8 months age assessments.

**Figure 4.13** Interrater reliability between assessors at 8 months age assessments
4.6.3 Interrater Reliability at the 12 Month Age Assessment

Figure 4.14 represents an ICC=0.984, Spearman r=0.9870 and p=0.0000

![Graph showing reliability data between Marlette and Alana at 12 months age assessment]

**Figure 4.14** Interrater reliability between assessors at 12 month age assessments
4.7 ISSUES REGARDING THE SAMPLE AND SAMPLE SIZE

The sample used in this study was selected from two clinics within a contained time period and must therefore be classified as a sample of convenience. In that regard the availability of subjects to include in the sample during the study period determined the sample size and number of infants included in the study.

A review of the results indicated the following regarding sample sizes:

4.7.1 When comparing the current sample of infants to the Canadian 50% percentile, the results showed a significant difference (p=0.01) for the 4 month old infants. In this regard the sample was large enough to actually indicate a significant difference. For the 8 and 12 month age groups, the results indicated highly non-significant p-values (p=0.95 and p=0.70 respectively), from which can be deducted that there is strong evidence that the average percentiles for these age groups did not differ significantly from 50%. Thus the current sample contained strong evidence for the null hypothesis ($H_0$: mean=50%) and larger sample sizes could be deemed unnecessary.

4.7.2 Comparisons were also done between race groups and clinics, but these results were not part of the main aim of the study, and was done more for interest sake to see if these variables might play a role. In these cases the statistical results were not clear, but did show trends for possible differences between the groups. A case could thus be made for follow-up studies to verify the trends found in the current sample. So, based on the effect sizes calculated from the current sample, the following sample sizes were determined: clinics – 260 babies per clinic, race 75 per race group. The latter was calculated based on differences between black and white race groups.
DISCUSSION

5.1 INTRODUCTION

The clinical utility of an assessment tool should be taken into account when considering which assessment tool to administer (Spittle et al., 2008). Clinicians need an easily accessible assessment tool that needs minimal training and that can be administered easily. The practicality of the AIMS lends itself to being used in a high risk clinic environment; the assessment requires minimal handling of the infant which allows the infant to move around freely (Bartlett, 1995). The AIMS incorporates all these features which make it feasible for therapists to use in a clinical setting (Spittle et al., 2008). In a systematic review of the psychometric properties of assessment tools for infants and children, the AIMS showed that it had the best clinical utility (Spittle et al., 2008).

The purpose of this study was to validate the Canadian norms for the AIMS (Alberta Infant Motor Scale) for infants aged four to eighteen months within the Cape Metropolitan region. This chapter presents a discussion of the results with the inclusion of other studies that have tested the same constraints.
5.2 FACTORS INFLUENCING MOTOR DEVELOPMENT

5.2.1 DEMOGRAPHICS

5.2.1.1 Gender

Overall the female infants performed better than their male counterparts, although the difference was insignificant (Refer to section 4.4.2 in Results Chapter). However, when the relationship between gender and percentile is examined, statistical significant difference is found between the motor performance of males and females at the 4 month percentile rank, with female infants scoring significantly better than males (refer to Section 4.4.4 of Results, Chapter 4). A possible explanation could be that female infants attain gross motor milestones earlier than their male counterparts, but the exact reasons for this is unclear (Garza, de Onis, Martorell, Dewey & Black 2006). A study by the WHO multicentre growth reference study group (Garza et al., 2006), states that differences in gross motor development between female and male infants is not due to physiological sex based differences. The difference in motor development is postulated to be due to differences in handling and care practices, such as positioning of infants during feeding, play and rest. Therefore further research into gender specific strata is required to provide more insight into the attainment of motor milestones in infants.

5.2.1.2 Ethnicity

Ethnicity was not a primary objective of this study but the findings related to ethnicity is of interest due to the effects of ethnicity and gross motor development as well as the diversity of the infants assessed in this research project. The current study on the AIMS within the Cape Metropole included infants from different race groupings, namely black (57%), coloured (53%), Indian (1)1% and White (8) 12%.

No statistical significant differences were found between the race groupings overall, but statistical significant differences were found between race groupings between the different age groupings (Refer to 4.4.8 of the Results, Chapter 4). Explanations in the
differences of gross motor development in infants of various ethnic backgrounds include biological factors such as birthweight and gestational age and environmental factors such as the choice of parental and child rearing practices (Kelly, Sacker, Schoon & Nazroo, 2006). As stipulated in Chapter 3, only full-term infants (> 37 weeks gestation) were included in this study. Since infants with a low birth weight (<2500g) and low gestational age (<37 weeks) were excluded, low birthweight and gestational age were ruled out as having a negative influence on gross motor development in this study. However, in the presence of favourable conditions, physical growth and gross motor development in early childhood are heterogeneous across different ethnic populations (Garza et al., 2006).

In this study, the infants at four months also performed significantly better than the Canadian norms. Therefore this finding is in agreement with Garza et al (2006) who reported significant differences in gross motor attainment in infants from Ghana and infants compared to Norway. Reports indicated that Ghanaian carers engaged in practicing optimal positioning of infants so as to increase the possibility of gross motor milestone attainment, whereas Norwegians allowed for the infant to attain gross motor milestones on their own without accelerating it by facilitation. This explanation may also be applicable to the difference between this South African sample and the Canadian cohort. Capute, Shapiro, Palmer (1985) also reported that black infants achieved gross motor milestones earlier than white infants. Although Garza et al. (2006) concluded that these differences in gross motor development may be due to care practices associated with culture, further analyses to understand the differences between countries needs to be conducted.
5.3 Cross Cultural Validation

The overall AIMS scores of the infants included in this study revealed that the Canadian normative data can be used to compare infants from 8 – 12 months of age within the Cape Metropole, South Africa; however care needs to be taken when infants’ scores at 4 months are compared to the scores of the normative sample.

In a cross-cultural validation study in the Netherlands, the Dutch infants scored lower on the AIMS than the Canadian normative sample this could be attributed to there being a large timeframe between the two studies (Fleuren et al., 2007). The Canadian infants were assessed between 1990 and 1992 and the Dutch children were assessed in 2004. Secondly the Dutch government have advocated supine sleep positions to prevent Sudden Infant Death Syndrome (SIDS). Numerous studies have shown that the supine sleep position has a negative impact on gross motor development (Majnemer & Barr, 2005).

Cross cultural validity of an assessment scale is important as the developmental characteristics of infants may differ from one country to another (Fleuren et al., 2007). The AIMS was developed in Canada, that is, before this assessment tool can potentially be used across cultures and for infants from different ethnic and socioeconomic backgrounds, cross-cultural validation needs to be established (Jeng et al., 2000). There is a lack of published research into cross-cultural validation of assessment scales (Chapter 2). Only one study reviewed in Chapter 2 were aimed at cross-cultural validation of the AIMS (Fleuren et al., 2007). Fleuren et al., (2007) concluded that new normative data for the AIMS is required for Dutch children as well as a recommendation for children in other European countries. These finding affirms the need for cross-cultural validation of motor development scales.
5.4 SOCIOECONOMICS AND GROSS MOTOR DEVELOPMENT

5.4.1 Differences found between public and private institutions

Overall, regardless of gender, the infants from the Pikanini Baby well clinic (Private Clinic) scored higher percentile rankings than the infants from Hanover Park baby clinic (Public Clinic). However no statistical significant differences were found. Statistical significant differences were found when variables such as age of percentile ranking, gender and differences between the two clinics were compared (refer to Results, Chapter 4). This finding contradicts the findings from the literature which indicate that living in poverty has a negative effect on development. (Seguin, Xu, Potvin, Zunzunegui, Frohlich, 2003).

A study conducted in Berlin, Germany, children with a lower social level were found to have had lower motor skills outcomes. The study therefore states that there are differences in motor development due to the social level of the child being assessed (Scheffler, Kettelhut, Morgenstern, 2004). An association between low income and poor developmental attainment (PDA) was found across all age groups of children in a study conducted in Canada (To, Guttmann, Dick, Rosenfield, Parkin, Cao, Vydykhan, Tassoudji, Harris, 2004).

Less than sufficient household incomes are linked to poor overall health and more hospital admissions among infants within the first 5 months of age (Seguin et al., 2003). Insufficient household income also has an impact on toddlers’ health regardless of neonatal health problems or maternal education. Even with universal health care, children’s health can be negatively affected by the absence of material resources (Seguin, Xu, Gauvin, Zunzunegui, Potvin, Frohlich, 2007). Recent studies show that there is a connection between poor children with growth delay and cognitive and motor development (Cheng, Yip, Karlberg, 2001.)
In this cohort of infants, the difference in socio-economic status may have been too large to negatively impact the motor development scores of infants assessed at Hanover Park which is a relatively poorer area. This is in concordance with a study conducted in Brazil, where no significant differences were found in motor development between infants of low and middle socioeconomic status (Paine & Pasquali, 1983). Socioeconomics was not adequate assessed in this study as it was not a study objective, but it, should be considered in future studies.

5.5 CHARACTERISTICS OF THE AIMS

5.5.1 RELIABILITY OF THE AIMS

5.5.1.1 Interrater reliability for the AIMS assessments at 4, 8, 12 and 18 months of age

As found with the systematic review in Chapter 4 all of the studies testing interrater reliability demonstrated high levels for the AIMS (Jeng et al., 2000; Fleuren et al., 2006; Campbell & Kolobe, 2000; Tse et al., 2008; Blanchard et al., 2004; Piper & Darrah, 1994). The correlation coefficients ranged from 0.72-0.99 and are illustrated in Table 2.3 of the systematic review, Chapter 2. The current study reflects excellent interrater reliability values for reliability at 4 months; 8 months and 12 months (Refer to Section 4.6 of Results, Chapter 4). Interrater reliability of an assessment tool is important so as to determine the stability of the tool over raters (Piper & Darrah, 1994). If two raters showed good levels of interrater reliability then that means that the two raters had the same understanding and interpretation of the construct of the assessment tool (Stemler, 2004).

It is important that the AIMS demonstrates high levels of interrater reliability as health care professionals from different professional backgrounds are able to use this tool to assess infants who might be at risk for developmental delay and subsequently to rehabilitate and refer these infants accordingly (Blanchard, Neilan, Busanich, Garavuso, 2004).
5.7 AIMS ASSESSMENT AT 18 MONTHS OF AGE

There is virtually no variability of the AIMS score of infants at 18 months as the AIMS has no items for 18 month gross motor milestone attainment. The AIMS is therefore not sensitive enough to detect differences in the quality of motor skill attainment at 18 months. Furthermore, due to the centralisation of the data at 18 months, the conversion of raw scored into percentile ranks cannot be conducted. Hence 18 month assessments cannot be analysed statistically but rather presented descriptively. Another limitation is that a ceiling effect is noted from 12 - 15 months of age and reflects the limited clinical application of the scale for infants 15 months and older (Personal correspondence with one of the authors of the AIMS, Refer to Appendix VII). Future research is required to enable better assessment of the quality of movement of infants aged 15 months and older.
CHAPTER 6

CONCLUSION

Health professionals working in the area of infant motor development are looking for an assessment tool that will highlight motor activities acquired, those still developing and that are not part of the infant’s gross motor repertoire, as well as a tool that will detect small changes in motor development that are not found by other widely used tools. The AIMS was therefore designed to address these areas in infant motor development (Piper & Darrah, 1994).

The results yielded by this study demonstrate that the AIMS can be used by paediatric health care professionals in the Cape Metropole, South Africa for healthy infants between the ages of 8-12 months of age; however care should be taken when comparing infants at 4 months of age to the Canadian normative sample.

6.1 LIMITATIONS OF THE STUDY

Randomisation was not done and therefore the results may not be generalisable to South African infants. The principal researcher assessed, observed and scored all the infants who participated in the study which could have led to observer bias for the assessments at 8, 12 and 18 months of age. It was not possible to employ a research assistant as resources such as funds and time to train someone for the AIMS were limited.

Only 67 infants were assessed at 4 months with large amounts of infants being lost to follow up resulting in 27 infants assessed at 18 months of age (Refer Figure 4.1 of the Results, Chapter 4). Reasons for the lost to follow-up could be due to the fact that many parent(s) had to go back to work after 4 months maternity leave and enrolled their infants with a crèche or day mother who in turn was not able to bring the infant for the assessments (telephonic correspondence with parent(s)). Infants who participated in the study were also healthy and therefore some parent(s) did not see the necessity to participate in follow up assessments (telephonic correspondence with parent(s)). Infants
were also lost to follow up because parent(s) changed contact details such as telephone
topernumbers and addresses and did not notify the principal researcher or leave forwarding
details of their whereabouts.
Another limitation of the study was the inability to statistically analyse the 18 month
data. The AIMS reaches a ceiling effect from 14 months onwards and is not sensitive to
changes in gross motor development for infants between the ages of 14-18 months of
age. Hence the 18 month data could not be statistically compared to the assessments
at 4, 8 and 12 months or to the Canadian normative sample.

6.2 RECOMMENDATIONS
This study demonstrates that the AIMS is a reliable assessment tool and the Canadian
norms are valid for infants aged 8-12 months within the Cape Metropole, as previously
mentioned, care should be taken when infants scores at 4 months are compared to the
scores of the normative sample. The following recommendations should be taken into
account when making use of the AIMS in a clinical setting.

6.2.1 THE BENEFITS OF THE AIMS AS A GROSS MOTOR ASSESSMENT TOOL
As mentioned in previous chapters, the AIMS demonstrates excellent psychometric
properties (Systematic Review, Chapter 2). In addition to this the AIMS is easy to use
and places no undue stress on the infant assessed as minimal handling of the infant is
required.
The AIMS also boasts good feasibility especially considering the financial constraints
the South African health system has to contend with, as highlighted in the Introduction,
Chapter 1.

6.2.2 TRAINING IN THE AIMS
As discussed in previous chapters the AIMS does not require extensive training as it is
easy to use and is purely observational. Assessors need to have an understanding of
the analysis of movement as well as the qualitative aspects of the scale such as, anti
gravity movement, posture and weight bearing. The authors stipulate that even
paediatric therapists need to read the AIMS manual and become familiar with the items of the scale and their descriptors. Assessors do not have to be certified on the AIMS in order to make use of it, but the authors do offer one day workshops to explain the administration, limitations, scoring and uses of this clinically feasible tool.

6.2.3 RECOMMENDATIONS FOR FUTURE RESEARCH ON THE AIMS ASSESSMENTS FOR SOUTH AFRICAN INFANTS

This study served as a pilot preliminary study to assess whether or not the AIMS is valid for assessing gross motor development in a small cohort of infants. Thus many recommendations can be made for any future research within the South African context.

- A larger sample of infants from different ethnic groups (at least 75 infants per race group) should be used for future research to determine if the AIMS can be used across different race groups.
- Efforts to reduce loss to follow-up should be rigorous in a larger study to reduce selection bias, so as to minimize the effects of loss to follow up.
- Future research on a longitudinal cohort should not include assessments for 18 month old infants as the AIMS reaches a ceiling effect after 14 months and is therefore not sensitive to changes in gross motor development after this age period.
- Research assistants should be employed in future studies so as to minimize rater bias if infants are to be followed up on the AIMS.
- Structured qualitative information regarding socio-economic background e.g. parental education, household income, should be gathered to assess the effect thereof on motor development.
REFERENCES


To T, Guttmann A, Dick PT, Rosenfield JD, Parkin PC, Cao H, Vydykhan TN, Tassoudji M, Harris JK (2004): What factors are associated with poor


APPENDIX I

SYSTEMATIC REVIEW

SEARCH STRATEGY

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Infant Motor Scale and responsiveness

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SYSTEMATIC REVIEW

STUDIES EXCLUDED
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| Palisano RJ, Kolobe THA, Hayley SM, Lowes LP, Jones SL, Boyce WF  
Validity of the Peabody Developmental Gross Motor Scale as an evaluative measure of infants receiving physical therapy.  
Infants included in the study were diagnosed with cerebral palsy, Down syndrome and hydrocephalus. |
| Campbell SK, Kolobe THA, Wright B D, Linacre JM  
Validity of the Test of Infant Motor Performance for prediction of 6,9 and 12 month scores on the Alberta infant Motor Scale  
Developmental Medicine and Child Neurology 44: 263-272 (April 2002). | Exclusion Criteria:  
The study examined the predictive validity of the TIMP for the AIMS. |
| Fetters L and Tronick E Z  
Discriminate power of the Alberta Infant Motor Scale and the Movement Assessment of Infants for prediction of Peabody Gross Motor Scale scores of infants exposed in utero to cocaine.  
Pediatric Physical Therapy; 12:16-23 (2000) | Exclusion Criteria:  
The study examined the predictive validity of the AIMS and the MAI for the Peabody Gross Motor Scale of infants exposed in utero to cocaine. |
## Quality assessment of methodological quality appraisal tool:

<table>
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<th>Psychometric property</th>
<th>Definition</th>
<th>Criteria used to rate the psychometric properties</th>
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| Content validity      | The extent to which the domain of interest is comprehensively sampled by the items in the measure | (1) Patients were involved during item selection and/or item reduction  
(2) Patients were consulted for reading and comprehension  
Rating: + Adequate method used (patients and investigator or expert involved)  
± Doubtful method used (patients only)  
– Inadequate content validity (no patient involvement)  
? No information found on content validity |

The extent to which scores on the
Construct validity measure relate to other measures in a manner that is consistent with theoretically derived hypothesis concerning the domains that are measured

(1) Hypotheses were formulated
(2) Results were acceptable in accordance with the hypotheses
(3) An adequate measure was used
Rating: + Adequate design, method, and result
± Doubtful method used
– Inadequate construct validity
? No information found on construct validity

Internal consistency The extent to which the items in a (sub)scale are inter-correlated; a measure of the homogeneity of a (sub)scale

(1) Factor analysis was applied in order to provide empirical support for the dimensionality of the instrument
(2) Cronbach’s alpha between .70 and .90 for every dimension/subscale
Rating: + Adequate design and method was used:
factor analysis; alpha .70–.90
± Doubtful method used
– Inadequate internal consistency
? No information found on internal consistency
Test–retest reliability

The extent to which the same results are obtained on repeated administrations of the same measure when no change in physical functioning has occurred

(1) Calculation of an intra-class correlation coefficient (ICC); ICC > .70
(2) Time interval and confidence interval were presented

Rating: + Adequate design, method, and ICC > .70 ± Doubtful method used – Inadequate reliability

? No information found on test–retest reliability

Responsiveness

The ability to detect important change over time in the concept being measured

(1) For evaluative instruments, responsiveness should be assessed
(2) Hypotheses were formulated and results were in agreement
(3) An adequate measure used

Rating: + Adequate method and results ± Doubtful method used – Inadequate responsiveness

? No information found on responsiveness
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<th>Time to administer</th>
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<td>Rating: + Easy; summing up of the items ± Moderate; simple formula – Difficult; complex formula ? No information found on scoring method</td>
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Reprinted with permission from Annals of Rheumatic Diseases

The reference: Psychometric Evaluation of Health-Related Work Outcome Measures for Musculoskeletal Disorders: A Systematic Review


J Occup Rehabil DOI 10.1007/s10926-007-9093-0

Summary of the assessment of the Psychometric properties of the questionnaires measuring disability in patients with neurological and neuro-musculoskeletal disorders:
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Rating: + = positive; 0 = intermediate; - = poor; ? = no information available.

Kinds of study population(s) used in the studies: (a) community, (b) primary care, (c) outpatients’ clinic, and (d) hospital patients.
APPENDIX III

Quality of studies using the Quality assessment of methodological quality appraisal tool

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<td>Ease of Scoring</td>
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### Quality assessment of methodological quality appraisal tool:

<table>
<thead>
<tr>
<th>Psychometric property</th>
<th>Definition</th>
<th>Criteria used to rate the psychometric properties</th>
</tr>
</thead>
</table>
| Content validity      | The extent to which the domain of interest is comprehensively sampled by the items in the measure | (1) Patients were involved during item selection and/or item reduction  
(2) Patients were consulted for reading and comprehension  
Rating: + Adequate method used (patients and investigator or expert involved)  
± Doubtful method used (patients only)  
– Inadequate content validity (no patient involvement)  
? No information found on content validity |
| Construct validity    | The extent to which scores on the measure relate to other measures in a manner that is consistent with | (1) Hypotheses were formulated  
(2) Results were acceptable in accordance with the |
<table>
<thead>
<tr>
<th>Theoretically derived hypothesis concerning the domains that are measured</th>
<th>Hypotheses</th>
</tr>
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</table>

(3) An adequate measure was used
Rating: + Adequate design, method, and result
± Doubtful method used
– Inadequate construct validity
? No information found on construct validity

<table>
<thead>
<tr>
<th>Internal consistency</th>
<th>The extent to which the items in a (sub)scale are inter-correlated; a measure of the homogeneity of a (sub)scale</th>
</tr>
</thead>
</table>

(1) Factor analysis was applied in order to provide empirical support for the dimensionality of the instrument
(2) Cronbach’s alpha between .70 and .90 for every dimension/subscale
Rating: + Adequate design and method was used:
factor analysis; alpha .70−.90
± Doubtful method used
– Inadequate internal consistency
? No information found on internal Consistency

<table>
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<tr>
<th>The extent to which the same</th>
<th>(1) Calculation of an intra-class correlation</th>
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<td>coefficient (ICC); ICC &gt;.70</td>
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</table>
Test–retest reliability

results are obtained on repeated administrations of the same measure when no change in physical functioning has occurred

(2) Time interval and confidence interval were presented
RATING: + Adequate design, method, and ICC > .70 ± Doubtful method used – Inadequate reliability
? No information found on test–retest reliability

Responsiveness

The ability to detect important change over time in the concept being measured

(1) For evaluative instruments, responsiveness should be assessed
(2) Hypotheses were formulated and results were in agreement
(3) An adequate measure used
RATING: + Adequate method and results ± Doubtful method used – Inadequate responsiveness
? No information found on responsiveness

Time to administer

Time needed to complete the measure

RATING: + Less than 10 min – More than 10 min
? No information found on time to
Summary of the assessment of the Psychometric properties of the questionnaires measuring disability in patients with neurological and neuro-musculoskeletal disorders:

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Content validity</th>
<th>Construct validity</th>
<th>Internal consistency</th>
<th>Test–retest reliability</th>
<th>Responsiveness</th>
<th>Time to administer</th>
<th>Ease of scoring</th>
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The reference: Psychometric Evaluation of Health-Related Work Outcome Measures for Musculoskeletal Disorders: A Systematic Review


J Occup Rehab DOI 10.1007/s10926-007-9093-0

Reprinted with permission from Annals of Rheumatic Diseases
<table>
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<tr>
<th>Questionnaire</th>
<th>Content validity</th>
<th>Construct validity</th>
<th>Internal consistency</th>
<th>Test–retest reliability</th>
<th>Responsiveness</th>
<th>Time to administer</th>
<th>Ease of scoring</th>
</tr>
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</table>

Rating: + = positive; 0 = intermediate; - = poor; ? = no information available.

Kinds of study population(s) used in the studies: (a) community, (b) primary care, (c) outpatients’ clinic, and (d) hospital patients.
APPENDIX IV

The Alberta Infant Motor Scale score sheet
APPENDIX V

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM FOR USE BY PARENTS/LEGAL GUARDIANS

TITLE OF THE RESEARCH PROJECT:
The validation of the Canadian norms of the Alberta Infant Motor Scale (AIMS) within the Cape Metropole.

REFERENCE NUMBER:

PRINCIPAL INVESTIGATOR:
Alana Manuel

ADDRESS:
Division of Physiotherapy
Department of Interdisciplinary Health Science
Stellenbosch University
PO Box 19063
Tygerberg
7505

CONTACT NUMBER OF PRINCIPAL INVESTIGATOR:
(Alana Manuel): 082 687 4406

Your child is being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how your child could be involved. Also, your child’s
participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you or your child negatively in any way whatsoever. You are free to withdraw him/her from the study at any point, even if you do initially agree to let him/her take part.

This study has been approved by the Committee for Human Research at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

- The aims of this study are to establish normal values for the Alberta Infant Motor Scale for infants within the Cape Metropole. The Alberta Infant Motor Scale was developed in Canada and is used to assess the gross motor development of infants from birth to 18 months of age. The investigator is interested in the gross motor development of infants’ form the Cape Metropole and wants to assess the infants’ motor development with the Alberta Infant Motor Scale. Approximately one hundred and fifty infants will participate in this study.

Your infant’s gross motor development will be video recorded and will also be assessed at a later date by a second assessor. The assessment is done by observation only and requires minimal handling of the infant. Your child will be placed in different positions like: lying on the tummy, lying on the back, sitting and standing to see if your child can move in and out the different positions. Your child will be fully, but lightly, clothed during the evaluation and the whole evaluation should not take longer than 20 minutes. Your child will be given time to rest and/or eat or drink something if he (she) is tired and/or thirsty. If it is impossible to test your child on the day of evaluation (due to the fact that your baby is feeling tired/is crying and/or sick), you will be asked to come back for another evaluation on a day that suits you within the ten days. You have the right to withdraw your child from
the study at any time during the evaluation and can also request that the video recording of your child be destroyed.

Why has your child been invited to participate?

- We are interested in your child’s gross motor development and your child can help us to establish normal values for gross motor development for South-African infants.

What will your responsibilities be?

- You will be expected to bring your child to your Baby Well Clinic when he/she is four, eight, twelve and eighteen months old.
- If you choose to participate in this research project, it is advised not to allow your child to walk in a walking ring/baby walker, as this may delay your child’s motor development.

Will your child benefit from taking part in this research?

- If there are any problems detected during the assessments, your child will be referred to the appropriate health care worker for therapy.

Are there any risks involved in your child taking part in this research?

- There are no risks for your child if you choose to let your child participate in this study and your child will not be hurt at all during the evaluation.

Who will have access to your child’s medical records?

- Your child’s personal details will be treated as confidential and protected. If it is used in a publication or thesis, the identity of your child will be anonymous. Only the principal investigator will have access to this information. All video recordings will be destroyed once the project is completed.
What will happen in the unlikely event of your child getting injured in any way, as a direct result of taking part in this research study?

- If any emergency occurs during the assessments it will be handled by a registered nursing sister or doctor on duty at the Baby Well Clinic.

Will you or your child be paid to take part in this study and are there any costs involved?

- You or your child will not be paid to take part in the study, but your/your child’s transport will be covered for each study visit. There will be no costs involved for you if your child does take part.

Is there anything else that you should know or do?

- You should inform your family practitioner or usual doctor that your child is taking part in a research study.
- You should also inform your medical insurance company that your child is participating in a research study.
- You can contact me, Alana Manuel at 082 687 4406 if you have any further queries or encounter any problems.
- You can contact the Committee for Human Research at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your child’s study doctor.
- You will receive a copy of this information and consent form for your own records.

Declaration by parent/legal guardian

By signing below, I (name of parent/legal guardian) ..................................................... agree to allow my child (name of child) ..................................................... who is ......... years old, to take part in a research study entitled:
The validation of the Canadian norms of the Alberta Infant Motor Scale (AIMS) within the Cape Metropole.

I declare that:

- I have read or had read to me this information and consent form and that it is written in a language with which I am fluent and comfortable.
- If my child is older than 7 years, he/she must agree to take part in the study and his/her ASSENT must be recorded on this form.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is voluntary and I have not been pressurized to let my child take part.
- I may choose to withdraw my child from the study at any time and my child will not be penalized or prejudiced in any way.
- My child may be asked to leave the study before it has finished if the study doctor or researcher feels it is in my child’s best interests, or if my child does not follow the study plan as agreed to.

Signed at (place) .......................................................... on (date) ........................... 2007.

................................................................. .................................................................
Signature of parent/legal guardian Signature of witness

Declaration by investigator

I, Alana Manuel declare that:
- I explained the information in this document to ........................................
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understand all aspects of the research, as discussed above
- I did/did not use a translator (if a translator is used, then the translator must sign the declaration below).

Signed at (place) ............................................... on (date) ...................... 2007.

.......................................................... ..................................................
Signature of investigator Signature of witness
APPENDIX VI

PATIENT DEMOGRAPHIC CAPTURE SHEET

1. Name and surname (mother): ………………………………………………………………………
2. Name and surname (father): ………………………………………………………………………
3. Name and surname (baby): ………………………………………………………………………
4. Date of birth (baby): yr 2007/mm……/day…………
5. What is the sex of your baby? (please tick the appropriate)
   o Female
   o male
6. Birth weight: …………..kg
   Gestation: ………………weeks
7. Has your baby been hospitalized in the past four months?
   o Yes
   o No

   If the answer is Yes, for how long: …………..days/………..weeks

   Reason for hospitalization: ……………………………………………………………
8. Has your child been using a baby walker since the previous assessment?
   o Yes
   o No
9. Address: ………………………………………………………………………
   ………………………………………………………………………

10. Contact Number: ………….. (Home)…………………………………… (Work)…………………. (Cell)
11. What is the occupation of the infant’s

   mother ……………………………………………………………
   father ……………………………………………………………
   legal guardian …………………………………………………
12. Home address: father………………………………………………………………………

   mother ………………………………………………………………………

127
11. Work address: father........................................................................................................
    mother...........................................................................................................
12. Relative’s address: .................................................................................................
13. Relative’s contact number: ...................................................................................
APPENDIX VII

RE: Another Q regarding the AIMS from South-Africa Wednesday, September 16, 2009 12:47 PM

From: "Burger, Marlette, Ms <mbu@sun.ac.za>" <mbu@sun.ac.za>Add sender to ContactsTo: "Darrah, Johanna" <johanna.darrah@ualberta.ca>Cc: "Louw, QA, Prof <qalouw@sun.ac.za>" <qalouw@sun.ac.za>, "alana manuel" <manuelalana@yahoo.com>Dear Darrah

Thank you so much for the detailed explanation.

One final question: You mentioned that you used percentile graph to determine precise percentile ranks.

I am just curious, if an infant is exactly 7 months old and obtained an AIMS score of 24 – his percentile rank lies between the 25th and the 10th percentiles (Appendix I), how did you then determine his precise percentile ranking?

Kind regards,

Marlette

--------------------------------------------------------------------------------

From: Darrah, Johanna [mailto:johanna.darrah@ualberta.ca]
Sent: Tuesday, September 15, 2009 11:13 PM
To: Burger, Marlette, Ms <mbu@sun.ac.za>
Subject: RE: Another Q regarding the AIMS from South-Africa

I'm sorry to be late in my reply - it is the beginning of term and my teaching is heavy.

The reason that the table only goes to 14 months is because most children were walking at this age and thus received a full or close to full score after this age. You can see this from Appendices III and IV on page 205. It is very observable from the percentile graph on page 203, also on the back of the score sheet.
The difficulty with using Appendix II on page 204 that this calculated percentile rank represents the percentile rank for the mean age of the age grouping. Our selection of infants across the age groupings was successful that this percentile usually represents a child that is in the middle of the age category (e.g. 2 weeks, 1.5 months etc). Thus using this percentile rank for all infants in the age category is a bit deceiving and also why the percentile ranks sometimes seem out of sync with the ranks derived from the percentile graph. In order for the graph and table results to be the same, the child’s age has to be ‘mid-point’ in the age group concerned. For our research we have used the percentile graph to determine precise percentile ranks.

Whatever you use you will have the same problem that most children over 14 months of age in the Canadian norms reached a ceiling on the test (i.e. score close to 58)

I hope this helps

Johanna

From: Burger, Marlette, Ms <mbu@sun.ac.za> [mailto:mbu@sun.ac.za]
Sent: Wednesday, September 02, 2009 6:59 AM
To: Darrah, Johanna
Cc: Louw, QA, Prof <qalouw@sun.ac.za>; Kidd, M, Prof <mkidd@sun.ac.za>; alana manuel
Subject: Another Q regarding the AIMS from South-Africa

Dear Prof Darrah

I am writing the e mail on behalf of one of my masters’ students (physical therapy) and Prof Martin Kidd her statistician and hope you can assist us with the following. [I have send you an e-mail almost a year ago and you were so kind to respond and to give advice.]

We completed the validation of the Canadian norms for the AIMS for infants aged four to eighteen months within the Cape Metropole in Cape Town, South Africa a few months ago.

We used the Table on page 204 [Appendix II] of the AIMS manual to determine the infants percentile ranks at 4, 8 and 12 months, but cannot use it at 18 months since there is no percentile ranks for infants older than 14 months.

The statistician has conducted the inter rater reliability up to 12 months but cannot use the same analyses for the 18 month old group since we don’t have the percentile scores for 18 months. Which table do you suggest should we use to determine the percentile scores at 18 months? Should we rather use Appendix IV [page 205] to determine the infants’ percentile ranks at 4, 8, 12 as well as 18 months? What do you recommend?
Thank you (again) for your time and assistance in this matter.

Warm regards from South Africa!

Marlette Burger
Lector/Lecturer

Fisioterapie / Physiotherapy

Departement Interdisiplinere Gesondheidswetenskappe / Department of Interdisciplinary Health Sciences

Fakulteit Gesondheidswetenskappe / Faculty of Health Sciences

Universiteit Stellenbosch / Stellenbosch University

Tel: 938 9300/3

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