CORRELATION BETWEEN TWO SCORING SYSTEMS OF A GROSS MOTOR ASSESSMENT IN INFANTS AGED 3 TO 18 MONTHS OLD

SANTITA MEKKRASIN

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR
THE DEGREE OF MASTER OF SCIENCE
(PHYSICAL THERAPY)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2016**

Thesis
entitled

CORRELATION BETWEEN TWO SCORING SYSTEMS OF A GROSS MOTOR ASSESSMENT IN INFANTS AGED 3 TO 18 MONTHS OLD

Santita Mekkrasin
.....
Miss Santita Mekkrasin
Candidate

Raweewan Lekskulchai
.....
Asst. Prof. Raweewan Lekskulchai,
Ph.D. (Physiotherapy)
Major advisor

Sureelak Sutcharitpongsa
.....
Asst. Prof. Sureelak Sutcharitpongsa,
M.D.
Co-advisor

.....
Prof. Patcharee Lertrit,
M.D., Ph.D. (Biochemistry)
Dean
Faculty of Graduate Studies
Mahidol University

Raweewan Lekskulchai
.....
Asst. Prof. Raweewan Lekskulchai,
Ph.D. (Physiotherapy)
Acting Program Director
Master of Science Program in
Physical Therapy
Faculty of Physical Therapy
Mahidol University

Thesis
entitled

CORRELATION BETWEEN TWO SCORING SYSTEMS OF A GROSS MOTOR ASSESSMENT IN INFANTS AGED 3 TO 18 MONTHS OLD

was submitted to the Faculty of Graduated Studies, Mahidol University
for the degree of Master of Science (Physical Therapy)
on
June 6, 2016

Santita Mekkrasin
.....
Miss Santita Mekkrasin
Candidate

.....
Lect. Namfon Mahasup,
Ph.D. (Medical Sciences)
Chair

Raweewan Lekskulchai
.....
Asst. Prof. Raweewan Lekskulchai,
Ph.D. (Physiotherapy)
Member

Sureelak Sutcharitpongsa
.....
Asst. Prof. Sureelak Sutcharitpongsa,
M.D.
Member

.....
Prof. Patcharee Lertrit,
M.D., Ph.D. (Biochemistry)
Dean
Faculty of Graduate Studies
Mahidol University

R. Vachalathiti
.....
Assoc. Prof. Roongtiwa Vachalathiti,
Ph.D. (Physiotherapy)
Dean
Faculty of Physical Therapy
Mahidol University

ACKNOWLEDGEMENTS

I would like to express my deepest gratefulness to my lovely major advisor, Assistance Professor Raweewan Lekskulchai. Thank you for her suggestion, encouragement and knowledge in both academic and real life. She is my good example to follow her actions and words.

I also would like to express my deepest appreciation to my pretty co-advisor, Assistance Professor Sureelak Sucharitpongsa, MD. For her helps especially, in data collection periods. Thank you for her kindness and encouragement. She is always told me “Keep going, everything will be good”

Moreover, my appreciation goes to all my participants, their parents, and the staffs from Developmental care for High-risk infants clinic at Siriraj hospital, Vaccination clinics at Salawan communication hospital and Klong-Yong communication hospital for their assistance and warm welcome that supported my research.

Unforgettably, I would like to thank my friends, senior students of master degree, Ph.D. students of Physical Therapy faculty, Mahidol university and also thanks pediatric physical therapists at the physical therapy clinic for their help and good cooperation.

Finally, my very special thanks are to my beloved family members and my relatives for their love, warmest and supporting everything throughout my life. Especially my father and mother, they always encouraged me to fight with any obstacles and teach me to think in positive way with everything.

Santita Mekkrasin

CORRELATION BETWEEN TWO SCORING SYSTEMS OF A GROSS MOTOR ASESSMENT IN INFANTS AGED 3 TO 18 MONTHS OLD

SANTITA MEKKRASIN 5636293 PTPT/M

M.Sc. (PHYSICAL THERAPY)

THESIS ADVISORY COMMITTEE: RAWEEWAN LEKSKULCHAI, Ph.D, SUREELAK SUTCHARITPONGSA, M.D. (PEDIATRICS)

ABSTRACT

This study modified the new scoring system for the Alberta Infants Motor Scale (AIMS). The objective of this study was to investigate concurrent validity between the AIMS original and modified scoring systems and compare the movement components (weight bearing, posture and anti-gravity movement) of typical and delayed development infants aged 3-18 months. All participants were evaluated for their level of development using the Mullen Scale of Early Learning. Then the researcher classified the infants into 4 groups: 1) Typically developing infants aged below 9 months 2) Delayed development infants aged equal or above 9 months 3) Typically developing infants aged below 9 months and 4) Delayed development infants aged equal or above 9 months. After that, all infants were assessed for gross motor movement components by AIMS. The raw scores were converted from the categorical scale to the continuous scale by Rasch analysis.

The results of this study showed that there were good levels of correlation between the two scoring systems. Moreover, there were significant differences between movement components of typical and delayed development infants. Specifically, infants with developmental delays had lower movement component scores than typical infants.

In pediatric physical therapy, understanding of the main problems of movement components in infants is important. The knowledge from the present study could support physical therapists in understanding more about the specific movement components of individual infants. Further studies should be conducted to translate the description of the modified scoring system into the Thai language and further modify the format for clinical use.

KEY WORDS: GROSS MOTOR DEVELOPMENT/ MOVEMENT COMPONENTS/ ALBERTA INFANTS MOTOR SCALE/ RASCH ANALYSIS

71 pages

ความสัมพันธ์ระหว่างระบบการให้คะแนนสองแบบของการประเมินการเคลื่อนไหวอย่างหยาบ ในทารกอายุ 3 ถึง 18 เดือน

CORRELATION BETWEEN TWO SCORING SYSTEMS OF A GROSS MOTOR ASESSMENT IN INFANTS AGED 3 TO 18 MONTHS OLD

สัณฑิตา เมฆกระสินธุ์ 5636293 PTPT/M

วท.ม. (กายภาพบำบัด)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์: ระวีวรรณ เล็กสกุลไชย, Ph.D, สุรีย์ลักษณ์ สุจริตพงศ์, M.D. (PEDIATRIC)

บทคัดย่อ

งานวิจัยครั้งนี้ได้พัฒนาการระบบการให้คะแนนของแบบประเมิน Alberta Infants Motor Scale (AIMS) โดยมีวัตถุประสงค์ เพื่อหาความเที่ยงตรงเชิงสภาพของแบบประเมิน AIMS ฉบับดั้งเดิมและฉบับปรับปรุง และเปรียบเทียบองค์ประกอบการเคลื่อนไหวของทารกที่มีพัฒนาการล่าช้าและปกติ อายุ 3-18 เดือน ทารกทุกคนจะได้รับการวัดระดับพัฒนาการโดยแบบประเมิน Mullen Scale of Early Learning จากนั้นผู้วิจัยได้แยกทารก เป็น 4 กลุ่ม คือ 1) ทารกพัฒนาการปกติ อายุต่ำกว่า 9 เดือน 2)ทารกพัฒนาการล่าช้า อายุต่ำกว่า 9 เดือน 3) ทารกพัฒนาการปกติ อายุมากกว่าและเท่ากับ 9 เดือน และ 4) ทารกพัฒนาการล่าช้า อายุมากกว่าและเท่ากับ 9 เดือน ทารกทุกคนจะได้รับการประเมินพัฒนาการด้านการเคลื่อนไหวด้วยแบบประเมิน AIMS จากนั้นจะนำคะแนนดิบจากการประเมินไปแปลงจากคะแนนแบบลำดับให้เป็นคะแนนแบบต่อเนื่องด้วย Rasch analysis

ผลจากการศึกษา พบว่า ความเที่ยงตรงตามสภาพของทั้งสองแบบประเมินอยู่ในระดับดี และพบว่า องค์ประกอบการเคลื่อนไหวในทารกพัฒนาการปกติและล่าช้ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ โดยคะแนนของทารกพัฒนาการล่าช้าได้คะแนนองค์ประกอบการเคลื่อนไหวต่ำกว่าทารกพัฒนาการปกติทั้งหมด

ในการรักษาผู้ป่วยเด็ก การเข้าใจถึงปัญหาขององค์ประกอบการเคลื่อนไหวอย่างแท้จริงนั้นเป็นสิ่งที่สำคัญ ความรู้จากการศึกษาครั้งนี้ จะมีส่วนช่วยให้นักกายภาพบำบัดเข้าใจถึงองค์ประกอบการเคลื่อนไหวที่มีจำเพาะของทารกแต่ละคนได้ชัดเจนยิ่งขึ้น การศึกษาครั้งต่อไป อาจพัฒนาการแบบฟอร์มการประเมิน โดยการแปลคำอธิบายแต่ละองค์ประกอบเป็นภาษาไทยและปรับปรุงรูปแบบของแบบฟอร์มเพื่อให้สามารถใช้ได้ในทางคลินิก

71 หน้า

CONTENTS

CONTENTS (cont.)

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AIMS	Alberta Infants Motor Scale
CNS	Central Nervous System
ADL	Active Daily Living
PT	Physical Therapy
VLBW	Very Low Birth Weight
CA	Corrected Age
ATNR	Asymmetrical Tonic Neck Reflex
GMFM	Gross Motor Function Measure
HADS	Hospital Anxiety and Depression Scale
CHSQ	Children's Hand-skill ability Questionnaire
SIS	Stroke Impact Scale
TIMP	Test of Infant Motor Performance
MAI	Movement Assessment of Infants
NICU	Neonatal Intensive Care Unit
PDMS	Peabody Development Motor Scale
ICC	Intra-class Correlation Coefficient
KSPD	Kyoto Scale of Psychological Development
CBDS	Child Behavior Development Scale
TD	Typically Developing
DD	Delayed Development
CA	Corrected Age
GA	Gestational Age
Kg.	kilogram
Cm.	centimeter
Head cir.	Head circumference
WHO	World Health Organization
TBCS	Taiwan Birth Cohort Pilot Study

LIST OF ABBREVIATIONS (cont.)

HINT	Harris Infant Neuromotor Test
IMP	Infants Motor Profile
PEDI-CAT	Pediatric Evaluation of Disability Inventory Computer Adaptive Test
Mod.AIMS	Modified Alberta Infants Motor Scale

CHAPTER I
INTRODUCTION

Motor development is a process to develop various movement abilities that important to perform motor tasks (1). In addition, motor development is related to how the infant respond when facing with different environments. Thus, the complete motor milestone is significant and effect on motor skill, emotional and social interaction (2). The process of motor development is starting since prenatal period and continue to postnatal period. Thus the process requires several factors that will promote motor development (1) such as maturation of neuromuscular system, previous movement experience and new movement experience.

Motor skill is the voluntary movement of body and limbs to achieve goals. Motor skill is natural process that infants must learn for adapting and moving into various environments. Thus motor skills need to be learned for attaining movements. The motor skills are divided into 2 type; i.e. gross and fine motor skills. The gross motor skills are movements of large muscles to perform actions e.g. walking or jumping. Fine motor skills are movements of small muscles that require precision actions e.g. typing or drawing. However, to achieve the goal, large and small muscles must work together because large muscles related to fine motor skills and small muscles are key muscles to complete the tasks (3).

Developmental milestone can reflect to the maturation rates of central nervous system (CNS)(4). In addition, developmental milestone is the most standard measurement of basic movement for infants (5). The benefits of developmental tests are the use of the test outcome to promote planning of treatment programs. The results from development tests will provide information about level of milestone that the infant can reach. Thus early screening should be started as soon as possible in infants, to decrease morbidity and impairment and to improve active daily living (ADL) in long-term.

Charitou S in 2010 studied prediction of infant's motor development (6). The result demonstrated that motor milestone e.g. supine, prone, sitting or standing, can reflect motor development of the infants. Both supine and prone positions are important key factors that influence prognosis of motor development after infants age more than 2 months. This study concluded that early assessment is significantly related with future specific intervention. Thus delayed motor developments do not only affect infant's emotional and cognitive abilities but also emotional problems of parents e.g. anxiety about the impairment of infants.

Physical therapist is a major multidisciplinary member for infant with delay development or disable child. The advantage of early intervention should occur in early life because of plasticity of brain in this time. During this age, dendrites are growing up and highly activated of synapse formation (7). So early age is a proper range to develop motor skills and these skills could become experiences for child to control their movements in various environments and improve infant's quality of life, decrease developmental delay and prevent functional impairment (8).

Cameron EC in 2005 studied the effects of an early physical therapy (PT) intervention for very preterm, very low birth weight (VLBW) infants using a randomized controlled clinical trial (9). The result reported that PT intervention on motor performance in VLBW preterm infants aged 4 months corrected age (CA) was not significantly. However, the author described benefits of PT intervention that it could decrease rate of abnormal motor delay in preterm infants at age of 4 months.

McManus BM in 2011 studied effectiveness of early intervention physical, occupational, and speech therapy services for preterm or low birth weight infants in Wisconsin, United States (10). The results demonstrated that preterm infants in early intervention group had significant better in cognitive function than control group at 24 months after term. During early intervention, the family support was also the key factors that can enhance effects of early intervention to become more effective.

The example of infant's motor development assessment is the Alberta Infant Motor Scale (AIMS). The AIMS is a standard measurement that suitable for infants with both nor mal and delay development. The goal of AIMS is to identify and evaluate delay or atypical motor development in 4 positions: supine, prone, sitting and standing. In addition, it can be used as an assessment of pre-post intervention for

health care professional. The assessment requires minimal handling, allowing the infant to perform their real spontaneous movements. (11)

However, the description and scoring system of AIMS still have some limitations. The scoring system of AIMS is on nominal scale divided into 2 points : 0 and 1; 0 represents inabilities to perform some or all 3 movement composites and 1 indicates abilities to perform all 3 composites completely. But in pediatric clinical assessments, the examiners may observed some composites and some components are not complete. If scoring system of original AIMS was used, the development of specific components e.g. posture, anti-gravity and weight bearing of gross motor movements may not be able to assess.

Pai-jun in 2004 examined the item structures of the AlMS (12). The result demonstrated that AIMS is not suitable for assessing motor development in infants ages above 9-10 months because, have few items available to discriminate infants ability in standing dimension. In addition, only few items in AIMS are available for use before 3 months e.g. PN01 all infants passed this items, which represent that the items is too easy. And this study reported that percentile scoring of original AIMS had limitations. If the infants have different raw score only 1 point, the percentile range can change to the other level.

From literature review, the assessments that examine movement composites still necessary for evaluating motor developments. Thus in clinical practice, the physical therapist must know which components are lacking. Thus in this study, the original AIMS scoring will be modified. In addition, the concurrent validity of the modified AIMS and original AIMS scoring systems will be studied.

1.1 Purposes of the study

1.1.1 General objective

To investigate concurrent validity of the modified AIMS scoring system using the original scoring system as a gold standard

1.1.2 Specific objective

To compare movement components including weight bearing, antigravity movement, posture and total scores obtained from the modified and original AIMS scoring systems.

1.2 Parameters of the study

1. Weight-bearing ability score
2. Posture ability score
3. Anti-gravity ability score
4. Total score of modified AIMS
5. Total score of AIMS

1.3 Hypothesis of the study

1. There would be significant correlation between modified AIMS scores and original AIMS scores in infants aged below 9 months
2. There would be significant correlation between modified AIMS scores and original AIMS scores in infants age above 9 months

1.4 Scope of the study

This study aimed to study concurrent validity of the modified AIMS in infants aged from 3-18 months. The examiner assessed gross motor ability in infants by using modified AIMS scoring system for each of the three composites: weight-bearing, posture and anti-gravity separately. The total score of the modified AIMS was compared with total score of the original AIMS and using Rasch analysis to convert the data scale from discrete to continuous scale. After that, this study showed concurrent validity of modified AIMS and original AIMS scores by using correlation statistic.

1.5 Advantages of the study

This study could improve the original AIMS scores. The scoring system is more elaborate by dividing scale into 3 points ranging from 0 to 2. Thus the modified scoring system could show real movement skills. And this study would report 4 the concurrent validity of the modified scoring system of the AIMS and original AIMS. Thus this study could prove whether the result of the modified scoring system of AIMS can replace the original AIMS. In addition, the modified AIMS could consider each movement component e.g. weight-bearing, posture and anti-gravity movement for therapists to understand the infant's specific impairment of components. Thus if the therapist know the specific impairment, the appropriate intervention for each child will be indicated to promote the treatment outcome more effectively.

CHAPTER II
LITERATURE REVIEW

2.1 Theories of motor development

In pediatric physical therapy, the motor assessment is important tool to assist clinicians to understand more about motor development. In addition, the motor assessment can determine the development of infant more precisely and to solve the movement problems. Thus reference point is significant key for clinician to consider which is the typical development pattern. The appropriate plan of intervention for delay development infants should base on theoretical framework to apply effective intervention and report reasonable outcome (11).

2.1.1 The neuro-maturation theory

In 1930 the neuro-maturation theory was invent and popular in human motor development studies. This theory was established by Arnold Gesell and the concept was mention on the changing process of gross motor skill. In human development, the maturation of central nervous system (CNS) is important part. Thus the pathway of motor development is starting from cephalocaudal and proximal toward distal direction. The cephalocaudal is the development maturation from head to tail direction. The first voluntary movement will develop from head control. After that, will descend through the shoulder, trunk, pelvis and lower extremities. And in proximal toward distal development is motor control from center to outward. Thus the control of movement start from midline of neck or trunk and distribute to shoulder, finger and the pelvis can control earlier then leg and feet control. However, the body systems must work together, so movements of one part will relate with other parts. Within this model, the CNS is a major role in all stages of development and extrinsic factor is only minor role to support developments (11, 13, 14, 15).

Since this theory, the maturation will develop from cephalocaudal and proximal-distal direction and also require several characteristic elements about neuromaturation systems

The development of infants is developed from primitive reflex. After that, the development will progress to mass movement reflex patterns to voluntary and able to control movement by themselves. The development is risen from head to tail or cephalocaudal pathway. The control of movement is started from proximal and descend to distal part. And the series of motor development must relate among infants. While the rate of motor development must relate with each infants also.

2.1.2 The dynamic system theory

The dynamic system theory has developed by Thelen in 1980. The concept of this theory is assumed about the natural phenomenal e.g. hurricane. Because the hurricane can build up from their self-organization, thus central control system is only one part to complete hurricane. The dynamic system theory is the integrate of self- organization of multiple subsystems to achieve the task. In human development, many systems have equivalent role to generate infant's motor skill such as the neurological, cognitive, arousal and motivation even though environment.

Basic concepts required in dynamic system theory include the reciprocal movement of lower limbs result by related structure work together, the development of agonist-antagonist activity, strength of extensor muscle for act in antigravity movement, the body size and composition is altered, upright position by control head and trunk for move antigravity, the synchronize pattern of reciprocal lower limb movement., visual flow sensitivity for maintain position during movement in various environment. And ability to recognize components of the task and have motivation to move forward for achieve to goal (14, 16).

2.2 Factors affecting motor behavior and development

The development of infants both intrinsic and extrinsic factors have influence with maturation in infants (2, 15).

2.2.1 Intrinsic factors

The internal factors consist of genetics and maturation. Both genetics and maturation can refer to physiological system of the body e.g. electrolytes, hormone, autonomic nervous system and immune systems. Thus these factors will control the stability of homeostasis to promote growth, development and physical activity. In addition, endocrine system is also important for the child during development. Because hormones are important for regulating physical growth from prenatal to puberty period and also control metabolism and utilize the energy to supply fuel to the body.

2.2.2 Extrinsic factors

The extrinsic factors include of the nutrition and culture. Nutrition is one of key factors that support development. The effect of inadequate nutrition have significant correlated with intrauterine growth retardation and brain development. Thus intrauterine growth retardation is major problem that lead to development of disability. In addition, culture variation is also affect with development. In Kenya, the infants have more rapid heads up, independent sitting and walking than infants in North America. Because in early months, the Kenya infants must seat in the hole on the ground and wrap them with blankets to make erected body. The benefit of culture can facilitate motor skill experience and lead infants growing up strong and healthy.

2.3 Motor development in infancy

Infancy period is age from birth to independent walking. The motor development will reach walking independently at 12-18 months in typical infants. Each sequence of motor development has an effect with overall development. In normal posture, the infants will confront with gravity force by developing the alignment of body segment. Thus this period is recommended for early motor assessment for proper intervention and also facilitate motor development that associated with motor age (11).

2.3.1 Prone position

The physiological flexion is dominance posture in neonatal period. The head is turned to one side for breathing. During physiological flexion, the hips is flexion and pelvis is in anterior tilt. Over 1 months, the physiological flexion is disappear. And the infants starting prone on elbows for learn to shift weight in varies direction. At 3 months, he can lift his head in 45 degrees and control the head in midline. By 4 months, he can lift the head to 90 degrees with chin tucked and forward position of the elbows. After that, the infants able to prone on extend arms for lift thoracic against gravity and the pelvis still posterior tile for stabilize head and upper trunk. Approximate 5 months the pivot prone is develop, the neck, trunk and lower limb is extend and pelvic is more anterior tilting. Before creeping, the infants is able to move in quadruped. The weight is act onto elbow and excessive abduct of lower limb for increase stability (17).

2.3.2 Supine position

In supine position, the physiological flexion is also appear. All upper and lower limbs is stay in flexion position. Over 1 months, the head able to move side to side, upper and lower limbs slightly extension by physiological flexion is diminish. At 2 months, infants can move heads side to side easier. During 3 months, the infants can holding upper limbs in space and grasp the object close to the body. After that, the infants starting to reach the hands to knees and feet or feet to mouth against gravity. After ATNR disappear, the infants begin to lift his legs away from ground. Often play foot to foot contact. And start to reach the hand to ipsilateral knee and foot and then across the midline to reach contralateral knee and foot. At 5 months, the infants interest in oral stimulation so he often bring his feet to mouth. During feet to mouth, the pelvic is in posterior tile. The benefits of posterior tile can gain strengthening and mobility of pelvis (17).

2.3.3 Rolling

The rolling development can divide into 2 patterns: Non-segmental rolling and segmental rolling. From birth to 6 months the infants will roll in non-segmental pattern. He often roll from supine to prone in one unit and without rotation of spine

and also call log rolling. And at 6 months, the infants start rolling with segmental rolling pattern. In this period, infants is able to rolling from following sequence; head, lower limbs, upper limbs and follow with pelvis or shoulder girdle. Thus segmental rolling will rotate within body axis or intra-axial rotation. The body righting reaction is important for rolling from prone to supine and supine to prone. But If ATNR (Asymmetrical Tonic Neck Reflex) still appear e.g. in atypical developmental infants, this reflex will block ability of rolling (4).

2.3.4 Pull to sit

The pull to sit during neonate period have benefit to indicate antigravity flexor muscle response when head position is change. In addition, pull to sit is reflex to the maturation of labyrinthine and optical righting systems. During neonate in typical infants, the head is lag and may observe the contraction of neck flexor-shoulder elevator muscle or sternocleidomastoid. There is no activity of upper limb and abdominal. But flexion of hips and knee may present. At 1 months, general development is same as neonate and head still lag while pull him up. But lower limbs is slightly extension by increase elongation of lower limb musculature. At 2 months, the infants still have head lag but some infants try to control his head by fix his eyes on examiner's face and upper extremities starting active elbow flexion. At 3 months during pull to sit the head is more stable and flexion forward. The pull to sit development in 4 months the infants try to anticipate which sequence can lead head lag and then will correct postural adjustment before lift the head. In 5 months, the infants can lift the head by flexion and the shoulders will help to stabilize the head by elevate the shoulder. In 7 months the capital flexor muscles is strong enough to lift the head away from the ground. And in 7 months the infants able to pull the body up in sitting and neck stay in active flexion while pull to sit (17).

2.3.5 Sitting position

In neonatal period when held the infants in sitting position, the spine is stay extremely flexion in c curve. The head is in chin tuck and resting on chest. The pelvis lay perpendicular to the floor and weight bear on ischial tuberosity. About 3-4 months the antigravity extension of neck and trunk is appear. So the infants starting to

lift the head while sitting. At 5 months, infants initial to sitting without external support by prop sitting. The infants will use two hands for produce tripod base for increase wide base of support. At 6 months the infants starting to sit in ring sitting. The infants will sit in wide base of support and use less support from upper limb. Both hips and knees is flexed and external rotation. At 7 months he can move head and limb during ring sitting. The develop of intra-axial rotation is developed, thus the benefits is learn to move from supine and prone to sitting and adjusted the environment become available for interacted. At 8 months in this months the infants able to sit independently. The back have fully antigravity extension and complete secondary curve of spine (4).

2.3.6 Crawling

Crawling movement is common developed in infants age 6 months. The crawling movement is first locomotion skill for move through varies environment. The crawling is homolateral pattern that require coordination of muscle control in varies parts e.g. head, neck and trunk. The infants may reach the toy in front of her, raising the head and chest away from the ground. Thus the benefits of this combination, the body will slightly locomotion in forward direction to move from one place to other place.

2.3.7 Creeping

Creeping movement mostly appear in infant ages 9 months. The development of creeping is begin from crawling and develop to creeping. Thus movement of creeping is contralateral pattern; the arms and legs is use in opposite side to one another. If the infant have more efficient to creeping, the sequence become more synchronous and repetitive. Several study report, if the infants who skip crawling and pass through creeping will have less efficient creeping than infants who have crawling experience (18).

2.3.8 Upright gait

During neonatal period when hold the infants in support standing. The infants will standing with narrow base of support and chin is resting on chest. In

addition when the examiner hold infant slightly forward, he will respond by automatic stepping. In the end of 2 months, the maturation of central nervous system make stepping reflex diminish. At 4 months, he is able to control his head in all posture. And the progression of antigravity cervical extensor and flexor is occur. During 5 months when hold the infants in support standing, the infants can weight on lower limb partially and the head is more stable when move in varies direction. At 7 months, the infants can walk with wide base of support by held the hand of parents. The pattern of hips is external rotation and abduction. At 8 months the infants able to pull his body up, thus upper limb is primary source and lower limb is minor source. By 10 months the infants will pull the furniture for assist to standing. In this months, kneeling posture is developed, thus the strength of lower limbs become a major source for pull body up and upper limb only help to maintain the balance during kneeling. After 10 months the infants begin to stepping in sideway while catch the furniture. When age increasing, he able to cruising with release one hand from support and rotate the trunk to one side while still sustain balance. Over next several weeks, he able to stand independently and upper extremities is in high guard position. After that, high guard position gradually change to low guard or close to the body. Then the infants can move upper limbs freely from center of body or hold the object during walking with more stable (4).

2.3.9 Reaching

In first 4 months, infants begin to develop eye-hand coordination for catch the objects. And infants is often alternative glances between the object and hand. From proximodistal theory in early reaching, the movement developed from shoulder and elbow after that, extend to wrist and hand. At the end of 4 months, the infants is able to reach for create tactile contact with the objects. However, the accuracy reaching is depends on several factors e.g. speed of the movement and position of the infant's during reaching.

2.3.10 Grasping

In newborn period, when place the object e.g. finger in palm the infants will response by grasp an object. This is grasping reflex that appear in newborn and

this reflex will decline when the infants age at 4 months. Voluntary grasping will appear when completely in sensorimotor mechanism development. When the infants age reach 14 months, prehension ability is as same as adult's grasping ability. However the environment factors is also associate with efficient grasp e.g. size, weight, shape and texture of the object (18).

2.4 Delay developmental infants

The developmental delay is defined for the infant with ability not reaching expected developmental milestone age (20). Thus infants with developmental delay infants may have neurological impairment (21). The epidemiology is 2-3 percent (22). The risk factors that lead to developmental delay can occur in perinatal through postnatal and also in neonatal periods (21). The development can be divided into 4 abilities: gross and fine motor development, language development, cognitive development and psychosocial development (20). Because delay development does not show obvious sign, parents should concern about lacking of development in infants (21). Thus this study will focus on gross motor development: The delayed development of gross and fine motor that will affect muscle tone and limbs structure especially lower limbs (22). The observation of gross motor delay in infants will find immature movements. At 4.5 months, the infants do not pull up to sit or at 9-10 months, the infants are unable to stand while holding on (20). And if the infants do not receive appropriated treatments, these impairments will become greater risk for long-term in neurodevelopmental disabilities.

2.5 Assessment

The assessment is the tool to investigate the individual's functioning capacity and limitation. The objective of assessment is measure in depth specific behavior of functional skill. Thus the result from assessment will use to provide the information for planning the treatment, to re-assessment about progression and to investigate the supporting factors that promote client's recovery.

In pediatric physical therapy, the assessment is complex procedure to identify and confirm the result of the development problems or degree of disabilities from screening results. Thus for accurately result, the pediatric assessment is require trained personal for administrated and scoring the assessment. However, the cons of assessment is use substantial time and high cost (19).

2.5.1 Test format

In assessment, both standard test and non-standard test is essential component to cover evaluate of functional activity and participation

2.5.1.1 Standardized test

The standardized is process to establish the administration and scoring of the test for decrease external influence that may disturb accuracy result. Standardized test will use the formal strategy to measure functional assessment. The items have carefully selected and clearly define. In clinical setting, standardized test must investigation and analyze the validity and reliability for use in same administered to everyone and every time. The scoop from standardized test is more narrow and specific than non-standardized test. However, the cons is use longer time and expensive cost.

2.5.1.2 Non-Standardized test

The non-standardized test will use in individual patients. The test will evaluate important activity for each clients e.g. daily home, work and leisure time by observational assessment to mention how the client's ability has change over time. The non-standardized test will not require for valid and reliability measure. And the scoop of the test is too broad. But client's feels and meaningful of client's life is a major keys of assessment. Thus the test in non-standardized is very unique and individual for each clients.

In the case to standardized test is unavailable, non-standardized test is alternative tool because may require shorter time to evaluate clients ability. Thus the non-standardized test not only evaluate important particular skill but also provide the immediate feedback to clients after intervention (15, 19).

2.5.2 Test design

The 2 types of format test include of norm reference and criterion reference tests.

2.5.2.1 Formal test

The format test can classified into 2 test; norm reference test and criterion reference test

2.5.2.1.1 Norm referenced test

The norm referenced tests is design to measure the individual child's performance that related with performance level of a large group in varies age levels. Thus objective of norm reference is determine how an individual performs relative to the sample for find differentiated, diagnosis and placement. The administration of norm reference is based on standard manner. But norm reference test is not support for physical therapy treatment planning, because the purpose may not associated with intervention. And the test construction is not developed from task analysis. The example assessment in norm reference test in pediatric field consist of Balay Scales of Infant Development and Bruininks-Oseretsky Test of Motor Proficiency.

2.5.2.1.2 Criterion referenced test

The criterion referenced test will determine change of child's performance in his own ability e.g. level of assistant that patients require from external support. The criterion reference test is appropriated for evaluation of the treatment's effectiveness. The items of the test is based on task analysis and the objective is associate with intervention. And the administration may not depends on standard manner. The benefits of criterion reference test is more helpful to planning physical therapy intervention and evaluate the progression of patients. The assessment of pediatric physical therapy is The Brigance Diagnostic Inventory of Early Development, The Milani-Comparetti Motor Development Screening test and The movement assessment of infants (23, 24).

2.5.2.2 Informal test

The fundamental of informal test consist of interview, self-administration and performance base assessments.

2.5.2.2.1 Interview assessment

The outcome from interview assessment is most benefits when the interviewer focus on how to administer and scoring systems. Thus the interviewer who ask the parents about infant's ability must pass the training course for interview with parents of the infants. The characteristic of interview assessment will define standard question and record answers in standard form. During interview, the interviewer must ask question under scope of standard format for prevent external influence that may decline the real outcome

2.5.2.2.2 Self-administered assessment

The types of this assessment, the clients will complete whole assessment by themselves. The pattern of this assessment is questionnaire. The patients must understand the question and answers written. The preciousness of the assessment depends on quality of the instrument and personal ability to answers the questions. The assessment must confirm that does not bias in the answers.

2.5.2.2.3 Performance-based assessment

The performance based assessment will use evaluator observation of child's ability in functional task. The assessment will base on ability to perform basic active daily living completely, but not focus on instrumental active daily living e.g. environment and performance in environment. And in performance-based assessment will spend more time and costs than other assessment (15).

2.6 Scales of assessment

From scoring system of AIMS, the nominal scale only assessment scale that related with interpretation in the result of AIMS.

2.6.1 Nominal Scale

The nominal is the lowest scale that often used in discrete or category data. The nominal scale will label the characteristic of the data e.g. blood type, sex or hemiplegic side involvement. Almost questionnaire often use nominal scale to answers such as (0) no and (1) yes, (0) male and (1) female and (0) disagree and (1) agree. The number in nominal scale is unable to count for compare how the difference between each characteristic. These only indicate the pattern of data. Thus the property within categories will be equal, but only different in description of categories. In addition, the meaning of nominal scale is lack of greater or lesser value than other e.g. female and male have similar value (23).

However, the nominal scale is use to evaluate health assessment e.g. AIMS. The scales of AIMS is define 0 when infant's movement is observed and 1 for cannot observe movement. But in case of partial ability, no scale can be identified. The scores from nominal scale cannot represent the real movement ability. From the nominal level, the measurement is not elaborate enough to evaluate movement's ability of the infants. Thus, the artificial result from the assessment can make the therapist did not understand the true impairment of the infants. And this problems will lead the intervention become less effectiveness. Therefore, this study will use mathematical model called Rasch analysis to statistically convert the data from discrete to continuous scale.

2.7 Rasch Analysis

From the limitation of discrete scale that describe above, the problems can be solving by Rasch analysis. The Rasch analysis is mathematical model published in 1960 by Danish mathematician Georg Rasch. The beginning applied to identify abilities and difficulty of language in educational psychology. And last 10 years, it has become widespread to use in clinical and diagnosis research. Because of traditional model may be low level of sensitivity and specificity to diagnosis. Thus the mistake from low precision its lead to unclear of patient's problems that can effect with physical therapy intervention.

Rasch analysis is mathematic model to provide psychometric information. Thus Rasch analysis can convert the observational assessment from ordinal to create linear measure on interval scale. Because the score between ranking of ordinal scale is nonequivalent. For instance, two patients have same total score 10, the total score of two patients cannot indicate that they will have same functional ability. Rasch analysis can transform the raw ordinal score from test score, rating scales and dichotomous checklist to linear measure in the interval scale by use maximum likelihood estimate to order items and subjects simultaneously. This method will fine the response of interaction between item's difficulties and person's abilities. All item's difficulties and person's abilities will find the fitting by use unidimensional continuum model, which is represent to the summation of the scores (25,26).

Hart DL in 2002 reported the advantage of unidimentional scale that associates with physical functioning (27):

1) Use the strength items of previous outcome tools.
2) Reduce ceiling and floor effect.
3) Can be use in each individual patients.
4) Assists in clinical decision making.
5) Can use in patients group's study.
6) Improve responsiveness of unique group of patients.

Rasch measurement will analyze of 2 parameters: items difficulty and person ability. The Rasch analysis will determine the items from easy to difficult base on hierarchical continuum line. Rasch analysis will estimate in difficulty item on a "logits" or log-odds unit of a person with failing zero. Thus a logits is the natural log of the performance odds of each items that associated with the performance of the total set of items : In greater difficulty items will use the logits larger (28). And in person's ability, Rasch analysis can find estimate the ability in person who not pass or fail in all items, or who passes or fails all items by unnecessary to use upper or lower bound to comparison (29). Nowadays, analyzing the data of Rasch technique is more available by Rasch software e.g. WINSTEPS, BIGSTEP program (28,31) . The result of software will present each individual person that respondent fits along the continuum, the level of difficulty that accomplish by each item on an interval scale and goodness-of-fit of the Rasch model (23).

2.7.1 Use of Rasch analysis

The using of Rasch analysis is beginning from educational and psychology area. At present, the method have extend to use in varies rehabilitation research e.g. neurological, orthopedic even though pediatric fields. For improve assessment scale and validate the measurement.

Russell DJ in 2000 studied Improved scaling of the gross motor function measure for children with cerebral palsy: evidence of reliability and validity (231). The result reported that when use Rasch analysis in GMFM. The ordering of items difficulty is sort from easy to difficult task from 88 items to 66 items. And use in shorter time because Rasch analysis will remove the misfit items. And the data transfer from ordinal to interval scale, the interpretability of total score and change score is clearly to present child's gross motor function.

Antonucci G in 2002 studied Rasch analysis of the Rivermead Mobility Index: a study using mobility measures of first-stroke inpatients (3) . The result demonstrated Rasch analysis can confirm that the scale of Rivermead Mobility Index in all items is suitable to use to evaluate patient's functional status in stroke patients. Because the scale have reliability and sensitivity to detect changing in pre-post rehabilitation program.

Page SJ in 2002 studied Scaling of the revised Oswestry low back pain questionnaire (33). The result reported that the Oswestry low back pain questionnaire is more accurate, quick and simple to use analyze the items with Rasch model. The scale in revised ODQ version show more accuracy and sensitivity to use in LBP in varies disability level.

Wongsaprom W in 2005 studied comparison of motor performance scores between gross motor function measure – 88 and gross motor function measure – 66 in Thai infants (34). The result reported Rasch change score is highly sensitivity to detect the change of gross motor function overtime than other scoring system. And can solve the problems in percentage score. In addition, Rasch score is more reliable and precise to estimate the ability and responsiveness.

Smith AB in 2006 studied Rasch analysis of the dimensional structure of the Hospital Anxiety and Depression Scale (26). The result demonstrated that when analyze the HADS items with Rasch method. The items is more specific to measure

anxiety and depression. In addition, the assessment have better recognition in difference levels of distress, thus this benefits lead to improve psychological support for in wide range of cancer patients.

Temcharoensuk P in 2007 studied comparison of gross motor components in typical infants aged 1-2 months (35) . The result reported Rasch analysis can improve sensitivity of ability score. So the maturation can be achieve clearly. In addition, the author suggested that Rasch analysis is appropriated, especially in the study to evaluated the development pattern and compare the effectiveness of treatment before-after intervention.

Mayhew A in 2011 studied Moving towards meaningful measurement: Rasch analysis of the North Star Ambulatory Assessment in Duchene muscular dystrophy (36). The result demonstrated that the change of 1 point of NSAA is related with interval scale. Thus the items that analyze from Rasch-transformed measurement have more precisely scale that suitable to use in research and treatment trial.

Moreover, Rasch analysis has been use to applied in the subjective pain scaling (37), to justify summation of comprehensive ADL score in stroke patients (38), to investigate construct validity of Children's Hand-Skill ability Questionnaire (CHSQ) in disability childs (39), to evaluate the psychometric properties of scale of Catherine Bergego Scale in unilateral neglect patients (40) and to assess psychometric characteristic of the Stroke Impact Scale (SIS) (30).

2.7.2 Advantage of Rasch analysis

Rasch analysis is a statistical to change ordinal convert to interval scales. Therefore the Rasch method is wildly use in nowadays. From literature review, most author in many fields is describe the advantage of Rasch analysis.

Russell DJ in 2000 studied Improved scaling of the gross motor function measure for children with cerebral palsy: evidence of reliability and validity (31) . They report the benefits of Rasch analysis following describe:

1) The items are arrange in order from easy to difficult.
2) Rasch analysis can transfer ordinal to interval scale.
3) Rasch analysis can eliminate misfit items which make the items redundant . And allow only items that important to assess gross motor ability.

4) Decrease administration time to assess

5) Available to use in computer scoring system to calculated child's total score and standard error within individual's score.

6) Rasch analysis can calculated the estimate even though child's score not administration all items.

7) Psychometric properties make the items more reliability and validity.

Hart DL in 2002 studied Development of an index of physical functional health status in rehabilitation (27). And reported the advantage to Rasch analysis:

1) Rasch analysis can produce linear scale.

2) Rasch analysis able to manage if the data is missing.

3) Rasch analysis can be calculated standard errors of measurement from individual measures.

4) Identify the deviation between observed and expected response.

2.8 Test of motor development

Nowadays, infants have low birth weight and birth complication is increasing. This problems will effect with motor development. Especially delay development is the highest rate of these problems (11). Physical therapy is a key role to assess motor development in infants with CNS dysfunction. Because motor development is one of the best indicator that reflex to well-being in early life. The purpose of motor assessment is analyze motor problems as fast as possible for provide appropriate treatment to minimize infant's motor problems.

The widely assessment in pediatric physical therapist to measure infant's motor development include of

2.8.1 Alberta Infants Motor Scale (AIMS)

The Alberta Infant Motor Scales is used to assess gross motor maturation in infants aged from 0 to 18 months. The goal of AIMS is to identify and evaluate delay or atypical motor development. The AIMS is developed in 1994 by Piper and

Darrah. The concept of AIMS is nearly with neuromaturational theory and dynamic systems theory. The AIMS is standard measurement that suitable for 1.) infants who have normal development to assess their developmental change 2.) infants who are a high risk for delay developmental 3.) infants who have been diagnosed with developmental conditions or disorder 4.) infant who received the developmental assessment from health professional. It can be used as an assessment the prognosis of pre-post intervention for health care professional. The requirement of AIMS consists of 3 important component: weight-bearing, posture and anti-gravity. In addition AIMS is an observational assessment in 4 dimension: prone, supine, sitting and standing. The assessment requires minimal handling, allowing the infant to perform their real spontaneous movement (11).

2.8.2 Gross Motor Function Measure (GMFM)

The GMFM is standard observation assessment that design to evaluate change of gross motor function in cerebral palsy children. The recommendation of GMFM is over 2 years with moderate to severe motor dysfunction but can do the task follow the demonstration of GMFM. The GMFM is useful in both clinic and research measurement and take times 45-60 minutes to complete all dimension. The GMFM was created by the group of multidisciplinary e.g. physical therapist, physician and biostatistician at McMaster University in Canada. The GMFM have two versions: the original 88 items (GMFM-88) and modified version 66 items (GMFM-66). In original version, the GMFM include of 4 dimension with 88 items : lying and rolling; sitting; crawling and kneeling; standing; and walking, running and jumping. The GMFM is focus on the movement what a child can do and also in quality of performance. Rating scale could separate into 4 rate. A score 0 represent that the child cannot initiated to perform the movement, a score of 1 show that the child can perform the movement but achieve less than 10% of whole movement, a score 2 that indicate the child can perform movement but not completely and a score of 3 show that the child can perform whole movement completely. During assessment the child must remove all clothes and gait aids. And the therapist can facilitate the child to move in starting position but cannot help to achieve the task (31,41).

2.8.3 Test of Infant Motor Performance (TIMP)

The Test of Infant Motor performance is selective control of movement and postural control assessment for functional performance in daily life e.g. change body positions and control head movement that effect with the eyes for focus the object or people. The TIMP is the test that appropriate for infant age 32 weeks postconceptional age to 4 months corrected age in preterm and 4 months chronological age for full-term infants. The objective of TIMP is explore the motor delay in infants. In addition TIMP can classified the risk of poor motor outcome in vary degrees and assess changing pre-post motor outcome from the treatment. The TIMP version 1 is create by Girolami and developed to latest version 3. The TIMP include of 2 subscales: observing items and elicit items. Observing items will assess spontaneous movement e.g. able to control head movement within central line of body and elicited items will evaluate infant's position respond from attractive sight and sound. The latest version 3 consist of 28 dichotomous scores from observing items and 31 items scores from elicited items. The TIMP take time about 25-35 minutes to success the assessment. And during assessment the infant are in alertness or active states (42,43).

2.8.4 Movement Assessment of Infants (MAI)

The Movement Assessment of Infants (MAI) is neuromotor assessment in infants age below 12 months. The MAI was create by 3 pediatric physical therapist and suitable for medical member that work involve infant development such as physical therapist, occupational therapist, nurse, physician even though psychologist. The TIMP is early tool that can identify development in infants with neuromotor dysfunction in both qualitative and quantitative measure. On the other hand, the MAI can monitor outcome of physical therapist intervention. And the MAI is an follow-up instrument for measure motor development in high risk infant after discharge from NICU also. The MAI consist of 65 items and will be complete in 45-60 minutes. The MAI can separate into 4 components of movement: muscle tone, primitive reflexes, automatic reaction and volitional movement. In muscle tone assessment will measure against gravity posture, resistance passive stretch and muscle consistency. In primitive reflexes will observe the early infancy reflex. In automatic reaction will evaluate equilibrium, righting and protective reaction in infants. And measuring in volitional

movement involve with fine and gross motor behaviors including hearing and vision screen (41,44,45).

2.8.5 Peabody Development Motor Scale (PDMS)

The Peabody Development Motor Scale is assessment to evaluate gross and fine motor development in children with handicap condition and use for follow up high risk infants in pediatric clinic. The PDMS is published in 1983 by a physical educator and a special educator. The proper age range for use PDMS is birth to 7 years. The total items of gross motor scale is 170 items and can categories into 17 age level by 10 items for each age range. Five skill classification consisted of : reflexes, balance, non-locomotion, locomotion, receipt and propulsion of objects is contain in gross motor scale. And total items of fine motor scale is 112 items and divide into 6 or 8 items for 16 age range. Total categories of fine motor scales consist of 4 skill: grasping, hand use, eye-hand coordination and manual dexterity. The total administer of PDMS is 40-60 minutes. The scoring is three-point scale; 0, 1 and 2. A score 0 indicate the children perform the task not successful. A score 1 represent the children can start to perform but not success. And a score 2 show the children is able to perform successful and complete in criteria (41,46,47).

2.8.6 The Mullen Scales of Early Learning

The Mullen Scales is diagnostic observation about infant's cognitive functioning that based on neurodevelopmental theories. The Mullen Scales of Early Learning can be used for children from birth to 68 months. The Mullen Scales measure 5 domains including gross motor, visual reception, fine motor, receptive language and expressive language. The administration time is about 15-60 minutes. The gross motor scale focuses on central motor control and mobility in supine, prone sitting and standing positions. And the items cover unilateral and bilateral control of limbs. This assessment is suitable for use in clinic by professional member e.g. physical therapy, occupational therapy, speech pathologist, clinical psychologist, special educators and school psychologist. Test-retest reliability in gross motor scale was 0.96 for young infants. And it also has high degree of agreement when evaluating over time. Concurrent validity in fine motor scale with Peabody Fine Motor Scale was

0.65 to 0.82. Concurrent validity with Bayley Scales of infants development in gross motor scale was also high (0.76) The score of Mullen Scales ranges from 0 to 5. If total scores in each scale are equal or lower than 30, it indicates delay development and needs for intervention (45).

2.9 The Selected Motor Development Evaluation: Alberta Infant Motor Scale (AIMS)

The Alberta Infants Motor Scale (AIMS) is the performance-based, norm-referenced in infants from birth to 18 months established by a Canadian pediatric physical therapist in 1994. The construction of AIMS is base on both neuromaturation model and also identify components of the dynamic motor theory. The AIMS is administration from observation of infants with minimal handling and place the infants in four positions. The objective of AIMS is identify gross motor movement of infants with motor delay or atypical development and evaluated the maturation of motor development overtime. The AIMS will evaluates the motor maturation and milestone that focus on response of spontaneous movement from facilitation the new environment constraint. Thus, 3 components that require from spontaneous movements of AIMS following: first, the body parts that weight bearing second, the postural alignment of each body part and the against gravity movement.

2.9.1 Content

The AIMS is the gross motor behavior assessment in infants. It include of 58 items that evaluate ability of movement in four positions: prone (21 items); supine (9 items); sit (12 items); and stand (16 items). Each items is presented the line drawling of infants performing the movement. And have written description of weight-bearing, posture and antigravity which is necessary in movement pattern and skill in infants.

2.9.2 Scoring

The scoring of AIMS is dichotomous choice or binary fashion that can classified to “observed” and “not observed”. 0 indicated cannot observed all movement components and 1 represented can observed all movement components. But no alternative option for infants who has partial credits. The examiners should complete the scores at the end of assessment, not while observing. The examiner will observed ability of infants in each positions. Thus the items between least to most mature will call “window” for each position skill. All items within window in each positions should scoring either “observed” or “not observed” by observation only. Some items within window may not appear cause by already mastered or discarded, the scored should credit in “not observed”. The total scores of AIMS is calculated from subscale score of each positions. Thus, items below the least mature that can observed will credited 1 score. In the same time, each “observed” items within window also credits 1 scores also. The sum of credit points is the subscale score. And the sum of four subscale score will calculate for infant’s total score.

The infant’s total scores will plotting at the graph for find the percentile rank. The infant’s age group will located in horizontal axis of graph. And the total AIMS scores will located in vertical axis. The percentile ranking of infants is intersection point of perpendicular line that draw from each axis. The result of percentile rank will describe the proportion of normative sample of infants at same age. The percentile can indicated to motor development of infants. The infants who have highly percentile rank may decrease risk of delay motor development. For example, 90 percentile rank represent the infants have total score is equal to 90% of infants in same age group and only 10% have higher scores. Thus, in infants who have lower percentile rank about 10% may need long-term motor development follow up or obtain the intervention of motors delay (11).

2.9.3 Reliability and validity

The reliability of AIMS examined interrater reliability show high reliability between 2 rater. Pearson product moment correlation coefficients values from .95 to .98, SE is lower than 1.11 And test-retest reliability in same examiner that interpret from total score of AIMS show r values ranging from .85 to .97 (11) For the

concurrent validity of AIMS when compare with Peabody Development Scales of Infants Development (PDMS) show high concurrent validity (correlation coefficient = .90 to .99 in normal infants) (11,48). In addition, concurrent validity of AIMS and Bayley Motor Scale is show good to high concurrent validity also (correlation coefficient range from .85 to .97 in typical infants)(49). The author concluded that AIMS is the assessment that have reliability and validity to evaluate infant's motor development. Because AIMS is highly reliable tools when use in difference examiners and when apply in same participants in varied times. In addition, highly degree of correlation in concurrent validity with standard pediatric measurement e.g. PDMS and Bayley Motor Scale.

In the study of Uesugi M in 2008 studied the reliability and validity of the Alberta Infant Motor Scale in Japan (50). The result present good to high in intra-reliability and inter-reliability (ICC = .86 to .93 for and .89 to .93). In addition, concurrent validity of AIMS have correlation with Kyoto Scale of Psychological Development 2001 (KSPD) with high correlation (r = .97 to .98). This study concluded that reliability and validity of AIMS is high. And the level of pediatric experience or expertise did not influence with rater's reliability.

And the study of Valentini NC in 2012 studied Brazilian Validation of the Alberta Infant Motor Scale (51). The result reported show high reliability of both inter-intra reliability (ICC = .86 to .99 and .91 to .99). This study examined the concurrent validity between AIMS and Child Behavior Development Scale (CBDS). The CBDS is spontaneous and stimulated behavior assessment. The standardized of CBDS is base on Brazilian children age from 1 to 12 months. The result show moderated correlation between AIMS and CBDS (r = .34). Because the CBDS have only 15 items of motor subscale. Unlike the AIMS have the motor items extend to 58 items.

2.9.4 Limitation of AIMS

The AIMS is not suitable to use in infants with severe motor impairment for example, spina bifida or cerebral palsy. The AIMS have specific purpose to measure motor skill in infants with normal pattern of movement but immature motor development. Because the infants who have abnormal pattern of movement e.g.

spasticity. The abnormal pattern of movement will not allow the minimum ability to pass the items on AIMS. And their scores is keep quiet even though, their motor performance is improve. In addition, the AIMS is not valid to measure motor ability in infants age older than 18 months but still have motor skill in infants level (11).

The AIMS is widely use in pediatric physical therapy but the AIMS still have limitation. The result of AIMS is not sensitive enough to discriminated motor delay or identifies which movement components is impair. Thus if the assessment cannot indicated what movement components is key problems, the intervention cannot be plan suitably for each infants. From literature review, the limitation is AIMS is following:

1. The scoring systems do not have the credits for infants who able to complete the movement only partial (11).

2. The result that reported in percentile is not represent to real spontaneous movement (12).

3. The age range of AIMS is too wide, some items have the ceiling effect (12).

However, the assessment that focus on movement components is still necessary to use for analyze gross motor movement. Therefore, this study will modify the description and scoring system of AIMS. And also use raw score to indicated the gross motor ability. In addition, this study will use cut off the age of participants above and below 9 months to confirm that AIMS is not suitable for infants age more than 9 months from the result of previous study. Thus this study will modify the new assessment to make more sensitivity for detect the infant's ability that specific on gross motor components**.**

CHAPTER III
MATERIALS AND METHODS

3.1 Design of the study

This study was a cross-sectional design to study concurrent validity of the modified and the original AIMS scoring systems in infants aged 3 to 18 months

3.2 Participants

Infants aged between 3 and 18 months, whose parents were willing to let their infants participate in this study were recruited. The infants were screened for the following criteria;

3.2.1 Inclusion criteria

1.) Typically developing infants (TD) aged between 3 to 18 months

2.) Delay developmental infants (DD) aged between 3 to 18 months

3.2.2 Exclusion criteria

1.) Severe congenital disorder that affect to gross motor development

2.) Congenital anomalies

3.) Recent surgery within 6 months

4.) Unstable medical conditions

5.) Cannot focus and follow object

6.) Cannot respond to voice or sound

7.) Uncontrolled seizure

8.) Sick on testing day

3.3 Instrumentations and outcome measure

1. Manual Alberta Infant Motor Scale sheet
2. Mullen Scale of Early Learning assessment sheet
3. Firm mat
4. Examination table
5. Adjustable bed
6. Toys
7. Video camera

Figure 3.1 Firm mat

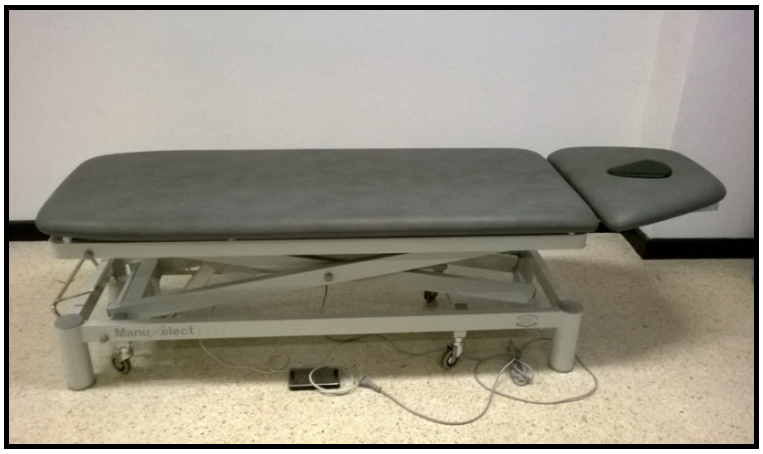


Figure 3.2 Adjustable bed

Figure 3.3 Toys

Figure 3.4 Video camera with stand

3.3.2 Outcome measure

Outcome measures of this study were the ability scores of the modified and original AIMS in 3 components of movement e.g. weight-bearing, posture and anti-gravity movement in 4 positions of infants aged 3-18 months.

3.4 Procedure

3.4.1 Recruitment

All participations who met the study criteria were recruited. The researcher explained the objective and procedure to parents. And parents were asked to in sign an inform consent of this study. This study was approved by Ethic Committee of Mahidol University Institutional Review Board of Siriraj Hospital

3.4.2 Infant preparation

Before assessment, the infants were checked for any precautions or conditions that could disturb the assessments such as fever. The infants wore a diaper only. During assessment infants should be alert and active. Their parents were allowed to join throughout the assessments. The assessment would stop, if infant could not perform the tasks from any conditions. If the assessment was not complete, the assessor would make another appointment to re-assess within 1 week later.

3.5 Validity of measurement

3.5.1 Validity of Modified AIMS and AIMS

Validity of the modified scoring system using the original scoring system as a gold standard was conducted.

3.5.2 Intrarater reliability

- *Modified AlMS and AIMS*

The intrarater reliability of AIMS was examined by comparing the AIMS scores of the first time assessment with the second assessment scores 2 weeks later.

3.5.3 Mullen Scale of Early Learning assessment

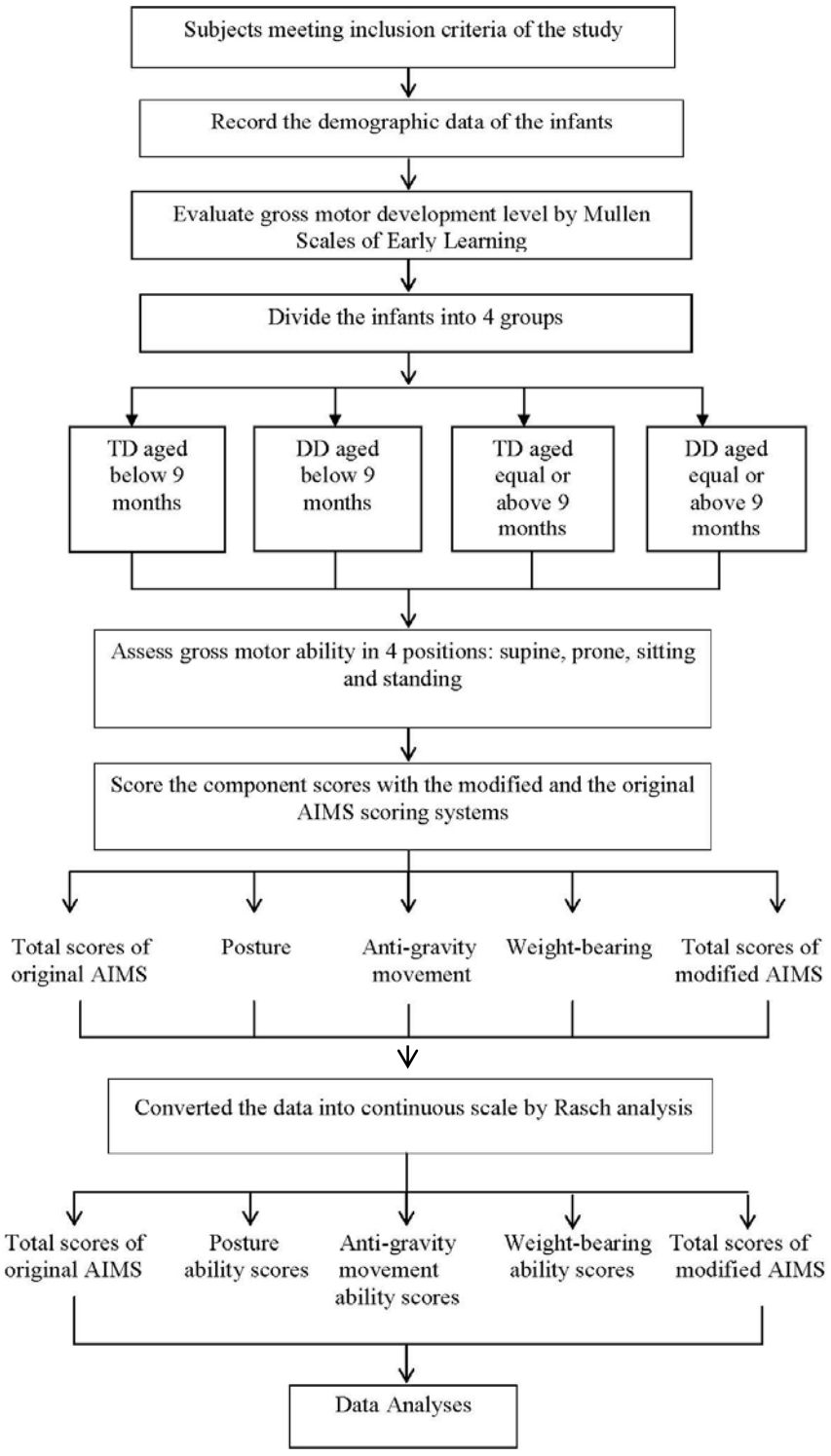
This study, the assessors of the AIMS and Mullen Scale of Early Learning were separated to prevent the bias from assessors. The assessor of Mullen Scale of Early Learning was trained to use and interpret the test from an expert pediatrician. The feedback of expert pediatrician about the Mullen Scale of Early Learning assessor were show in Appendix.

From the interpretation of Mullen Scale of Early Learning, the infants, T-scores in gross motor dimensions used to classify them into groups. Infants with T-score greater than 30 were classified as TD infants and those with T-score of equal or less than 30 were classified as DD infants.

3.6 Testing procedure

Prior to the assessment, the demographic data including age, sex, height, length, gestational age, medical history, birth complication, date of birth and head circumference were interviewed from parents. All infants were evaluated of gross motor developmental level by Mullen Scale of Early Learning to divided them into 4 groups : 1) TD aged below 9 months 2) DD aged below 9 months 3) TD aged equal or above 9 months and 4) DD aged equal or above 9 months. After that, all infants were recorded for the gross motor movement in 4 dimensions : prone, supine, sitting and standing subscales from the front and side views by two video recorders.

The modified scoring system is different from original scale. The measurement scale of AIMS is nominal scale. The 0 point represents “not observe” all movement component and 1 point represents “all movement component are observed”. But modified scoring system of AIMS, the scoring is divided to 3 points: 0 represents “not observe” any movement components, 1 point represents “observe partial” movement components and 2 point represents “all movement components are observed”. Afterward, the raw scores were collected and analyzed the categorical to interval scale by Rasch analysis.



* : *TD : Typically Developing infants*

DD : Delay Development infants

Figure 3.5 Flowchart of the study

3.7 Data Analysis

Statistical analysis was performed by SPSS version 19. The p-value of less than 0.05 represented statistical significance. Statistics used in this study were

1. The descriptive statistics for demographic data
2. Kolmogorov-smirnov goodness of fit test for assessing normal distribution of data
3. Intraclass correlation coefficient (ICC) model 2, 1 for analyzing correlation and agreement between the modified and the original AIMS scoring systems
4. Independent t-test for comparing total score of modified AIMS between groups of infants.

CHAPTER IV
RESULTS

4.1 Demographic Data of Participants

Forty-one Thai Infants were recruited and classified into 4 groups by age and levels of gross motor development. Of the total, 19 were boys and 22 were girls. All infants were evaluated to classify for motor development groups by Mullen Scales of Early Learning and also assessed gross motor by using Modified scoring system of AIMS. Table 4.1 shows the numbers of infants in each group. Table 4.2 shows the demographic data of all infants.

Table 4.1 Characteristic of infants

Group*	Number of participants		Total
	Girls	Boys	
1	6	5	11
2	6	4	10
3	6	4	10
4	4	6	10
Total	22	19	41

* : *Group 1 = Typical developmental Infants aged below 9 months*
Group 2 = Delay developmental Infants aged below 9 months
Group 3 = Typical developmental infants ages above 9 months
Group 4 = Delay developmental infants aged above 9 months

Table 4.2 Demographic data of infants (N = 41)

Group	Category	Mean	SD
1.	CA (months)[a]	6.27	1.67
	Birth weight (grams)	2218.63	997.26
	GA (weeks)[b]	32.18	4.79
	Weight (kg)	7.80	1.22
	Length (cm)	67.86	4.45
	Head cir. (cm)[c]	42.95	3.39
2.	CA (month)[a]	6.00	2.10
	Birth weight (grams)	1875.00	706.70
	GA (weeks)[b]	31.60	3.68
	Weight (kg)	7.19	1.52
	Length (cm)	67.40	5.78
	Head cir. (cm)[c]	43.03	3.30
3.	CA (month)[a]	14.70	2.540
	Birth weight (grams)	2508.88	479.90
	GA (weeks)[b]	36.00	2.82
	Weight (kg)	11.33	2.61
	Length (cm)	75.20	3.01
	Head cir. (cm)[c]	45.03	2.13
4	CA (month)[a]	14.20	2.20
	Birth weight (grams)	2096.00	942.76
	GA (weeks)[b]	33.40	5.08
	Weight (kg)	10.04	1.91
	Length (cm)	76.65	5.76
	Head cir. (cm)[c]	46.74	1.60

a: CA = correct age

b: GA = gestational age

c: Head cir. = head circumference

4.2 Results

4.2.1 Assessing normality of data

This study used the Kolmogorov-Smirnov goodness of fit test to assess normal distribution of the data. The results showed that all data were normal distribution ($p > 0.05$).

4.2.2 Converting categorical data into continuous scale

The raw scores from AIMS modified scoring system, weight-bearing score, posture score and anti-gravity score were computed by Rasch analysis. The Rasch analysis was used to convert the categorical scale onto continuous scale by WINSTEP version 3.36. The converted scores were called the AIMS ability score, weight-bearing ability score, posture ability score and anti-gravity ability score. All ability scores were normal distributed and analyzed by parametric statistics.

4.2.3 Concurrent Validity of the Modified Scoring System of Alberta Infants Motor Scale

The concurrent validity of the Modified Alberta Infants Motor Scale was determined by the correlation between modified and original scoring systems of AIMS. The data distribution were tested by Kolmogorov-Smirrov Goodness of Fit-test. All data were normal distribution. The Intra-class correlation coefficient was used to analyze the concurrent validity and agreement. The correlation between the two scoring systems was 0.996 ($p<0.05$) . This correlation presented good level of correlation.

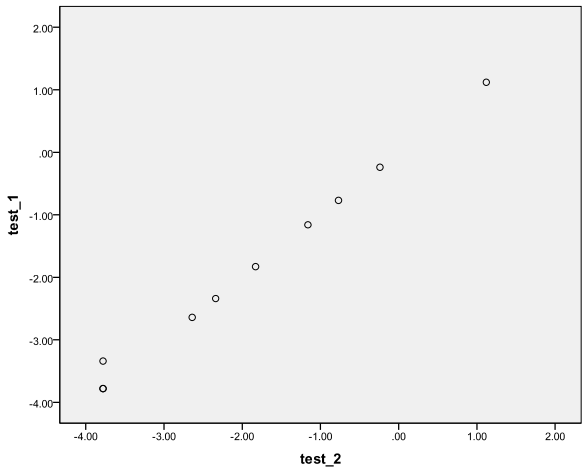


Figure 4.1 The scatter plot of the relationship between the modified and original scoring systems of the Alberta Infants Motor Scale ($r = 0.997$, $p < 0.05$)

4.2.4 Comparison between movement components in typical and delay developmental infants

Descriptive data of posture ability score, anti-gravity ability score, weight bearing ability score and Modified AIMS ability score were used to compare the abilities between typical and delay development infants in each group. Result of movement components in both typical and delay development infants are shown in Table 4.3 to 4.6 The independent t-tests were used to compare of movement components of typical and delay development infants in each group.

4.2.4.1 Comparison between movement components in typical and delay development infants aged above and below 9 months

Table 4.3 shows the comparison of posture ability score in typical and delay development aged above and below 9 months. The result indicated that there were significant differences between posture ability of typical and delay development infants aged above and below 9 months.

Table 4.3 Comparison of posture ability scores of TD and DD infants

Age Group	Infants		95% CI	p-value
	Typical Development	Delay Development		
< 9 months	0.2773 ± 1.394	-0.9550 ± 0.3007	0.130 – 2.334	0.03*
>=9 months	2.512 ± 0.590	1.8340 ± 0.7539	0.041 – 1.314	0.03*

Table 4.4 shows the comparison of anti-gravity ability score of typical and delay development aged above and below 9 months. The result showed that there were significant difference between anti-gravity ability of typical and delay development infants aged below and above 9 months.

Table 4.4 Comparison of anti-gravity ability score of TD and DD infants

Age Group	Infants		95% CI	p-value
	Typical Development	Delay Development		
< 9 months	0.3382 ± 1.430	-0.9270 ± 1.029	0.115 – 2.414	0.03*
>= 9 months	2.638 ± 0.594	1.833 ± 0.647	0.221 – 1.388	0.01*

Table 4.5 show the comparison of weight bearing ability score in typical and delay development aged above and below 9 months. The result revealed there were significant difference between weight-bearing ability of typical and delay development infants aged below and above 9 months.

Table 4.5 Comparison of weight bearing ability scores of TD and DD infants

Age Group	Infants		95% CI	P-value
	Typical Development	Delay Development		
< 9 months	0.581 ± 1.452	-0.688 ± 0.858	0.164 – 2.374	0.02*
>= 9 months	2.889 ± 0.544	2.058 ± 0.874	0.146 – 1.515	0.02*

Table 4.6 show the comparison of total Modified AIMS ability score in typical and delay development aged above and below 9 months. The result showed that there were no significant difference between total Modified AIMS ability score of typical and delay development infants aged below and above 9 months.

Table 4.6 Comparison of total Modified AIMS ability score of TD and DD infants

Age Group	Infants		95% CI	P-value
	Typical Development	Delay Development		
< 9 months	-0.7118 ± 2.344	-2.391 ± 1.711	-0.212 – 3.570	0.07
>= 9 months	3.078 ± 0.962	1.966 ± 1.376	-0.003 – 2.227	0.05

CHAPTER V
DISCUSSION

5.1 Characteristic of Subjects

The subjects in this study were Thai typically and delay developing infants aged from 3 to 18 months. The selected aged range was according to the description of AIMS manual. The gross motor development level was tested to evaluate infant's development. Parent interviews were used to screen for exclusion criteria and the demographic data of all subjects were also recorded. The infants with overweight and/or over height were not excluded from this study. This study divided the subjects into 4 groups by age and gross motor developmental level using; 9 months as the cut point (12) for all infants with typically and delay developing, group 1) typically developing infants aged below 9 months 2) delay developmental infants aged below 9 months 3) typically developing infants aged, equal or above 9 months, and 4) delay developmental infants aged equal or above 9 months.

Because the outcomes of this study were ability scores that needed the accuracy to find the main problem of the infants. In our knowledge, the data of most developmental tests are on nominal scale. The nominal scale is not sensitive enough to assesse the movement components. Hence, Rasch analysis is play the key role to convert nominal scale onto continuous data. Furthermore, the advantage of Rasch analysis could make the items more reliability and validity. And also able to calculate ability scores for individual infants. This is the good way to apply because each infant has a unique impairment.

However, this study was not equalize the sex of infants and types of pregnancies in each group due to number of infants. According to the longitudinal study of WHO from multicenter growth reference study in 2006 (52). They assessed the gross motor milestone achievement of different sexes in infants aged 4-12 months. The result reported that there were no significant differences between boys and girl in motor milestone achievement. Also study of Lung et al in 2011 evaluated the

reliability and validity of Taiwan Birth Cohort Pilot Study (TBCS)(53) They studied children aged between 6-60 months old in gross motor dimension. They summarized that there were no gender differences in gross motor dimension. And the study of Brouwer et al in 2006 examined the longitudinal comparable motor milestone between singletons and twins aged 0-24 months (54). The result concluded that there were no difference between the motor milestone in healthy singletons and healthy twin. From these studies it could be confirmed that differences in sexes and types of pregnancies should not affect with the results of this study.

5.2 Concurrent validity of the Modified scoring system of the AIMS

The concurrent validity is important for new assessment to compare the test with gold standard assessment. It will describe how well of the correlation between 2 tests that could measure the same thing. The concurrent validity of Alberta Infants Motor Scale original scoring system and Alberta Infants Motor Scale modified scoring system was good correlation (0.997) . Many previous studies reported the concurrent validity of other developmental tests with Alberta Infants Motor Scale original version (49).

Tse et al in 2008 examined the concurrent validity of the Harris Infant Neuromotor Test (HINT) and the Alberta Infant Motor Scale (55) original version in both typical and at-risk infants aged at 4 to 6.5 and 10-12.5 months longitudinally. The results showed good correlation between HINT and AIMS original version at the aged of 4 to 6.5 (r = -0.809) and also 10-12.5 (r = -0.928) months in at-risk infants and in typical infants at the aged of 4 to 6.5 (r = -0.867). However, at the age of 10-12.5 months, the correlation was moderate to good (r = .596).

Heineman et al in 2013 reported reliability and concurrent validity between Infant Motor Profile (IMP) (56) and Alberta Infants Motor Scale original version in term and preterm infants aged of 4, 6, 10, 12 and 18 months longitudinally. The author showed that there were strong correlation with IMP in performance domain and AIMS original version (rs = 0.81-0.84) especially in infants aged 10-12 months.

Duman et al in 2015 studied validity and responsiveness of Pediatric Evaluation of Disability Inventory Computer Adaptive Test (PEDI_CAT) and Alberta Infant Motor Scale (AIMS); They studies in inpatient pediatric post-acute care hospital infants and children aged < 18 months. The result presented fair correlation between PEDI-CAT in mobility domain (rs = 0.32) and AIMS original version.

5.3 Comparison between movement components in typical and delay developmental infants

Gross motor developmental tests are widely used to evaluate development milestone in pediatric physical therapy. However, the developmental tests that assess movement components are still rare. Therefore, the outcome of this study is the movement component ability scores e.g. weight bearing, posture and anti-gravity movement that necessary for all movements of infants. The result reported that the gross motor movement component including weight bearing, posture and anti-gravity movement between typical and delay development in infants aged 3-18 months corrected age were significant difference except total modified AIMS ability score. And the movement components e.g. weight bearing ability score, posture ability scores, anti-gravity ability score and total modified AIMS ability score of delay development were lower than typical development in all age groups. The discussion of all results would be reported in general knowledge about the difference between characteristic of typical and delay developmental infants.

Several studies reported that infants with motor delays have delayed maturation of central nervous system (58). Hence, this immaturity may affect with gross motor achievement. Low muscle tone is highly correlated with developmental delay e.g. delay in gross or fine development. Muscular hypotonia has influence on their daily movement skills in infants with delay development. Moreover, difficulty to maintain posture is the important impairment (4). Because of joint hyper mobility is the result from low muscle tone that could lead to ligament laxity. This cause will make the infants difficult to move the body against gravity (58), and at slower rate of postural reaction development. They will have difficulty to maintain balance while the

perturbations were acted with their body. So compensatory movement strategies were used to assist in body stability. In addition, the deviation movement patterns are occurred e.g. walk in deviation pattern wide-base gait and out-toeing or sitting in W position. All of these deviated positions were resulted by low muscle tone and ligament laxity (4). Infants with motor delay also have less trunk rotation, anti-gravity postural control development and lower limb association in prone pivot, knelling, kneeling to sitting and also reciprocal creeping (59). Several previous studies also reported that the movement abilities of delay and typical development infants were difference.

Deffeyes in 2008 reported that sitting postural sway indicates developmental delay infants(60). The author studied sitting postural sway between delay and typical development infants aged 5 months to 2 years by AMTI force plate. The author summarized that typical developmental infants have more exploring wider variety of solutions to postural control.

Hsue in 2014 studied the movement patterns used to rise from a supine position in children with development delay and age-related differences in these populations (61). The studies analyzed developmental movement patterns of typical and delay development children in 3 components (upper extremities, trunk/axial and lower extremities) by video records. The result revealed that the maturation rate of children in 2-6 years with delay development are more varies and difference when compare with typical developing children.

5.3.1 Comparison between total Modified AIMS ability score in typical and delay development aged below and above 9 months

The result of this study showed no significant difference between total score of modified AIMS in typical and delay developmental infants. This study developed the new scoring system that divide the outcomes into 3 levels: 0, 1 and 2 (the description of each level were explained above). The assessor watched the video of all infants and rated the scores in the assessment sheet. In each item, the scoring was separated for 3 movement components : weight-bearing, posture and anti-gravity movement. Then all of movement component scores were converted from categorical scale to continuous scale by Rasch analysis. After that, if the movement components

in each item were missed at least 1 component, the total score would become 0. On the other way, if the movement components were completely achieve for 3 components, the total score would become 1. It is not be surprised that total scores of delay and typical developmental infants were not difference. Because in each age range, the dominant of movement components were alternated to play a key role to support motor milestone achievement at that age. The study of Temcharoensuk in 2007 found that in typical developmental infants aged 12 months, the gross motor movement component still not completely mature. From this result, it could be concluded that at age of 1-9 months, most positions of infants were required in weight bearing follow by posture and anti-gravity movement . For example, in 1-3 months, the infants need more weight shifting and more muscle activate. The posture will progress from fully flexion and close to body then become more extend. In 4-6 months, the infants have more muscle strengthen to create varies pattern e.g. prone position, the infant have more mobile of cervical and thoracic spine. The infants can extend neck easier and the stability of shoulder is more developed. At the end of this age range, the infants start to learn anti-gravity activity by sitting with support but this anti-gravity component is not completely matured. At 7-9 months, the infants could perform the activity in more upright and weight bearing e.g. crawling , creeping or sitting independently. However, infants aged 10-12 months, weight bearing ability score were are highest score but, the anti-gravity movement score was higher than posture. The author summarized that the infants may prepare themselves to maintain balance in upright position e.g. standing and walking (35). But in delay development, the sequence of movement component patterns might be varied from typically developing infants. From the previous study, there were no studies that assess the movement components in each age range, except the study of Temcharoensuk in 2007.

5.4 Clinical Implication and further study

The result of this study can be used in pediatric physical therapy clinic to evaluate movement components in both typical and delay development infants. The information from the assessment could report the main movement impairment in each

infant. And the data will provide the specific knowledge about the main movement problem that could be applied in clinical field. These findings showed that the movement components between typical and delay development infants aged 3-18 months were significant difference. Delay developing infants recorded lower scores than typical development infants in all components (weight bearing, posture and anti-gravity movement).

The result can be useful to apply in both clinic and research settings. In case of clinical application, the raw scores, because the outcome will show which components are the main problems. The plan of treatment are able to follow with the result of the assessment. In addition, the result can be used to measure effectiveness and progression of the treatment by assessing before and after treatments. The outcome of this study may be used to educate pediatric physical therapist to understand more deeply about the specific movement problems in motor delay infants which occur in individual infants. However, in case of research setting, the Rasch analysis is necessary to apply because the categorical scale is not sensitive enough to identify the impairment. Thus Rasch analysis is the key to convert from categories to continuous scale to make the scale more elaborated.

Although this study was the first study that explored about the comparison between movement components of typical and delay development infants. The researcher selected cross-sectional study design. The benefits of cross-sectional study were is that it requires short duration to collect the data. But the limitation of the design is that it cannot measure the progression rate of movement components of all infants. Therefore, a longitudinal study is of interesting to detect the progression of movement components. It is also challenging to translate the description of the modified scoring system of AIMS into Thai language and also add the pictures of infant's position in each item for more understanding and easier to use. Moreover, the researcher recommended that before use of this assessment in clinical or research setting, the user should be trained to use the scoring system with clear understanding of the description of each item deeply.

CHAPTER VI
CONCLUSION

This present study aimed to investigate concurrent validity of the modified AIMS scoring system in infants aged 3-18 months. The subjects of this study were typical and delay development infants. In addition, this study also compared gross movement component ability; which were weight bearing ability, posture ability, anti-gravity ability and total ability scores of the modified scoring system of the AIMS. The subjects were consisted of 41 Thai infants. All infants were recruited and classified into 4 groups by age and level of development 1) typical development infants ages below 9 months 2) delay developmental infants ages below 9 months 3) typical developmental infants aged equal or above 9 months and 4) delay developmental infants aged equal or above 9 months. They were assessed of level of development by Mullen Scales of Early Learning. And they were evaluated movement components in 4 positions; prone, supine, sitting and standing position using the AIMS. After that, the raw scores, which were the categorical scales were transform to continuous scale by Rasch analysis. Then the data in continuous scale were be analyzed by parametric statistical analysis.

The result showed that the concurrent validity between the two scoring systems of Alberta Infants Motor Scale was in good level. The result could explain that the modified scoring system can measure the same thing like the original system. This study also found correlation among the gross motor movement components. The result summarized that the gross motor movement component between typical and delay developmental infants were significant difference. Certainly, delay developing infants have lower scores than typical infants in all gross motor components. This results were similar to many previous studies that examined the difference between gross movement in delay and typical infants. This cause might be the result of central nervous system (CNS) of the delay developmental infants were not mature. From this reason, their gross motor pattern might become deviated. However, the total score of

modified AIMS in delay and typical development were not difference. Because in each age range has different dominant movement components. So in infants aged 3-18 months the component may alternate to become a key to support motor milestone achievement at that age. However, in motor delay infants, the researcher believes that the sequence of movement component pattern might be varied.

The Rasch analysis was used in this study to make the data more elaborate by converting data from categorical to continuous data. The advantage of Rasch analysis could make the items more reliability and validity. And also it is able to calculate ability scores for individual infant. Thus the researcher recommend the use of Rasch analysis to convert the data before entering for statistical analysis , if the modified scoring system of AIMS is used in research setting.

This study may be the first research that study about the movement components of typical and delay developmental infants. To reduce the duration to collect data, the cross-sectional study was selected. But the limitation of this study design is that it cannot detect the progression of movement component in individual infants. For further study, longitudinal study is recommended to identify the movement components in long term period. Translation the description of modified scoring system of AIMS into Thai language and add the pictures of infant's position in each item is suggested in further study for more understanding and easier to use.

REFERENCES

1.Ulijaszek SJ, Johnston, F. E., & Preece, M. A. The Cambridge encyclopedia of human growth and development. : Cambridge University Press; 1998.

2.Berk LE. Child development 5th ed, A Pearson Education Company. 2000.

3.Magill RA, Anderson DI. Motor learning and control: Concepts and applications: McGraw-Hill New York; 2007.

4.Tecklin JS. Pediatric physical therapy: Lippincott Williams & Wilkins; 2008

5.Johnson CP, Blasco PA. Infant growth and development. Pediatrics in Review. 1997;18(7):224-42.

6.Charitou S, Asonitou K, Koutsouki D. Prediction of infant's motor development. Procedia-Social and Behavioral Sciences. 2010;9:456-61.

7.Mundkur N. Neuroplasticity in children. The Indian Journal of Pediatrics. 2005;72(10):855-7.

8.Malina RM. Motor development during infancy and early childhood:overview and suggested directions for research. International Journal of sport and health science. 2004;2:50-66.

9.Cameron EC, Maehle V, Reid J. The effects of an early physical therapy intervention for very preterm, very low birth weight infants: a randomized controlled clinical trial. Pediatric Physical Therapy. 2005;17(2):107-19.

10.McManus BM, Carle AC, Poehlmann J. Effectiveness of part C early intervention physical, occupational, and speech therapy services for preterm or low birth weight infants in Wisconsin, United States. Academic pediatrics. 2012;12(2):96-103.

11.Piper MC, Darrah J, Maguire TO & Redfern L. Motor assessment of the developing infant: Saunders Philadelphia; 1994;1

12.Pai-jun ML, Campbell SK. Examination of the item structure of the Alberta Infant Motor Scale. Pediatric Physical Therapy. 2004;16(1):31-8.

13.Haywood K, Getchell N. Life span motor development: Human kinetics; 2009.

14.Campbell SK, Palisano RJ, Vander Linden DW. Physical therapy for children: Saunders; 2000.

15.Cech DJ, Martin ST. Functional movement development across the lifespan: Elsevier Health Sciences; 2002.

16.Everett T, Kell C. Human movement: an introductory text: Elsevier Health Sciences; 2010.

17.Bly L. Motor skills acquisition in the first year: an illustrated guide to normal development: Therapy Skill Builders Tuscson, AZ; 1994.

18.Gallahue DL, Ozmun JC, Goodway J. Understanding motor development:Infants, children, adolescents, adults: Mcgraw-hill Boston; 2006.

19.Mpofu E, Oakland TD. Assessment in rehabilitation and health:Pearson/Merrill; 2010.

20. First LR, Palfrey JS. The infant or young child with developmental delay. New England Journal of Medicine. 1994;330(7):478-83.

21. Aicardi J, editor The etiology of developmental delay. Seminars in pediatric neurology; 1998: Elsevier.

22. Merenstein JH. Behavioral and Developmental Pediatrics: A Handbook for Primary Care. Archives of Family Medicine. 1995;4(7):655.

23.Portney L, Watkins M. Foundations of clinical research: applications to practice. Prentice Hall, Upper Saddle River. 2008.

24.Montgomery PC, Connolly BH. Norm-Referenced and Criterion Referenced Tests Use in Pediatrics and Application to Task Analysis of Motor Skill. Physical therapy. 1987;67(12):1873-6.

25.Tesio L. Measuring behaviours and perceptions: Rasch analysis as a tool for rehabilitation research. Journal of Rehabilitation Medicine. 2003;35(3): 105-15.

26.Smith AB, Wright E, Rush R, Stark D, Velikova G, Selby P. Rasch analysis of the dimensional structure of the Hospital Anxiety and Depression Scale. Psycho-Oncology. 2006;15(9):817-27.

27.Hart DL, Wright BD. Development of an index of physical functional health status in rehabilitation. Archives of physical medicine and rehabilitation. 2002;83(5):655-65.

28.Avery LM, Russell DJ, Raina PS, Walter SD, Rosenbaum PL. Rasch analysis of the Gross Motor Function Measure: validating the assumptions of the Rasch model to create an interval-level measure. Archives of physical medicine and rehabilitation. 2003;84(5):697-705.

29.MacKnight C, Rockwood K. Rasch analysis of the hierarchical assessment of balance and mobility (HABAM). Journal of clinical epidemiology. 2000;53(12):1242-7.

30.Duncan PW, Bode RK, Min Lai S, Perera S. Rasch analysis of a new stroke-specific outcome scale: the Stroke Impact Scale. Archives of physical medicine and rehabilitation. 2003;84(7):950-63.

31.Russell DJ, Avery LM, Rosenbaum PL, Raina PS, Walter SD, Palisano RJ. Improved scaling of the gross motor function measure for children with cerebral palsy: evidence of reliability and validity. Physical therapy. 2000;80(9):873-85.

32.Antonucci G, Aprile T, Paolucci S. Rasch analysis of the Rivermead Mobility Index: a study using mobility measures of first-stroke inpatients. Archives of physical medicine and rehabilitation. 2002;83(10):1442-9.

33.Page SJ, Shawaryn MA, Cernich AN, Linacre JM. Scaling of the revised Oswestry low back pain questionnaire. Archives of physical medicine and rehabilitation. 2002;83(11):1579-84.

34.Wongsaprom W. Comparison of Motor Performance Scores Between Gross Motor Function Measure-88 and Gross Motor Function Measure-66 in Thai Infants: Mahidol University; 2005.

35.Temcharoensuk P. Comparison of Gross Motor Components in Typical Infants Aged 1-2 Months: Mahidol University; 2007.

36.Mayhew A, Cano S, Scott E, Eagle M, Bushby K, Muntoni F. Moving towards meaningful measurement: Rasch analysis of the North Star Ambulatory Assessment in Duchenne muscular dystrophy. Developmental Medicine & Child Neurology. 2011;53(6):535-42.

37.Pesudovs K, Noble BA. Improving subjective scaling of pain using Rasch analysis. The Journal of Pain. 2005;6(9):630-6.

38.Hsueh I-P, Wang W-C, Sheu C-F, Hsieh C-L. Rasch analysis of combining two indices to assess comprehensive ADL function in stroke patients. Stroke. 2004;35(3):721-6.

39.Chien C-W, Brown T. Construct validity of the Children's Hand-Skills ability Questionnaire (CHSQ) in children with disabilities: A Rasch analysis. Research in developmental disabilities. 2012;33(4):1242-53.

40.Azouvi P, Olivier S, de Montety G, Samuel C, Louis-Dreyfus A, Tesio L. Behavioral assessment of unilateral neglect: study of the psychometric properties of the Catherine Bergego Scale. Archives of physical medicine and rehabilitation. 2003;84(1):51-7.

41.Wilhelm IJ. Physical therapy assessment in early infancy: Churchill Livingstone; 1993.

42.Campbell SK, Wright BD, Linacre JM. Development of a functional movement scale for infants. Journal of applied measurement. 2002;3(2):190-204.

43.Campbell SK. Test-retest reliability of the test of infant motor performance. Pediatric Physical Therapy. 1999;11(2):60-6.

44.Brander R, Kramer J, an Dancsak M, Marotta M, Tolley B. Inter-rater and test-retest reliabilities of the Movement Assessment of Infants. Pediatric Physical Therapy. 1993;5(1):16-21.

45.Harris SR, Heriza CB. Measuring Infant Movement Clinical and Technological Assessment Techniques. Physical therapy. 1987;67(12):1877-80.

46.Campbell SK. Pediatric neurologic physical therapy: Churchill Livingstone; 1984.

47.Crowe TK. The Peabody developmental fine motor scale: An interrater reliability study. 1990.

48.Piper MC, Pinnell LE, Darrah J, Maguire T, Byrne PJ. Construction and validation of the Alberta Infant Motor Scale (AIMS). Canadian journal of public health= Revue canadienne de sante publique. 1991;83:S46-50.

49.Coster W. Critique of the Alberta Infant Motor Scale (AIMS). Physical & Occupational Therapy in Pediatrics. 1996;15(3):53-64.

50.Uesugi M, Tokuhisa K, Shimada T. The reliability and validity of the Alberta Infant Motor Scale in Japan. Journal of Physical Therapy Science. 2008;20(3):169-75.

51.Valentini NC, Saccani R. Brazilian Validation of the Alberta Infant Motor Scale. Physical therapy. 2012;92(3):440-7.

52.Onis M. Assessment of sex differences and heterogeneity in motor milestone attainment among populations in the WHO Multicentre Growth Reference Study. Acta paediatrica. 2006 Apr 1;95(S450):66-75.

53. Lung FW, Chiang TL, Lin SJ, Feng JY, Chen PF, Shu BC. Gender differences of children's developmental trajectory from 6 to 60 months in the Taiwan Birth Cohort Pilot Study. Research in Developmental Disabilities. 2011 Feb 28;32(1):100-6.

54. Brouwer SI, van Beijsterveldt TC, Bartels M, Hudziak JJ, Boomsma DI. Influences on achieving motor milestones: a twin-singleton study. Twin Research and Human Genetics. 2006 Jun 1;9(3):424-30.

55. Tse L, Mayson TA, Leo S, Lee LL, Harris SR, Hayes VE, Backman CL, Cameron D, Tardif M. Concurrent validity of the Harris Infant Neuromotor Test and the Alberta Infant Motor Scale. Journal of pediatric nursing. 2008 Feb 29;23(1):28-36.

56. Heineman KR, Middelburg KJ, Bos AF, Eidhof L, Bastide-Van Gemert L, Den Heuvel ER, Hadders-Algra M. Reliability and concurrent validity of the Infant Motor Profile. Developmental Medicine & Child Neurology. 2013 Jun 1;55(6):539-45.

57. Dumas HM, Fragala-Pinkham MA, Rosen EL, Lombard KA, Farrell C. Pediatric Evaluation of Disability Inventory Computer Adaptive Test (PEDI-CAT) and Alberta Infant Motor Scale (AIMS): Validity and Responsiveness. Physical therapy. 2015 Nov 1;95(11):1559-68.

58. Eckersley PM. Elements of Paediatric Physiotherapy, 1993

59. Hadders-Algra M, Carlberg EB. Postural control: A key issue in developmental disorders.

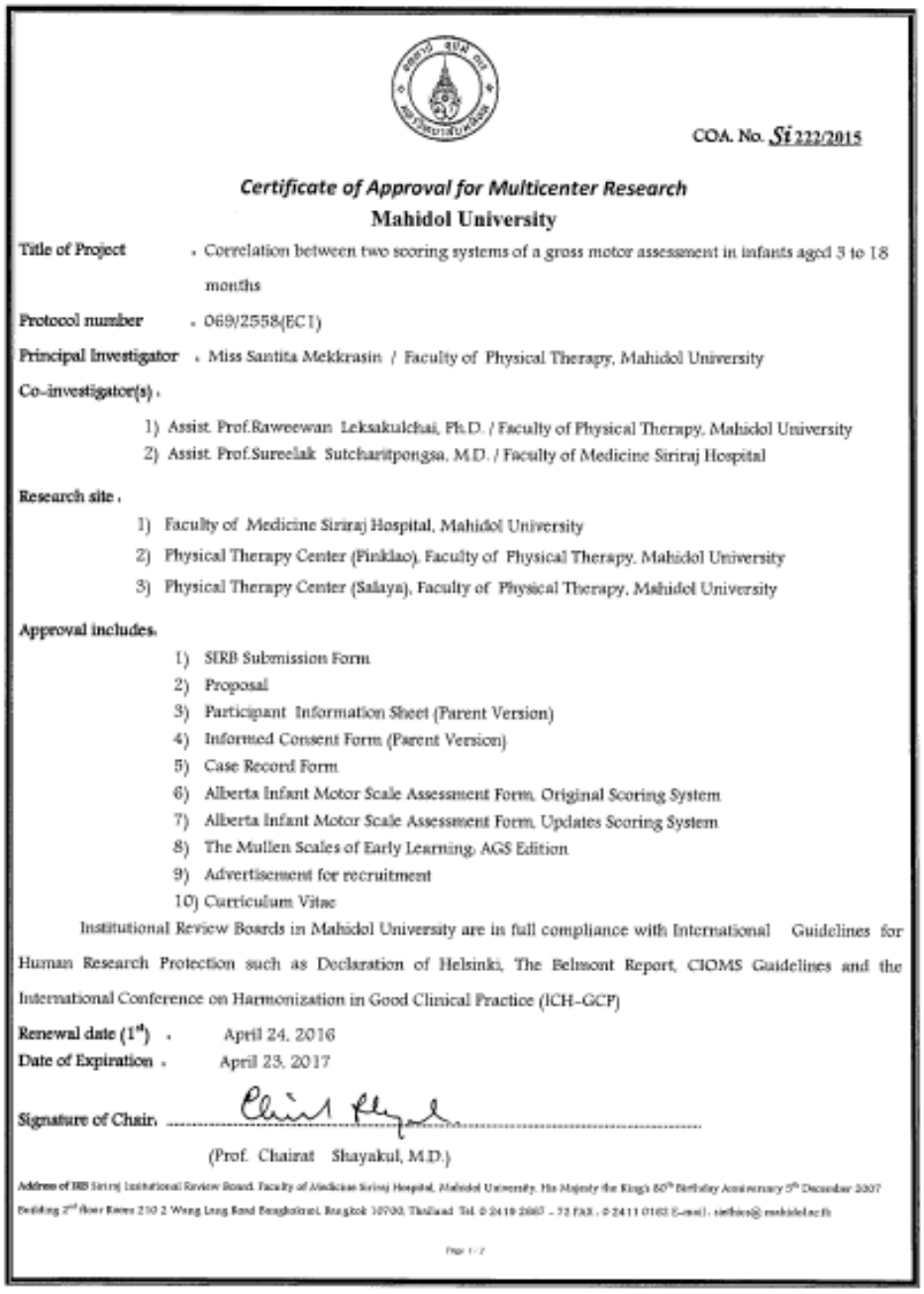
60. Deffeyes JE, Harbourne RT, Kyvelidou A, Stuberg WA, Stergiou N. Nonlinear analysis of sitting postural sway indicates developmental delay in infants. Clinical Biomechanics. 2009 Aug 31;24(7):564-70.

61. Kyvelidou A, Harbourne RT, Stergiou N. Severity and characteristics of developmental delay can be assessed using variability measures of sitting

posture. Pediatric physical therapy: the official publication of the Section on Pediatrics of the American Physical Therapy Association. 2010;22(3):259.

APPENDICES

APPENDIX A
THE ETHICAL COMMITTEE ON RESEARCH INVOLVING HUMAN RESEARCH



COA. No. Si 222/2015

Certificate of Approval for Multicenter Research

Mahidol University

Title of Project : Correlation between two scoring systems of a gross motor assessment in infants aged 3 to 18 months

Protocol number : 069/2558(EC1)

Principal Investigator : Miss Santita Mekkrasin / Faculty of Physical Therapy, Mahidol University

Co-investigator(s) :

1) Assist. Prof.Raweewan Leksakulchai, Ph.D. / Faculty of Physical Therapy, Mahidol University
2) Assist. Prof.Sureelak Sutcharitpongsa, M.D. / Faculty of Medicine Siriraj Hospital

Research site :

1) Faculty of Medicine Siriraj Hospital, Mahidol University
2) Physical Therapy Center (Pinklao), Faculty of Physical Therapy, Mahidol University
3) Physical Therapy Center (Salaya), Faculty of Physical Therapy, Mahidol University

Approval includes.

1) SIRB Submission Form
2) Proposal
3) Participant Information Sheet (Parent Version)
4) Informed Consent Form (Parent Version)
5) Case Record Form
6) Alberta Infant Motor Scale Assessment Form, Original Scoring System
7) Alberta Infant Motor Scale Assessment Form, Updates Scoring System
8) The Mullen Scales of Early Learning, AGS Edition
9) Advertisement for recruitment
10) Curriculum Vitae

Institutional Review Boards in Mahidol University are in full compliance with International Guidelines for Human Research Protection such as Declaration of Helsinki, The Belmont Report, CIOMS Guidelines and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP)

Renewal date (1st) : April 24, 2016

Date of Expiration : April 23, 2017

Signature of Chair .....

(Prof. Chairat Shayakul, M.D.)

Address of IRB Siriraj Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University, His Majesty the King's 80th Birthday Anniversary 5th December 2007 Building 2nd floor Rooms 210-2 Wang Lang Road Bangkoknoi, Bangkok 10700, Thailand Tel. 0-2419-2667 - 72 FAX : 0-2411-0162 E-mail : sirifaxx@mahidol.ac.th

Page 1 / 2

APPENDIX B
PARTICIPANT INFORMATION SHEET

เอกสารชี้แจงผู้เข้าร่วมการวิจัย (สำหรับผู้ปกครอง)

(Participant Information Sheet)

ในเอกสารนี้อาจมีข้อความที่ท่านอ่านแล้วยังไม่เข้าใจ โปรดสอบถามหัวหน้าโครงการวิจัย หรือผู้แทนให้ช่วยอธิบายจนกว่าจะเข้าใจดี ท่านจะได้รับเอกสารนี้ 1 ฉบับ นำกลับไปอ่านที่บ้านเพื่อปรึกษาหารือกับญาติพี่น้อง เพื่อนสนิท แพทย์ประจำตัวของท่าน แพทย์ท่านอื่น หรือผู้ที่ท่านต้องการปรึกษา เพื่อช่วยในการตัดสินใจเข้าร่วมการวิจัย

ชื่อโครงการ	ความสัมพันธ์ระหว่างระบบการให้คะแนนสองแบบของการประเมินการเคลื่อนไหวอย่างหยาบ ในทารกอายุ 3 ถึง 18 เดือน
ชื่อผู้วิจัย	นางสาวสัณฑิตา เมฆกระสินธุ์
สถานที่วิจัย	คลินิกเด็กสุขภาพดี โรงพยาบาลศิริราช คลินิกทารกพัฒนาการความเสี่ยงสูง โรงพยาบาลศิริราช คลินิกคัดกรองและติดตามพัฒนาการ โรงพยาบาลศิริราช หน่วยตรวจโรคกุมารเวชศาสตร์ คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล หน่วยตรวจโรคคลินิกกุมาร คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล ศูนย์กายภาพบำบัด (ปิ่นเกล้า) คณะกายภาพบำบัด มหาวิทยาลัยมหิดล ศูนย์กายภาพบำบัด (ศาลายา) คณะกายภาพบำบัด มหาวิทยาลัยมหิดล โรงพยาบาลส่งเสริมสุขภาพตำบลในเขตอำเภอพุทธมณฑล จังหวัดนครปฐม
สถานที่ทำงาน	คณะกายภาพบำบัด มหาวิทยาลัยมหิดล วิทยาเขตศาลายา 999 ถ.พุทธมณฑลสาย 4 ต.ศาลายา อ. พุทธมณฑล จ.นครปฐม 73170 หมายเลขโทรศัพท์ 099-2461416 (ตลอด 24 ชั่วโมง)

โครงการวิจัยนี้ทำขึ้นเพื่อ ศึกษาถึงความตรงตามสภาพของระบบการให้คะแนนของแบบประเมิน Alberta Infant Motor Scales (AIMS) ฉบับแก้ไข ซึ่งใช้ระบบการให้คะแนนแบบดั้งเดิมเป็นมาตรฐาน เด็กในปกครองของท่านได้รับเชิญให้เข้าร่วมการวิจัยนี้เพราะเป็นทารกอายุ 3-18 เดือน และมีคุณสมบัติตรงตามเกณฑ์การคัดเข้าของการศึกษาทุกประการ ซึ่งผู้วิจัยจะทำการประเมินระดับพัฒนาการด้วยแบบประเมิน Mullen Scales of early learning เพื่อดูถึงพัฒนาการรวมไปถึงเพื่อนำมาจัดกลุ่มประชากร และแบบประเมิน Alberta Infant Motor Scale (AIMS) ทั้งฉบับดั้งเดิมและฉบับแก้ไข เพื่อดูการเคลื่อนไหวของทารกในท่าทางต่างๆ โดยผู้วิจัยจะนัดหมายผู้ปกครองเพื่อนำทารกมาประเมินพัฒนาการและการเคลื่อนไหวเพียง 1 ครั้งเท่านั้น ใช้ระยะเวลาทั้งหมด ประมาณ 90 นาที

จะมีผู้เข้าร่วมการวิจัยนี้ ได้แก่ 1.) ทารกพัฒนาการปกติ อายุน้อยกว่า 9 เดือน 2.) ทารกพัฒนาการล่าช้า อายุน้อยกว่า 9 เดือน 3.) ทารกพัฒนาการปกติ อายุมากกว่าหรือเท่ากับ 9 เดือน และ 4.) ทารกพัฒนาการล่าช้า อายุมากกว่าหรือเท่ากับ 9 เดือน โดยจะแบ่งประชากรกลุ่มละ 10 คน ดังนั้นผู้เข้าร่วมวิจัยทั้งหมดในการศึกษานี้ประมาณ 40 คน ระยะเวลาที่จะทำวิจัยทั้งสิ้นประมาณ 12 เดือน

หากท่านตัดสินใจให้เด็กในปกครองของท่านเข้าร่วมการวิจัย จะมีขั้นตอนการวิจัยดังต่อไปนี้คือ

1. ผู้วิจัยจะขอนัดวันและเวลาที่ท่านและทารกในการปกครองของท่านสะดวกในการเข้าร่วมการวิจัย โดยผู้วิจัยจะชี้แจงถึงการเตรียมตัวทารกก่อนมาประเมิน เช่น ทารกควรได้รับประทานอาหาร/นม ก่อนประเมินประมาณ 1 ชั่วโมงเพื่อป้องกันการสำลักหรืออาเจียน และทารกควรนอนหลับให้เพียงพอเพื่อลดปัจจัยจากการง่วงนอน ซึ่งอาจทำให้ทารกมีอารมณ์ไม่แจ่มใส ร้องไห้โยเย ทำให้เคลื่อนไหวตอบสนองได้ไม่เต็มที่ นอกจากนี้ ผู้วิจัยจะบอกถึงอุปกรณ์ที่ผู้ปกครองต้องเตรียมมาเอง เช่น ผ้าอ้อมสำเร็จรูป ของเล่นที่ทารกชอบ เป็นต้น

2. การสอบถามเกี่ยวกับข้อมูลทั่วไปของทารกและวัดข้อมูลพื้นฐาน โดยผู้วิจัยจะทำการสัมภาษณ์ผู้ปกครองถึงข้อมูลทั่วไปของทารก (เอกสารแนบ 6.1) จากนั้นผู้วิจัยจะทำการวัดข้อมูลพื้นฐาน เช่น น้ำหนัก ส่วนสูง และเส้นรอบวงศีรษะ ใช้เวลาประมาณ 15 นาที โดยสถานที่ตรวจประเมินจะใช้ห้องวิจัยที่เป็นสัดส่วน และตั้งเครื่องปรับอากาศที่มีอุณหภูมิพอเหมาะ

3. การประเมินระดับพัฒนาการด้วยแบบประเมิน Mullen Scales of Early Learning ใช้เวลาประมาณ 30 นาที จะประเมินพัฒนาการรวมทั้ง 5 ด้าน ได้แก่ 1. พัฒนาการของกล้ามเนื้อมัดใหญ่ 2. พัฒนาการด้านรับรู้ทางสายตา 3. พัฒนาการของกล้ามเนื้อมัดเล็ก 4. พัฒนาการด้านการเข้าใจภาษา 5. พัฒนาการด้านการแสดงออกทางภาษา เพื่อแบ่งกลุ่มระดับพัฒนาการของทารก

4. การประเมินการเคลื่อนไหวด้วยแบบประเมิน Alberta Infant Motor Scale (AIMS) ใช้เวลาประมาณ 30 นาที ขณะประเมินทารกต้องถอดเสื้อผ้าออกคงไว้เฉพาะผ้าอ้อมสำเร็จรูป ให้ทารกนอนเล่นบนเบาะที่วางที่พื้น เพื่อสร้างความคุ้นเคยก่อน เพื่อให้สามารถเห็นการเคลื่อนไหวได้อย่างชัดเจนใน 4 ท่าทาง ได้แก่

1. ท่านอนคว่ำ 2. ท่านอนหงาย

3. ท่านั่ง 4. ท่ายืน

ซึ่งผู้วิจัยจะการประเมินแต่ละท่าทางโดยสังเกต 3 องค์ประกอบการในเคลื่อนไหวที่สำคัญ ดังนี้

- การลงน้ำหนัก : ผู้วิจัยสังเกตความสามารถของทารกในการลงน้ำหนักบนส่วนต่างๆของร่างกายได้อย่างสมมาตร สามารถถ่ายน้ำหนักไปมาได้ เมื่อเกิดการเคลื่อนไหวหนึ่งๆ
- การทรงท่า : ผู้วิจัยสังเกตการทรงท่าของทารกขณะเคลื่อนไหว
- การเคลื่อนไหวต้านต่อแรงโน้มถ่วงของโลก : ผู้วิจัยสังเกตความสามารถของทารกในการทรงท่าต้านแรงโน้มถ่วงของโลก

ผู้วิจัยจะเริ่มประเมินทารกจากพัฒนาการการเคลื่อนไหวที่เด่นในช่วงอายุนั้นๆ เช่น ในทารกอายุ 3 เดือนอาจเริ่มต้นจากท่านอนคว่ำหรือนอนหงาย ทารกอายุ 6 เดือนอาจเริ่มต้นจากท่านั่ง หรือทารกอายุ 15 เดือน อาจเริ่มต้นการจากท่ายืนตามด้วยท่าทางอื่นๆจนครบทั้ง 4 ท่าทาง โดยขณะประเมินผู้วิจัยจะบันทึกการเคลื่อนไหวด้วยกล้องวีดิโอ 2 ตัว ซึ่งจะตั้งกล้องทางด้านหน้าและด้านข้างของเบาะ เพื่อให้ครอบคลุมการเคลื่อนไหว เมื่อทารกแสดงการเคลื่อนไหวถึงระดับพัฒนาการที่สูงสุดแล้ว ผู้วิจัยจะหยุดการประเมินและสรุปคะแนนที่ได้จากการประเมินเพื่อใช้วิเคราะห์ผลต่อไป

ความเสี่ยงที่อาจจะเกิดขึ้นเมื่อเข้าร่วมการวิจัย คือ 1. ล้มขณะทำการประเมิน เช่น ท่ายืน ท่าเดิน ในกรณีที่ทารกยังยืนและเดินได้ไม่มั่นคง 2.การติดเชื้อจากเด็กสู่เด็ก เช่น ไข้หวัด โดยติดต่อจากการสัมผัสของเล่นหรืออุปกรณ์ต่างๆขณะทำการตรวจประเมิน 3.ทารกร้องไห้เนื่องจาก หิวนม ง่วงนอน ติดแม่ หรือจากสาเหตุอื่นๆ

การป้องกันความเสี่ยงของการวิจัย คือ 1. ผู้วิจัยจะใช้เบาะนุ่มรองที่พื้นขณะตรวจประเมิน เพราะหากเกิดการล้ม เบาะจะช่วยลดแรงกระแทกที่จะเกิดขึ้นกับตัวทารกได้ 2. ผู้วิจัยจะป้องกันการติดเชื้อระหว่างเด็ก โดยการทำความสะอาดของเล่นทุกครั้ง หลังจากวัดประเมินทารกในทุกๆคนด้วยน้ำยาทำความสะอาด และผู้ปกครองสามารถนำของเล่นมาเองได้ และ หากทารกไม่สบายในวันประเมินจะไม่ทำการตรวจ โดยจะนัดหมายวันตรวจอีกครั้ง หลังจากทารกหายเป็นปกติแล้ว 3.ทารกร้องไห้จากการ หิวนม ง่วงนอน ติดแม่ ผู้วิจัยจะทำการป้องกันโดยคุยกับผู้ปกครองถึงการเตรียมพร้อมทารกก่อนนำมาตรวจประเมินและขณะประเมินผู้ปกครองสามารถอยู่ภายในห้องเดียวกันได้

ประโยชน์ที่คาดว่าจะได้รับจากการเข้าร่วมวิจัย คือ ผู้ปกครองได้ทราบถึงระดับพัฒนาการทั้ง 5 ด้าน ได้แก่ 1. พัฒนาการของกล้ามเนื้อมัดใหญ่ 2. พัฒนาการด้านรับรู้ทางสายตา 3. พัฒนาการของกล้ามเนื้อมัดเล็ก 4. พัฒนาการด้านการเข้าใจภาษา 5. พัฒนาการด้านการแสดงออกทาง รวมไปถึงการประเมินการเคลื่อนไหวตามลำดับพัฒนาการ จากข้อมูลของการประเมินผู้ปกครองจะทราบถึงองค์ประกอบสำคัญของการเคลื่อนไหวตามลำดับพัฒนาการของทารกในปกครองของท่าน โดยข้อมูลจากการประเมิน สามารถเป็นความรู้หรือวิธีการแก่ผู้ปกครองในการช่วยส่งเสริมพัฒนาการเด็กให้ดียิ่งขึ้น

หากท่านไม่อนุญาตให้เด็กในปกครองของท่านเข้าร่วมในโครงการวิจัยนี้ จะไม่มีผลใดๆ ต่อการรักษาของทารกในการปกครองของท่านที่มีอยู่ในปัจจุบัน ไม่ว่าจะเป็นการพบแพทย์เพื่อรับการรักษา การได้รับคำแนะนำเกี่ยวกับอาหาร การได้รับวัคซีนและพัฒนาการการที่ถูกต้องตามวัย

การเข้าร่วมการวิจัยนี้ทารกในปกครองของท่านจะได้รับการประเมินพัฒนาการทั้ง 5 ด้าน รวมไปถึงการประเมินการเคลื่อนไหวตามลำดับพัฒนาการ หลังจากเสร็จสิ้นการตรวจประเมินผู้ปกครองจะได้ทราบถึงระดับพัฒนาการทั้ง 5 ด้านและการเคลื่อนไหวตามลำดับพัฒนาการของทารก นอกจากนี้ทารกจะได้รับของเล่นเพื่อส่งเสริมพัฒนาการ รวมไปถึงคำแนะนำแก่ผู้ปกครองในการกระตุ้นพัฒนาการ เพื่อนำไปช่วยกระตุ้นที่บ้าน และหากพบว่า ทารกในปกครองของท่านมีพัฒนาการที่ล่าช้า รวมไปถึงผู้ปกครองมีความประสงค์ที่จะให้ทารกได้รับการรักษาทางกายภาพบำบัด ผู้วิจัยจะให้การรักษาทางกายภาพบำบัดแก่ทารก รวมไปถึงให้คำแนะนำแก่ผู้ปกครองในการทำกายภาพเองที่บ้านด้วยตัวเอง โดยไม่เสียค่าใช้จ่ายใดๆ และหากเกิดอันตรายหรืออุบัติเหตุระหว่างการตรวจประเมิน ผู้วิจัย คือ นางสาวสัณฑิตา เมฆกระสินธุ์ จะเป็นผู้รับผิดชอบค่าใช้จ่ายทางการแพทย์

หากท่านมีข้อสงสัยที่จะสอบถามเกี่ยวกับการวิจัย หรือเกิดเหตุการณ์ไม่พึงประสงค์จากการวิจัยขึ้นกับเด็กในปกครองของท่าน ท่านสามารถติดต่อ นางสาวสัณฑิตา เมฆกระสินธุ์ ได้ที่ ห้อง 103 71/17-18 หมู่ 5 ต.ศาลายา อ.พุทธมณฑล จ.นครปฐม 73170 หมายเลขโทรศัพท์: 099-2461416

หากมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ทราบโดยรวดเร็วไม่ปิดบัง

ข้อมูลส่วนตัวของเด็กในปกครองของท่านจะถูกเก็บรักษาไว้ ไม่เปิดเผยต่อสาธารณะเป็นรายบุคคล แต่จะรายงานผลการวิจัยเป็นข้อมูลส่วนรวม ข้อมูลของผู้เข้าร่วมการวิจัยเป็นรายบุคคลอาจมีคณะบุคคลบางกลุ่มเข้ามาตรวจสอบได้ เช่น ผู้ให้ทุนวิจัย, สถาบัน หรือองค์กรของรัฐที่มีหน้าที่ตรวจสอบ, คณะกรรมการจริยธรรมฯ เป็นต้น

ท่านมีสิทธิ์ถอนตัวเด็กในปกครองของท่านออกจากโครงการวิจัยเมื่อใดก็ได้ โดยไม่ต้องแจ้งให้ทราบล่วงหน้า และการไม่เข้าร่วมการวิจัยหรือถอนตัวออกจากโครงการวิจัยนี้ จะไม่มีผลกระทบใดๆ ต่อการบริการและการรักษาที่เด็กในปกครองของท่านสมควรจะได้รับแต่ประการใด

โครงการวิจัยนี้ได้รับการพิจารณารับรองจากคณะกรรมการจริยธรรมการวิจัยในคนของมหาวิทยาลัยมหิดล ซึ่งมีสำนักงานอยู่ที่สำนักงานอธิการบดีมหาวิทยาลัยมหิดล ถนนพุทธมณฑล สาย 4 ตำบลศาลายา อำเภอพุทธมณฑล จังหวัดนครปฐม 73170 หมายเลขโทรศัพท์ 02-849-6223-5 โทรสาร 02-849-6223 หากท่านได้รับการปฏิบัติไม่ตรงตามที่ระบุไว้ ท่านสามารถติดต่อกับประธานคณะกรรมการฯ หรือผู้แทน ได้ตามสถานที่และหมายเลขโทรศัพท์ข้างต้น

ข้าพเจ้าได้อ่านรายละเอียดในเอกสารนี้ครบถ้วนแล้ว

ลงชื่อ.....ผู้ปกครอง

(.....)

วันที่.....

APPENDIX C
CONSENT FORM

หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัยโดยได้รับการบอกกล่าวและเต็มใจ (สำหรับผู้ปกครอง)

วันที่..... เดือน..... พ.ศ .....

ข้าพเจ้า.....อายุ.....ปี อาศัยอยู่บ้านเลขที่ ..... ถนน.....ตำบล.....อำเภอ ..... จังหวัด.....รหัสไปรษณีย์..... โทรศัพท์ .....

ผู้ปกครองของเด็กชาย/เด็กหญิง.....

โดยข้าพเจ้าได้รับทราบรายละเอียดเกี่ยวกับที่มาและจุดมุ่งหมายในการทำวิจัย รายละเอียดขั้นตอนต่างๆ ที่เด็กในปกครองของข้าพเจ้าจะต้องปฏิบัติหรือได้รับการปฏิบัติ ประโยชน์ที่คาดว่าจะได้รับของการวิจัย ความเสี่ยงที่อาจจะเกิดขึ้นจากการเข้าร่วมการวิจัย รวมทั้งแนวทางป้องกันและแก้ไขหากเกิดอันตรายขึ้น ค่าใช้จ่ายที่ข้าพเจ้าจะต้องรับผิด ชอบจ่ายเอง โดยได้อ่านข้อความที่มีรายละเอียดอยู่ในเอกสารชี้แจงผู้เข้าร่วมการวิจัยโดยตลอด อีกทั้งยังได้รับคำอธิบายและตอบข้อสงสัยจากหัวหน้าโครงการวิจัยเป็นที่เรียบร้อยแล้ว โดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ข้าพเจ้าจึงสมัครใจให้เด็กในปกครองของข้าพเจ้าเข้าร่วมในโครงการวิจัยนี้ :

ข้าพเจ้าได้ทราบถึงสิทธิ์ที่ข้าพเจ้าจะได้รับข้อมูลเพิ่มเติม ทั้งทางด้านประโยชน์และโทษจากการเข้าร่วมการวิจัย และสามารถถอนตัวเด็กในปกครองของข้าพเจ้าหรืองดเข้าร่วมการวิจัยได้ทุกเมื่อ โดยจะไม่มีผลกระทบใดๆ ต่อการบริการและการรักษาพยาบาลที่เด็กในปกครองของข้าพเจ้าจะได้รับต่อไปในอนาคต และยินยอมให้ผู้วิจัยใช้ข้อมูลส่วน ตัวของเด็กในปกครองของข้าพเจ้าที่ได้รับจากการวิจัย แต่จะไม่เผยแพร่ต่อสาธารณะเป็นรายบุคคล โดยจะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

หากเด็กในปกครองของข้าพเจ้ามีอาการผิดปกติ รู้สึกไม่สบายกาย หรือมีผลกระทบต่อจิตใจของ เด็กในปกครองของข้าพเจ้าเกิดขึ้นระหว่างการวิจัย ข้าพเจ้าจะแจ้งผู้วิจัยโดยเร็วที่สุด และหากข้าพเจ้ามีข้อข้องใจเกี่ยวกับขั้นตอนของการวิจัย หรือหากเกิดการบาดเจ็บ/เจ็บป่วย หรือหากเกิด

เหตุการณ์ที่ไม่พึงประสงค์จากการวิจัยขึ้นกับเด็กในปกครองของข้าพเจ้า ข้าพเจ้าจะสามารถติดต่อกับ นางสาวสัณฑิตา เมฆกระสินธุ์ ได้ที่หมายเลขโทรศัพท์ 099-246-1416 ได้ตลอด 24 ชั่วโมง

หากเด็กในปกครองของข้าพเจ้า ได้รับการปฏิบัติไม่ตรงตามที่ได้ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมการวิจัย ข้าพเจ้าจะสามารถติดต่อกับประธานคณะกรรมการจริยธรรมการวิจัยในคน หรือผู้แทน ได้ที่สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน สำนักงานอธิการบดี มหาวิทยาลัยมหิดล โทร. 02-849-6224-5 โทรสาร 02-849-6274

ข้าพเจ้าเข้าใจข้อความในเอกสารชี้แจงผู้เข้าร่วมการวิจัย และหนังสือแสดงเจตนายินยอมนี้โดยตลอดแล้ว จึงลงลายมือชื่อไว้

ลงชื่อ.....ผู้ปกครอง

(.....) วันที่.....

ลงชื่อ.....ผู้ให้ข้อมูลและขอความยินยอม/หัวหน้าโครงการวิจัย

(.....) วันที่.....

ในกรณีข้าพเจ้าไม่สามารถอ่านหนังสือได้ ผู้ที่อ่านข้อความทั้งหมดแทนข้าพเจ้าคือ.....
จึงได้ลงลายมือชื่อไว้เป็นพยาน

ลงชื่อ..... พยาน

(.....) วันที่.....

APPENDIX D
DATA COLLECTION FORM

แบบบันทึกข้อมูลผู้เข้าร่วมงานวิจัย

วันที่ .....เดือน.....พ.ศ. .....

ส่วนที่ 1 : ข้อมูลส่วนตัวของผู้เข้าร่วมงานวิจัย

1.1 รหัสผู้เข้าร่วมวิจัย.....

1.2 เพศ □ ชาย □ หญิง

1.3 น้ำหนัก (ปัจจุบัน).....กิโลกรัม

1.4 ความยาวลำตัว (ปัจจุบัน).....เซนติเมตร

1.5 เส้นรอบวงศีรษะ …….เซนติเมตร

1.6 น้ำหนักแรกเกิด ……กิโลกรัม

1.7 อายุครรภ์ …….. ..... สัปดาห์

1.8 อายุจริง ……... ปี ……สัปดาห์

1.9 อายุตามปฏิทิน …… ปี ……สัปดาห์

ส่วนที่ 2 : ข้อมูลสุขภาพเบื้องต้นของผู้เข้าร่วมงานวิจัย

1.1 โรคประจำตัวของทารก □ ไม่มี □ มี ……..

1.2 ยาที่รับประทานเป็นประจำ □ ไม่มี □ มี ……

1.3 ทารกเคยได้รับการส่งเสริมพัฒนาการหรือไม่ □ ไม่เคย เคย ……...…

APPENDIX E
PILOT STUDY

The objective of this study was to study concurrent validity of Alberta Infant Motor Scale using modified and original scoring system and compared movement components of typical and delay development infants aged below 9 months and aged above and at 9 months. The intra-rater reliability was performed to find the correlation of the scoring in two different time. The ability scores included of posture ability score, anti-gravity ability score, weight bearing ability and total score of AIMS modified version.

Sample size estimation

The sample size was calculated by using the following equation:

$$n = \left[\frac{Z_{\alpha/2} + Z_{\beta}}{[F(Z_0) + F(Z_1)}\right]^2 + 3$$

n = Sample size for total subjects

F(Z) = Fisher's Z transformation

= 0.5 In [(1 + *p*)/ (1 - *p*)]

Zα/2 = Z value that is used in the confidence at 95% or significant size at 0.05 (1.96)

Zβ = Z value that is used in the power as equal as 80% (0.842)

$F(Z_0)$ = 0.5 In [(1 + 0.34)/ (1 – 1.34)] = 0.35

$F(Z_1)$ = 0.5 In [(1 + 0.7)/ (1 – 0.7)] = 0.87

Therefore, the total number of participants in this study was 40 infants.

Demographic data of subjects

Ten infants (3 typical development developmental and 7 delay developmental infants) were recruited and divided into 2 groups by age and gross motor developmental level. The demographic data of the participant are showed in Table E.1.

Categories	Infants (n = 10)	
	TD (n = 3)	DD (n = 7)
	Mean ± SD	Mean ± SD
CA (months)	6.80±1.92	5.20±1.30
Birth weight (grams)	1830.00±593.12	1662.00±841.26
GA (weeks)	32.60±2.07	30.20±4.76
Weight (kg)	7.42±1.46	6.96±1.54
Length (cm)	72.40±13.63	73.20±14.02
Head cir. (cm)	44.00±3.60	42.61±3.65

Intra-rater reliability

The data showed test-retest reliability of one rater. The 1st assessment and 2nd assessment were 7 days apart. The Intraclass correlation coefficient were used to analyze test-retest reliability of modified scoring system of the AIMS. The data were analyzed by ICC (3,1) Two-way Mix and consistency. The result of test-retest of modified scoring system of the AIMS was good reliability. (ICC = 0.904). (n = 10)

Table A.1 The total ability scores of 1st assessment and 2st assessment of AIMS to determine intra-rater reliability (n=10)

Number of infants	1st assessment	2st assessment
1	-2.97	-2.97
2	-1.59	-1.69
3	-1.5	-1.5
4	0.13	0.07
5	-1.59	-1.59
6	-3.12	-2.82
7	-1.69	-1.69
8	-1.5	-1.5
9	-2.09	-2.09
10	-0.45	-0.45

Table A.2 Intraclass correlation coefficients (ICC) of the Mod.AIMS

Rater	ICC	p-value
Rater 1	0.904	<0.01

**p-value is less than 0.01*

Validity

The validity of this study was conducted to compare the data of AIMS Within same subjects. The pediatric physical therapist who had experience more than 10 years were invited to assess and score both original and modified scoring system of AIMS

BIOGRAPHY

NAME	Miss Santita Mekkrasin
DATE OF BIRTH	11 June 1991
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTEND	Mae Fah Luang University, 2010-2013: School of Health Science (Physical Therapy) Mahidol university, Master of Science (Physical Therapy)
HOME ADDRESS	25 Bhupit yak 7, Soi Samphopnarumit, Sukumvit 62, Old Railway RD., Bangjak Prakanong, Bangkok, 10260 Tel: 099-246-1416 E-mail: oh_eyes@hotmail.com