Distribution Agreement

Signature:

______________________________ _______________

JEE SOOK GIL 07/31/14

Factors Associated with Motor Milestone Development in Infants and Young Children

By

Jee Sook Gil

M.S.

Helena Pachón, PhD
Advisor

Usha Ramakrishnan, PhD
Committee Member

Factors Associated with Motor Milestone Development in Infants and Young Children

By

Jee Sook Gil

B.A., Hanyang University, 2001
M.S., Hanyang University, 2004

Advisor: Helena Pachón, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Hubert Department of Global Health
2014

Abstract

Factors Associated with Motor Milestone Development in Infants and Young Children
By Jee Sook Gil, M.S.

The purpose of this literature review is to explore the factors associated with the age at which specific gross motor milestones are attained in children around the world. Moreover, it describes measurement tools or scales used to evaluate infant's gross motor milestone attainment. Twenty four databases were searched with key words related to infants' motor milestone development, such as motor activity, infant, motor milestone, motor skills, and motor development. Eleven different factors associated with infant and young children's gross motor milestone development are explored: children's nutritional status, physical growth, cultural and ethnic differences, birth weight, maternal nutritional status, maternal environmental exposure, children's environmental exposure, children's health status, sleeping and playing position, attainment of other motor milestones and others.

The results demonstrate that children's nutritional status and physical growth are positively associated with gross motor milestones achievement at a certain age. Black mothers' rearing practices and children's prone sleeping and playing position are positively associated with children's motor milestone development. Having enough space where children can practice physical exercise is positively associated with infants' motor milestones achievement at certain ages. Improper maternal nutritional status and exposures to chemicals or polydrugs during pregnancy were associated with preterm birth, making them vulnerable to achieve normal motor milestones compared to full term infants. Sitting and crawling at an earlier age is positively associated with earlier development of other motor milestones such as walking. Socioeconomic status (SES), gender, birth length, and season of birth are not associated with infants' motor milestone achievement.

There are nutritional and non-nutritional factors that influence (positively or negatively) child motor milestone development. Four basic methods, the Alberta Infant Motor Scale (AIMS), the Bayley Scales of Infant Development (BSID), the Peabody Developmental Motor Scales (PDMS) and the Denver II have been used to assess child motor milestone development.

Factors Associated with Motor Milestone Development in Infants and Young Children

By

Jee Sook Gil

B.A., Hanyang University, 2001
M.S., Hanyang University, 2004

Advisor: Helena Pachón, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in in Hubert Department of Global Health

2014

Acknowledgements

It was a quite long journey to complete my thesis but I believe it was valuable experience for me to learn many things. I'd like to appreciate many people who helped me out to concentrate on my work. First of all, I would like to thank God who gives me wisdom and strength whenever I have a hard time and struggle with many kinds of difficulties. I also give thanks to God who provides me such a wonderful opportunity to learn many things through this journey.

I give my sincere thanks to my thesis advisor **Prof. Helena Pachón** who recommended this topic for me and guided me right way to complete my thesis. I'd like to appreciate her kind advice and understanding my personal excuse and encouraged me to concentrate on my work as well as taught me many valuable things. I also appreciate my committee member **Prof. Usha Ramakrishnan** who pointed out what I need and gave me specific idea how to summarize my thoughts. I learned how to organize my work with systematic ways. I'd like to thank both professors who supported me to build my conclusion through meetings.

I would like to thank to **Ms. Holly Patrick** who was my ESL teacher and taught me how to write my English expression and spent many time to correct my grammatical mistake and always encouraged me to focus on my work. I also thank to **Ms. Babara Abu-Zeid** (Health Science library at Emory) who assisted me to search documents based on my research topic and collect many data by using different databases.

I would like to thank my family who support me many other ways. Without their support and encouragement, I would not able to complete my thesis. Especially my mother and father who always worry about my health and pray to God provide me everything I need. I also thank to my sister Hyun Ju who supports me with many prayers and time and even sincere recommendation and she always encourages me to concentrate on my work. I would like to thank my sister Bonnie and brother in law Derrick tried to understand my situation and tried to support and encourage me to complete my work. I want to thank my husband Chang Bong and my daughter Shihyun that understand my studies and work and appreciate their patients and love.

Table of Contents

Introduction

Children's motor milestone development is an indicator of normal growth and development across the world. Generally, a healthy child can attain a specific gross motor milestone within a certain age range. Bushnell & Boudreau (1993) demonstrated as an example that as children mature, their hand movement abilities increase so that they have more opportunities to learn and better understand the properties of objects. In order to assess normal development in children, WHO construed windows of achievement that represent normal variation in ages of milestone achievement among healthy children (WHO 2006). This is useful information for screening children who appear to have delayed development so that appropriate measures can be made.

Milestone development consists of five key elements: gross motor control (head control, sitting, crawling, standing and walking); fine motor control (reaching, grasping and picking up objects); language (sounds, words, receptive and expressive language, verbal interaction); cognitive skills (thinking skills including learning, understanding, problem-solving, reasoning, and remembering); and social skills (interacting with others, having relationships with family, friends and teachers, cooperating, and responding to the feelings of others) (Adu-Afarwuah, 2007, Allen, 1990, Angulo-Barroso, 2010).

When babies reach three months, they make dramatic changes in their level of activity and response. They lose many of their newborn reflexes and achieve more voluntary control of their bodies. In this stage, infants can raise their head and chest when they are lying on their stomach (Angulo-Barroso et al., 2010). At seven months, the most important changes take place. This is the period when children learn to coordinate their senses like vision, touch and hearing. They also increase their motor abilities and develop skills like rolling over, sitting up and crawling (Angulo-Barroso et al., 2010). At nine months, infants can stand and grasp objects. Most infants at this age have the ability to cruise and pull from a sitting to a standing position. At the age of 12 months, infants can walk without support and this is followed by emotional change, social skills and interaction between caregiver and children (Bayley, 1965; Bertenthal et al., 1984; Bril, 1986). Essentially, most gross motor milestones have been attained or developed between four and twelve months. The first one to two years is a crucial time for providing children with an optimal diet, including micronutrients (e.g., iron and zinc), that includes breastfeeding for children's growth and development (Bushnell et al., 1993, Pelletier 1995, de Onis et al., 2000).

However, many children in developing countries do not attain appropriate motor milestone development due to under nutrition, or insufficient food intake. The 2013 World Hunger and Poverty Statistics report demonstrated that one of three children (32.5%) in developing countries was stunted (low height for age).Onis et al, (2000) demonstrated this condition was correlated with undernourishment in children who live in Asia (more than 70%) and in Africa (26%).Marsh et al. (2002) stated that under nutrition [i.e., underweight, stunting, wasting (low weight for height), and vitamin and mineral deficiencies]is one of the important factors that can affect infants' mortality rates in developing countries. For example, the national survey in Vietnam (1998) among children under five years reported that 39%were underweight, 34% were stunted and 11% were wasted due to prolonged condition ofunder nutrition (Marsh et al., 2002; NIN/UNICEF, 1999).Under nutrition due to prolong famine, infectious disease and poor feeding practice can lead to various diseases such as iron deficiency anemia. The WHO estimates that one-quarter of the world's preschool children (27%) suffer from iron deficiency anemia especially in developing countries. Such undernourished condition can delay both mental and motor development in early childhood and may continue even after adolescent period (Stoltzfus 2011).

Under nutrition also affects pregnant women in developing countries (Angulo-

Barroso, 2010) and contributes to one out of six infants being born with a lower birth weight. Furthermore, iron deficiency in mothers caused by undernourishment (Stolzfus 2011) can lead to preterm birth. Literature has shown that preterm birth leads to increased chance of neonatal mortality and also negatively affects children's motor milestone development (Allen 1990; Angulo-Barroso et al., 2010).

In addition, children's motor development cannot be solely determined by one factor such as nutrition. Milestones development is a set of age-specific skills that most children can attain within a certain age range and is influenced by variety of factors (Bayley, 1965; Bertenthal et al., 1984). Many studies have shown that the following factors affect development: children's health status (Bentley et al., 1997); feeding behavior; interaction with their caregiver (Hiroko Iwata et al., 1991); cultural differences (Hopkins et al., 1989); mothers' health (Yalcina et al., 2012; Nakajima et al., 2006); sleeping position(Fetters et al., 2007); birth weight(Allen et al., 1990); and surrounding environmental factors (Yalcin et al., 2012). Many previous studies have looked at one factor and its association with children's motor development. Considering the complexity of child development, it will be beneficial to see how multiple factors influence motor milestone attainment. Therefore, this literature review will explore multiple factors associated with the age (months) at which specific gross motor milestone are attained in children around the world, providing important information to be considered when assessing children's development. Moreover, the review will determine the types of measurement tools or scales used to evaluate infant's gross motor milestone attainment.

Methods

A literature search was conducted in order to determine the factors that were associated with infants' gross motor milestones, particularly in developing countries and compared to healthy, normal children. In this review, the WHO Window Achievement for Child Development was used as a reference study. The search was conducted from May 2013 to September 2013.

Prior to the literature review, the database resources were searched using from the search engine at Emory Woodruff Health Sciences online library. The databases used for searching scientific research were: BioMed Central, ABI/Inform Complete, Cochrane library, Dissertation and Theses (full text), EMBASE (medical journal from 1988 to current; overlapped with PubMed research), Heath Source (Nursing and Academic Edition), JSTOR, MEDLINE (National Library), Popline, PubMed, Research Library (similar to Medline), (1966), Science Direct, Toxnet (Toxicology Literature Online), DART (Developmental Toxicology Literature in Toxnet), Web of Science (medical or bioscience) and WHOLIST (WHO reports).

The literature was searched with the keywords: motor milestones in infants, motor development, motor skill, and motor activity. The results from each database tool were downloaded (abstract including title, author, publication and full text link page) with Endnote files. The files from each database engine were imported into the Endnote software program (EndNote X6), which was available from the Emory Online Library website.

The exclusion criteria were studies conducted on animals and studies not related to gross motor milestones (e.g., concentrating on motor performance, or not mentioning any specific gross motor milestone). Other exclusion criteria were studies only conducted with unhealthy infant or child populations (e.g., infants with Down syndrome or autism). These studies were not included in the literature review. However, studies that compared motor milestones between healthy and unhealthy infants were included in the literature review.

The total number of studies found from each database using the key words mentioned above was 2,574. Then, the duplicated results were deleted from each database and 1,650 relevant citation available. 1,020 citations were excluded if studies included animal studies, cell culture and twin studies after reviewing by titles. 622 articles were selected for reading at least abstract. 112citations were excluded if studies were related preterm infants or abnormal children or did not meet the target outcome (neuron functional development, motor gait pattern, behavior, stimulation reaction and children over 24 months) after abstract review. 503 relevant full text documents obtained. 361 documents were excluded if studies were written in other languages or studies were related to stair movement, pattern of foot, walking behavior, motor activity, only high risk children and if full term infants were very lower birth weight. 142 adequate documents were remained for review and 47 review documents were excluded. The remaining 95 studies were reviewed in order to explore significant differences among groups, such as by comparing intervention and control groups. This review also provides a general overview of the factors associated with infant's gross motor milestone attainment at a certain age.

Table 1 Database Research

Database	Date of search	Keywords searching	Documents (n)
ABI/INFORM Complete	June 6th, 2013	motor milestones in infants	4
BioMed Central	June 6th, 2013	motor milestones in infants	11
CAB Abstracts	June 6th, 2013	motor milestones in infants	39
CINAHL (Nursing LI Health)	June 27th, 2013	motor activity and infant	66
Cochrane Library	June 27th, 2013	motor activity and infant	165
DynaMed	June 7th, 2013	Infant motor milestone	21
Dissertation and Theses Abstracts and full text (cover North America & EU) Period: 1861~current	June 18th, 2013	motor milestone in infant or infant motor milestone	91
Environmental Sciences & Pollution Management	June 19th, 2013	motor milestone infants	25
EMBASE 68 (1980~current) medical journal some diff ==>check with PubMed as duplicate	June 24th, 2013	motor milestones in infants	46
	June 26th, 2013	motor activity and Infant	479
ERIC	June 19th, 2013	motor milestone infants	32
Global Health ==> similar to CAB Abstract	June 19th, 2013	motor milestone infants	39
IBECS			
Health & Psychosocial Instruments	June 19th, 2013	motor milestone infants	5
Health Source: Nursing / Academic Edition	June 19th, 2013	motor milestone infants	6
JSTOR (192) (PubMed)	June 19th, 2013	motor milestone infants	40
MEDLINE (National Library) 109	June 24th, 2013	Motor Activity/ and Infant/ and Motor Skills/	70
PAIS International	June 19th, 2013	motor development and motor skill infants	2
POPLINE	June 19th, 2013	Motor milestone infants	11
		Motor development and motor skill infants	20
	June 26,2013	motor activity and Infant	133
Pubmed (same as Medline plus others)	June 7th, 2013	infant motor milestone	54
Research Library (1966)	June 19th, 2013	motor milestone infants	599
Science direct (4467)	June 24th, 2013	motor milestone infants	218
Springer Image	June 24th, 2013	motor milestone infants	3
Toxnet (Toxicology Literature Online) 58	June 24th, 2013	motor milestone in infants	43
DART (Developmental Toxicology Literature) 24 in toxnet	June 24th, 2013	motor milestone in infants	20
Web of Science (medical/bio science)	June 7th, 2013	Motor milestone in infant	127
WHOLIST (WHO Reports)	June 24th, 2013	motor milestone infants	205
26 databases used			
Sub-total Databases			2,,574
Final			97

Figure 1 Flow chart of the document selection

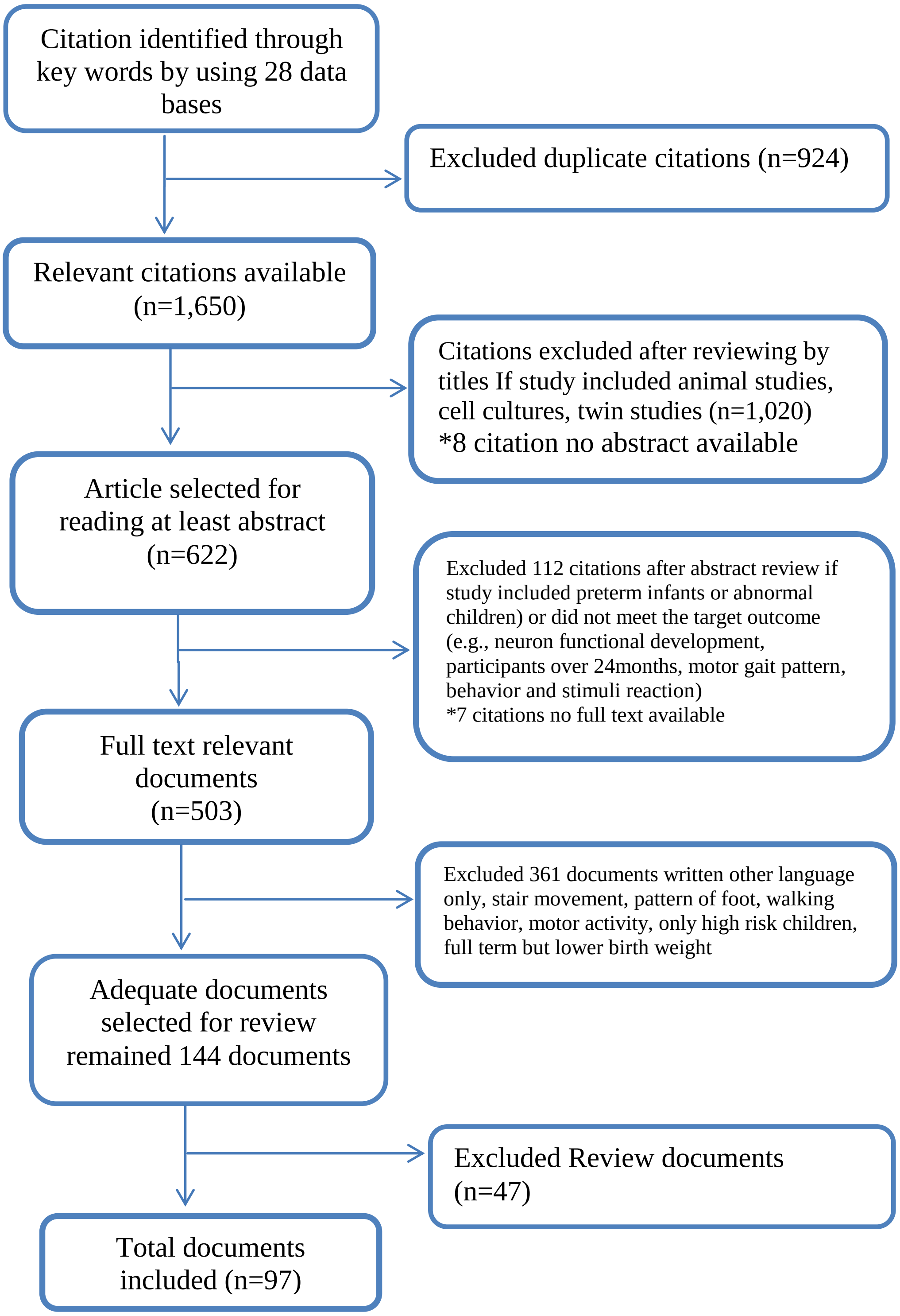
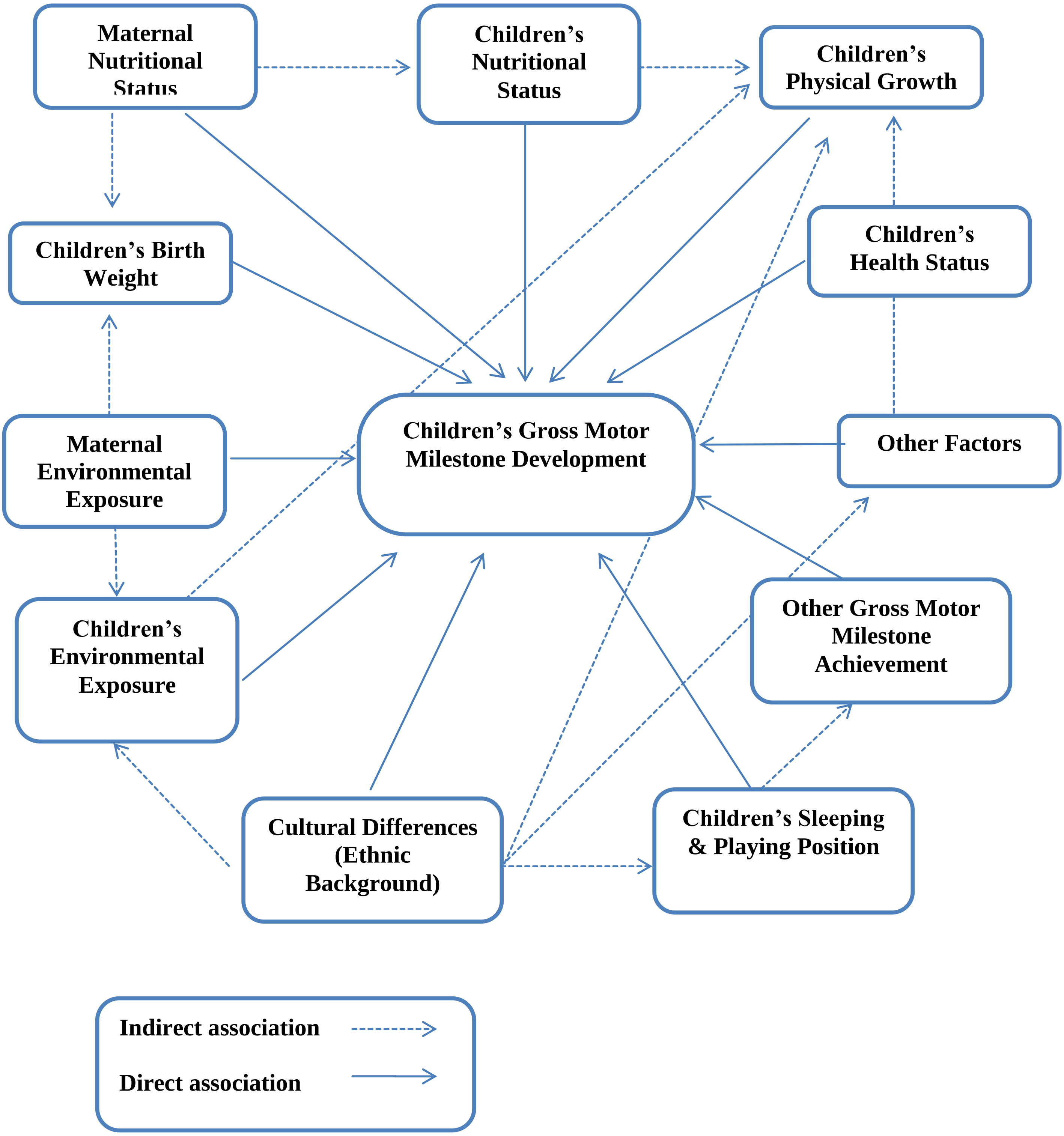

Citation identified through key words by using 28 data bases
Excluded duplicate citations (n=924)
Relevant citations available (n=1,650)
Citations excluded after reviewing by titles If study included animal studies, cell cultures, twin studies (n=1,020)
*8 citation no abstract available
Article selected for reading at least abstract (n=622)
Excluded 112 citations after abstract review if study included preterm infants or abnormal children) or did not meet the target outcome (e.g., neuron functional development, participants over 24months, motor gait pattern, behavior and stimuli reaction)
*7 citations no full text available
Full text relevant documents (n=503)
Excluded 361 documents written other language only, stair movement, pattern of foot, walking behavior, motor activity, only high risk children, full term but lower birth weight
Adequate documents selected for review remained 144 documents
Excluded Review documents (n=47)
Total documents included (n=97)

Figure 2 Conceptual Framework: Factors Associated with Infants' Gross Motor Milestone Development



RESULTS: Part I: Factors Associated with Motor Milestone Development

The development of infants and young children, including their motor milestone development, can be influenced by many factors. This chapter reviews 11 main factors evaluated to determine their association (positive, negative or null) with motor milestone development.

1.Children's Micronutrients Intervention and Nutritional Status

The influence of micronutrient intakes on children's physical growth and its' relationship to motor milestone development was reviewed. Micronutrients included zinc, iron and a combination of folic acid plus energy. Nutritional status as measured by the biochemical indicators, iron deficiency with or without anemia was also reviewed below.

Table 2 Association between Children's Motor Milestone Development and Children's Nutritional Intervention by Micronutrient supplement (iron, zinc, folic acid) and energy or Children's Nutritional Intakes

References	Positive Association	Negative Association	No Association
Surkan et al., 2013			✓
Yalcin et al.,2012	✓		✓
Angulo-Barroso et al., 2010	✓		
Katz et al., 2010		✓	✓
Shafir et al.,2008	✓		
Afarwuah et al.,2007	✓		
Olney et al.,2007	✓		
Kariger et al.,2005	✓		✓
Siegel et al., 2005	✓		
Kuklina et al.,2004	✓		
Jahari et al., 2000	✓		
Harahap et al., 2000			✓
Bentley et al., 1997	✓		✓

Each reference was related to a nutritional factor assessed in relation to gross motor milestone attainment. The check represents the type of association observed in each study. There can be single or multiple association

1) Positive Association with Motor Milestone Development

Across sectional study was conducted in Turkey to find out the effect of some demographic, social and infant characteristics, such as infant's physical growth. And presence of anemia, on the age of walking without support among healthy children ranging from12-23 months old (n=1,553). The age of walking alone was measured by the mean age of attainment. The results demonstrated that the mean age of walking without support was greater in a severe malnutrition region compared to lower malnutrition region. Additionally, children without anemia condition began walking alone at an earlier age than anemic children (Yalcin et al., 2012).

An observational study was conducted with 209 healthy infants (113 from Detroit, 47 from Beijing, and 49 from Accra) aged 9-10 months who lived in urban areas. The study compared the association of gross motor development with iron status and cultural difference. The 19 gross motor milestones (i.e., from sit to run position) were measured bypass or fail score of each gross motor milestone and the sum of passed items were the total score. At the baseline, children were stratified as an iron sufficient or iron insufficient (IS) and with anemic or no anemic. Infants who were a part of the IS (Iron sufficient) had a better score for gross motor milestone than those within iron-deficiency anemia or iron deficiency without anemia, regardless of their race(Angulo-Barroso et al., 2010).

An observational study was conducted with full-term African-American infants (n=106) at 9 to 10 months age, who lived in the inner city to explore the association between an infant's iron status and gross motor milestone development. The study defined the iron status among 77 infants: IDA (iron deficiency with anemia, n=28), NAID (non-anemic iron deficient, n=28) and IS(iron sufficient, n=21). Gross motor milestones (i.e., standing alone and walking alone) were measured by using the Peabody Developmental Motor scale (PDMS). There was a negative association between the PDMS and infant iron deficiency with or without anemia. Only 19% of infants who were iron deficient with or without anemia could stand and walk alone whereas 34% of the IS group could stand and walk alone (Shafir et al., 2008).

A micronutrient intervention study was conducted with infants 6-12 months with three intervention groups (n=313); multiple micronutrient Sprinkles powder (**SP;** generally provides the Recommended Nutrient Intake (RNI) of 6 vitamins and minerals**),** Nutritablet **(NT;** generally provides 14 vitamins and minerals plus some calcium and potassium), Nutributter **(NB**; the multiple micronutrient Nutributter, which generally provides the 14 vitamins and minerals plus some calcium, potassium, phosphorous, magnesium, and manganese as well as energy-108 kcal/d mainly from fat including 1.29 g linoleic acid/d and 0.29 g linolenic acid/d). These three intervention groups were compared to a **NI** (Non-Intervention group; n=96). And the age of walking without support was determined. Proportions of walking without aid were significantly higher in the three intervention groups, namely SP (39%), NT (36%), and NB (49%) groups than in the NI group (25%). But there was no significant difference between the three intervention groups. The odds of walking without aid at 12months of age, when adjusted for gender and household amenities, were greater in the three intervention groups than in the control group (Afarwuah et al., 2007).

A community based, randomized double-blind trial was conducted in Ghana, consisting of 771 children aged 5–19 months who received for 1 year one of three daily iron supplements: [iron+folic acid (FeFA; 12.5mg +50ug), zinc (10mg), iron+folicacid+zinc (FeFA+Zn)]. The percent of 14 gross motor milestones attainment was determined. The highest motor milestone achieved was recorded by observation. Locomotion was compared to the attained motor milestone among crawler and walker groups. 65 percent of children could creep or crawl, 84 percent of children could stand with support, and 97 percent of children could walk with aid. Regarding attained motor milestones, anemia with or without iron deficiency was significant predictors of motor milestone development after controlling for socioeconomic status, sex and age. Children with an iron sufficient were positively associated with motor milestone development than children with iron deficient with or without anemia (Olney et al., 2007).

A study in Tanzania was conducted with children 5-18 months old (n= 646). Fourteen items of gross motor milestone attainment were assessed (i.e., from pull to sit to standing on one foot). These were measured by motor milestone achievement at certain ages and confirmed with pictorial milestone charts. The result showed that not having anemia was also positively associated with the following motor milestones: pull to sit, creep, sit, stand and walk. Particularly, the odds of walking (OR=0.335, P=0.001) were 66% greater in non-anemic iron sufficient infants (Kariger et al., 2005).

A Nepali cross sectional community-based study was performed with children (n=485) from 4 to 17 months of age to determine the association between nutritional intake and motor milestone attainment. It classified two groups at baseline namely walker and non-walker, and measured motor milestones (MM) by using the Bayley Psychomotor Index (BPI) with a 17- item scale. The results showed that anemia status and meat consumption were significant predictors of walking. That is, there were positive associations of walking in children who did not have anemia and who had a higher intake of meat (Siegel et al., 2005).

A longitudinal study in Guatemala was conducted to determine the relation between nutritional factors (physical growth and dietary intake) and age of walking. Participants included children 3 months to 3years old (n=218). Seventeen gross motor milestones were measured by using the Gross Motor Development Scale (GMDS). Twenty four hour dietary recall was assessed biweekly at 9 and 12 months of age. The median and range of age of walking alone were 15 and 10-24months, respectively. Protein intake was associated with the earlier age of walking attainment (0.4 months earlier). These results remained the same after adjusting for birth length, postnatal growth and other maternal and infant factors (p=0.002) (Kuklina et al., 2004).

A randomized cohort study was conducted for 6months with12 month (n=53) and 18month (n=83) old children enrolled at daycare centers at. There were three treatment groups (**E, M and S**: **E group**: 1171kJ energy with 12mg of iron supplement, **M group**: 209kJ energy plus 12mg of iron, **S group:** only Energy, 104kJ). Gross motor milestones (i.e., from sit to run) were evaluated by using the Bayley Scale. Children who had higher energy with the iron supplement group (i.e., E) could achieve walking at an earlier age than other group (i.e., M and S).Similarly, energy contributed to having a higher Bayley Scale and more active compared to those in lower energy groups (i.e., M and S). At 12 months old, most children could walk with support. Whereas 100% of the children in group E could walk with support and run at 18 months, only 63% of children in group M and 50% of children in the S group respectively could achieve walking without aid at 18 months (Jahari et al., 2000).

A randomized double blind clinical trial was carried out with infants (n=85) 6-9months of age in Guatemala to determine the effect of daily zinc supplement on gross motor milestone achievement. The participants received a 4ml supplement (i.e., containing

10mg of zinc, n=43) or placebo (n=43). Fieldworkers delivered supplements orally during home visits over a 7 month period of time. Supplements were not distinguishable by families and study staff. At the base line, infants in the placebo group were more frequently observed sitting and standing than infants in the zinc treatment group. The distribution (%) of infant's attaining specific motor milestones (i.e., sitting, crawling, standing and walking) was measured at 3 and 7 months. At 7 months, the zinc treatment group (p=0.02) was more frequently observed sitting than the placebo group (Bentley et al., 1997).

2) Negative Association with Motor Milestone Development

A randomized controlled trial study was conducted in Southern rural Nepal with young children ages 1 to 36 months (n=3,264). There were three intervention groups: **zinc** (10 mg) only, **iron** (12.5 mg) **with folic** acid (50 mg)**, iron**(12.5 mg) and **folic acid**(50 mg)**with zinc** (10 mg)and placebo. Motor milestones were measured by percentage (%) and mean of age attainment. The age at which children begin walking tended to be delayed about 16.3 days in the iron with folic acid group compared to the control group. For children 12months old in the base line, age of walking was delayed around 28days in the iron with folate group. Similarly, the age of walking was extended beyond 18 months of age in the group receiving iron with zinc and folate treatment (Katz et al., 2010).

3) No Association with Motor Milestone Development

A randomized placebo control study in Nepal was conducted with 544 children from 4-17 months old. The participants randomly received micronutrient supplements daily for 1 year [Group 1: received zinc only (10mg), Group 2: iron (12.5mg) with folic acid

(50ug), Group 3: zinc with iron and folic acid, Group 4: sugar placebo). Motor milestones were compared with the MacArthur Communicative Development Inventory. The mean age of motor milestone scores were11.4 months and 11.8 months in the zinc and non-zinc treated groups, respectively. But there no was significant difference found between zinc treatment and control groups. For the iron treated group, the motor milestones score (11.8 months) was increased compared to the non-iron treated groups (11.5 months) but, there was no significant difference between iron and non-iron treated groups (Surkan et al., 2013)

A cross sectional study in Turkey was conducted with healthy children (n=1,553) at 12-23 months old to explore the effect of demographic, social ,infant characteristics (such as infant's physical growth and presence of anemia) and family characteristics on the age of walking without support. The age of walking alone was measured by the mean of age attainment. History of iron and vitamin supplementation during the first year of life was not associated with age of walking without support. Thus, there was no significant association between the age of walking without support and the history of iron and vitamin supplementation (Yalcin et al., 2012).

A randomized controlled trial study was conducted in Southern rural Nepal with young children ages 1 to 36 months (n=3,264). There were three intervention groups: **zinc** (10 mg) only, **iron** (12.5 mg) **with folic** acid (50 mg)**, iron** (12.5 mg) and **folic acid**(50 mg)**with zinc** (10 mg) and placebo. Motor milestones were measured by percentage (%) and mean of age attainment. There was no association between the proportion of children who could not walk at 12-18months of age with treatment groups and control group: zinc treatment (11.3%) and control groups (12.8%). There was no effect of zinc supplementation on sitting without aid, running, jumping and standing on one leg compared to control. Similarly, when compared to iron with folic acid and the control group, there was no effect of iron with folic acid supplement on sitting without support, running, jumping and standing on one leg. Also, there was no difference found among the four supplementation groups compared to control regarding the mean of age at which children began walking without assistance, even after adjustments were made with age of enrollment at child care, asset ownership, maternal literacy and prior child deaths in household (Katz et al., 2010).

A study in Tanzania was conducted with children 5-18 months old (n= 646). Fourteen items of gross motor milestone attainment were assessed (i.e., from pull to sit to standing on one foot). These were measured by motor milestone achievement at certain ages and confirmed with pictorial milestone charts. The result showed that there was no association between crawling and infants' anemic status(Kariger et al., 2005).

A study was conducted in West Java with children12-18 month's old who were randomly selected and supplied with different energy contents with or without an iron supplement for six months. The groups were as follows: (E): 1171 kJ energy with12 mg of iron supplement, (M): 209 kJ energy with12mg iron supplement, (S): only energy, 104 kJ. After treatment, 18 anemic (IDA) infants were selected from groups E and M and compared to 18 non-anemic (non-IDA) infants to compare motor development by using the Bayley Scale. There was no significant difference in the motor milestone scale between the IDA and non-IDA groups (Harahap et al., 2000).

A randomized double blind clinical trial was carried out with infants (n=85) 6-9months of age in Guatemala to determine the effect of daily zinc supplement on gross motor milestone achievement. The participants received a 4ml supplement (i.e., containing

10mg of zinc, n=43) or placebo (n=43). Fieldworkers delivered supplements orally during home visits over a 7 month period of time. Supplements were not distinguishable by families and study staff. At the base line, infants in the placebo group were more frequently observed sitting and standing than infants in the zinc treatment group. The distribution (%) of infant's attaining specific motor milestones (i.e., sitting, crawling, standing and walking) was measured at 3 and 7 months. There was no significant difference between the zinc treatment and placebo group in terms of the percent of infants attaining standing, crawling or walking at 3 and 7 months (Bentley et al., 1997).

2. Children's Physical Growth

Children's nutritional status and their physical growth were reviewed. Nutritional status was measured by biochemical indicators namely iron-deficiency anemia and iron deficiency. In terms of physical growth, indicators weight-for-age and height-for-age Z score were examined. Undernutrition denotes being underweight, stunted (low height for age), wasted (low weight for height) or with deficiencies in vitamins and minerals (Yacin et al, 2012, Kariger et al, 2005, Siegel et al, 2005)

Table 3 Association between Children's Motor Milestone Development and Children's Physical Growth

References	Positive Association	Negative Association	No Association
Yalcın et al., 2012	✓		
Afarwuah et al.,2007	✓		
Olney et al, 2007	✓		
Kariger et al., 2005	✓		
Siegel et al., 2005	✓		
Kuklina et al., 2004	✓	✓	

Mulligan et al., 1998	✓

1) Positive Association with Motor Milestone Development

A cross sectional study in Turkey was conducted with healthy children (n=1,553) at 12-23 months old to explore the effect of demographic, social ,infant characteristics (such as infant's physical growth and presence of anemia) and family characteristics on the age of walking without support. The age of walking alone was measured by the mean of age attainment. Physical growth was negative association with the age of walking without support. Children with both weight for age z-score(WAZ) or height for age z-score (HAZ) less than 1 standard deviation began walking at a later age than those with higher WAZ and HAZ (Yalcin et al., 2012).

A micronutrient intervention study was conducted with infants 6-12 months with three intervention groups (n=313); multiple micronutrient Sprinkles powder (**SP;** generally provides the Recommended Nutrient Intake (RNI) of 6 vitamins and minerals**),** Nutritablet **(NT;**which generally provides 14 vitamins and minerals plus some calcium and potassium), Nutributter **(NB**; the multiple micronutrient Nutributter, which generally provides the 14 vitamins and minerals plus some calcium, potassium, phosphorous, magnesium, and manganese as well as energy-108 kcal/d mainly from fat including 1.29 g linoleic acid/d and 0.29 g linolenic acid/d). These three intervention groups were compared to a **NI** (Non-Intervention group; n=96). And the age of walking without support was determined. The NT group had a significantly lower weight that is WAZ and WLZ (Weight for Length Z score) than the SP and NB groups. The WAZ and WLZ were significantly greater in group NB than in NT after controlling gender and maternal height. Particularly, with higher energy intake the NB group experienced a 43% greater mean weight gain compared to the SP group but 46% greater weight gain compared to the NT group. The percentage of walking without support was related to energy and micronutrient levels and weight gain. Thus, SP (39%), NT (36%) and NB (49%) groups could walk more compared to the NI group (25%)(Adu-Afarwuah et al., 2007).

A community based, randomized double-blind trial was conducted in Ghana, consisting of 771 children aged 5–19 months who received for 1 year one of three daily iron supplements: [iron+folic acid (FeFA; 12.5mg +50ug), zinc (10mg), iron+folicacid+zinc (FeFA+Zn)]. The percent of 14 gross motor milestones attainment was determined. The highest motor milestone achieved was recorded by observation. In walker group, Length for Age Z score (LAZ) was significantly related to motor milestone development after controlling for socioeconomic status, sex and age. Therefore, higher LAZ was positively associated with time in movement among those in the walker group (Olney et al., 2007).

A study in Tanzania was conducted with children 5-18 months old (n= 646).Fourteen items of gross motor milestone attainment were assessed (i.e., from pull to sit to standing on one foot). These were measured by motor milestone achievement at certain ages and confirmed with pictorial milestone charts. Physical growth increased the odds of walking (66%), but not crawling. The odds of walking alone doubled with 1 unit increase in HAZ ($P<0.001$). The odds of walking increased about 30% when 1 unit of WHZ increased ($p<0.05$) (Kariger et al., 2005).

A Nepali cross sectional community-based study was performed with children (n=485) from 4 to 17 months of age to determine the association between nutritional intake and motor milestone attainment. It classified two groups at baseline namely walker and non-walker, and measured motor milestones (MM) by using the BPI with a 17- item scale. The results demonstrated that LAZ and WAZ were significant predictors of walking. The odds for walking without assistance were increased by 70% and 65% when LAZ and WAZ increased by 1unit respectively. Among Non-walkers, they could walk earlier if they were underweight and ate more protein (Siegel et al., 2005).

A longitudinal study in Guatemala was conducted to determine the relation between nutritional factors (physical growth and dietary intake) and age of walking. Participants included children 3 months to 3 years old (n=218). Seventeen gross motor milestones were measured by using the GMDS. Twenty four hour dietary recall was assessed biweekly at 9 and 12 months of age. The median and range of age of walking alone were 15 and 10-24 months, respectively. Children who had better physical growth could walk earlier than others after adjusting maternal, infant's factors, along with diet. Particularly, when LAZ was increased by 1 unit, the infants could walk earlier (0.6months). This study showed that postnatal growth in length during the first year of life after birth played a key role in walking (Kuklina et al., 2004).

Another longitudinal observational study was conducted with healthy children (n=48) enrolled in a child care center to explore the effect of physical activity on children's motor development, activity level and body composition. Motor development was measured at 6, 9 and 12 months of age with the Bayley Scale of Infant Development (BSID). The results showed that gross motor development was associated with body composition at 6 and 12 months (Mulligan et al., 1998).

2) Negative Association with Motor Milestone Development

A longitudinal study in Guatemala was conducted to determine the relation between nutritional factors (physical growth and dietary intake) and age of walking. Participants included children 3 months to 3 years old (n=218). Seventeen gross motor milestones were measured by using the GMDS. Twenty four hour dietary recall was assessed biweekly at 9 and 12 months of age. The median and range of age of walking alone were 15 and 10-24 months, respectively. An infant's weight gain was negatively associated with age of walking (Kuklina et al., 2004).

3. Cultural and Ethnic Differences

Culture denotes social rules, habits and morals regarded collectively. It influences infants' behaviors patterns and governs a population (Crowther et al., 1997). According to the literature review, parents' motivation and expectations of their children's attainment of motor milestones were different depending on race (Allen et al., 1990). Therefore, the ethnic background including genetic factors of infants can be an important factor in determining children's future motor development (Davis et al., 1998). Particularly, parents' protective behavior regarding childcare practice can delay the achievement of children's gross motor milestone due to lack of movement experience. Additionally, infants reared in the westernized culture could delay gross motor development (Cintas, 1988). The cultural difference that was associated with gross motor development was compared with the WHO motor development study: windows of achievement for six gross motor development milestones (Clearfield et al., 2004).

Table 4 Association between Children's Motor Milestone Development and Children's Cultural and Ethnic Differences

References	Positive Association	Negative Association	No Association
Naqvi et al., 2012			✓
Angulo-Barroso et al., 2010	✓		
Kelly et al., 2006	✓		
Siegel et al., 2005	✓		
Nelson et al., 2004		✓	
Nixon-Cave et al., 2001	✓		
Stanitski et al.,2000	✓		
Allen et al., 1990			✓
Hopkins et al., 1989	✓		
Capute et al., 1985	✓		
Stewart et al., 1981	✓		
Grantham-McGregor et al., 1971	✓		
Phatak et al., 1969	✓		

1) Positive Association with Motor Milestone Development

An observational study was conducted with 209 healthy infants (113 from Detroit, 47 from Beijing, and 49 from Accra) aged 9-10 months who lived in urban areas. The study compared the association of gross motor development with iron status and cultural difference. The 19 gross motor milestones (i.e., from sit to run position) were measured bypass or fail score of each gross motor milestone and the sum of passed items were the total score. There was a significant difference between the Beijing and Accra infants and the Detroit and Accra infants. Particularly, the infants from Accra (Black infants) had better scores for attaining gross motor capabilities such as standing and walking with support compared to infants from Beijing and Detroit (Angulo-Barroso et al., 2010).

A Millennium Cohort Study (MCS) was conducted for 12 months with 9month old infants (n=15,994; 8,212 males, 7,782 females) who were born in the UK but had different ethnic backgrounds (Black African, Indian, White and others). It showed that there were ethnic differences regarding the gross motor milestone development. Black Caribbean infants who were born in the UK were more likely achieve gross motor milestones at an earlier age than those who were another race. Black infants achieved most of gross motor milestone at an earlier age than the White and Pakistan infants. Similarly, when adjusting for socioeconomic and other factor, the Black infants tended to experience earlier gross developments than other race groups. Black and Indian infants were more likely to have achieved gross development faster compared to others groups when adjusted for cultural tradition along with other factors (Kelly et al., 2006).

A Nepali cross sectional community-based study was performed with children (n=485) from 4 to 17 months of age to determine the association between nutritional intake and motor milestone attainment. It classified two groups at baseline namely walker and non-walker, and measured motor milestones (MM) by using the BPI with a 17- item scale. This study compared the odds of walking between low caste Hindu and Muslim children. The result showed that high caste Hindu (Brahmin or Chhetri) children had achieved walking earlier than children in a lower caste (Siegelet al., 2005).

A case control study was conducted with 9 children (5 males, 4 females) of 12-18 months of age to explore motor milestone development associated with cultural belief, tradition, parental handling and expectations, and environmental factors. It also examined the influence of these factors on achieving motor milestones such as sitting, crawling and walking. The gross motor milestone skill level was measured by Peabody Developmental Motor Scales (PDMS). This study showed parents' rearing practice and interacting with their infants as well as proper stimulation are important factors for developing motor performance. The study noted that the level and type of parents' encouragement toward their children would be different depending on ethnical background. African-American (AA) parents thought that parents needed to teach or expose children to certain environments where they can learn motor skills such as walking. However, Anglo European and Hispanic or Latino parents seemed to wait and give their children a chance to learn motor skills naturally or at their own pace. The results showed that the different perspectives could affect the infant's development of motor skills. According to the overall PDMS, AA infants (overall PDMS score was 75th to 88th percentile rank for their age group) had developed motor skills at least 1~4months earlier than Latino or European infants. In regards to sitting, AA infants were 5 months earlier than those with another race. For crawling, Hispanic infants achieved this skill at 5~7months but Anglo-EU infants achieved it at 8-11months. For walking independently, AA infants could walk without assistance as early as 8 months compared to those with another race (Nixon-Cave et al., 2001).

A cohort study conducted with 986 children (575 male, 471 female)from pediatric orthopedic offices at the Children's Hospital of Michigan explored an association between age of walking alone and race (black, white and others)for 6 months. The age at which children start walking independently was measured by the mean age of the walking among each ethnic background along with other factors. The mean age of walking alone was significantly earlier in AA children than white American (WA) children (Stanitski et al., 2000).

A British study interviewed 124 mothers from three different ethnic backgrounds (i.e., from Jamaica, English and India) in order to compare infants 'mean age of attaining three gross motor milestones: sitting, crawling and walking alone. The mother's expectation toward their child's achievement of motor milestones was also considered. Jamaican mothers expected their children to sit and walk alone earlier than English and

Indian mothers. The observation study showed that Jamaican infants achieved sitting and walking alone at an earlier age than English and Indian infants (Hopkins et al., 1989).

A longitudinal study in USA was conducted with 381 children born at term and had Bayley mental and motor indices beyond 68items. Gross motor milestones (e.g., roll prone to supine, roll supine to prone, sit with or without aid, creep, crawl, pull to stand, cruise, walk, walk backward and run) were assessed at 2 weeks, 2, 4, 6, 12, 15, 18 and 24 months. Gross motor milestones were measured by the mean age and percentage of attainment based on parental reports. The results showed that black children were more likely achieve most of the motor milestone earlier age than white children. Among the White children, males' children achieved most of the motor milestones earlier than females' children. However, in the black children, female children achieved gross motor milestones earlier than male children (Captute et al., 1985).

A cohort study in USA was conducted to compare the difference in gross motor development among 250(131 female and 119 male infants) AA children compared to European-American children age 2-24 months .The AA children were compared with the published norms drawn from the Denver population. The Revised Denver Developmental Screening Test (RDDST) was used for measuring children motor development (1-24 items). The results of the Gross motor sector showed that there were differences of one month or more (1-12 month range) between the two groups. There was 50% of achieve gross motor development from 1-4 months and 90% of them passed until 22 months. This result showed that African American children achieved more than one month earlier age than the Denver sample (Stewart et al., 1981).

A longitudinal study in Kingston, Jamaica was conducted with 300 infants from birth to 12 months to explore 14 gross motor behaviors. Gross motor milestone was measured by percentage of infants who achieved motor milestones at a specific point of time, and then compared with white infants (Gesell norm). Among the Kingston infants (birth weight above 2.5kg), they could achieve over 70% of motor milestones at a certain age compared with white children. Kingston infants achieved pull to sit with no head (64%) and standing alone (66%) earlier in age than white children (Grantham-McGregor et al., 1971).

A longitudinal study in India was conducted to explore motor and mental development of Indian infants (n=278, males 168, female 110) from 1 to 30 months. The motor development was measured every month by appointment with (BISD: 67 items) Development. The infants' performance were recorded as pass, fail or otherwise. The result showed that Indian infants tended to achieve 50% earlier in motor compared to American babies in Dr. Bayley's sample (Phatak et al., 1969).

2) Negative Association with Motor Milestone Development

A cross sectional study in Hong Kong was conducted with 72 infants from 0 to 9 months explored the mean of age of rolling over related to two different positions (i.e. from supine to prone or from prone to supine). The result showed that the mean age of roll over was achieved later in infants who were born in Hong Kong than in other studies conducted with children born in other countries (Nelson et al., 2004).

3) No Association with Motor Milestone Development

A cross sectional study was conducted with 103 mother s with children (11-81months) from urban (n=49, male 28)) and children 12-83months from rural (n=54, male 23) in

Tanzania. The study explored the association between parents ‘belief and acknowledgement regarding children’s motor milestone development. Children developmental outcome was assessed using the Battelle Developmental Inventory Screening Test. There was no association with children development and parent’s belief and acknowledgement (Naqvi et al., 2012).

A randomized case control cohort study was conducted with 100 black preterm infants in Ghana from 12-24 months old to evaluate the age of achieving12 gross motor milestones compared to the norm. The gross motor milestones (MM) were measured by the mean age of MM attainment and then compared to the norm. There was no statistically significant difference found between black and white children for three motor milestones (rolling from supine to prone, crawling, and pulling to stand) even though black infant achieved these milestones at earlier ages than white infants (Allen et al., 1990).

4. Children’s Birth Weight

Many studies showed that very low birth weight (VLBW) preterm infants (gestational age, 37 weeks and birth weight, 1500 g) are at high risk for developmental retardation including motor and mental ability. Some studies showed that preterm infants attain the ability to walk at a later age than term infants. The association with the age of attaining specific motor milestones and birth weight was measured by survival analysis (Jeng et al., 2008 & 2004 Luo et al., 2009). This information can be used for early identification of preterm infants in order to prevent motor delays. However, other studies reported that there was no significant difference in achievement of motor milestones at a certain age between preterm and term infants (Fetters et al., 2007).

Table 5 Association between Children's' Motor Milestone Development and Children's Birth Weight (Preterm or Full term):

References	Positive Association	Negative Association	No Association
Restiffeet al., 2012	✓		✓
Yalcin etal.,2012			✓
Luo et al., 2009	✓		
Pin et al., 2009	✓	✓	
Jeng et al.,2008	✓		
Little et al., 2005	✓		✓
Jeng et al., 2004	✓		
Pridham et al., 2002	✓		
Jenget al., 2000	✓		
Iwata et al., 1991	✓		
Allen et al., 1990	✓		
Palisano et al.,1985	✓		
GranthamMcGregor et al., 1971	✓		

1) Positive Association with Motor Milestone Development

A longitudinal study in Brazil was conducted to compare the gross motor development with preterm infants (PT; n=101) without cerebral palsy and infants who were full-term and healthy (FT; n=52). This study compared the age of walking without support between PT and FT infants by a monthly mean score using the Alberta Infant Motor Scale (AIMS). The AIMS showed significant differences between two groups during 8to 11 months. The difference decreased gradually from 12 to 16 months. Proportionally, full term infants were able to walk at an earlier age than pre term infants. Mean age of walking onset among full-term infants was 368.6 days compared to preterm infants (381.6 days). The walking attainment delayed among preterm infants. When birth weight increased for every

100 g increment, the likelihood ratio of walking increased by 11%; a 1 cm increment in birth length increased the likelihood ratio of walking attainment by 12%(Restiffe et al., 2012).

A cohort longitudinal study was conducted with29 preterm infants and 20 full term infants from 3 to 7 months until achieving walking alone or 18 months. The age of walking attainment was measured by the AIMS. The walking outcome was classified into three categories: **early** (walking attainment before 11 months of corrected age), **normal** (walking attainment between 11 and 15 months of corrected age) and **late** (walking attainment failed prior to 15 months). The distribution of age of walking attainment for full term infants (median =11months, range: 10-14.5months) attained earlier ages than preterm infants (median=12.8months, range 9.8-18months). Early walkers were higher birth weight compared to the normal and late walker group (Luo et al., 2009).

A longitudinal study in Australia was conducted to compare the motor development of preterm (n=62) and full term birth (n=53) infants 4 to 8 months old. Gross motor milestones such as rolling, propping in prone and sitting were measured with the AIMS. The results showed that the full term infants group received higher the AIMS scores than preterm infants at 4 months. Similarly, it demonstrated that all of the full term infants had significantly higher AIMS for sitting and standing at 8 months than preterm infant group. For sitting without arm support, 90% of term infants attained this skill at the age of 8 months but only 56% of preterm infants could sit for a very short time without arm support. At 8months, full term infants had significantly higher AIMS score in the area of sitting and standing compared to preterm infants (sit $p<0.001$, stand $p=0.016$) (Pin et al., 2009).

A cross sectional study in Taiwan was conducted with 29 preterm and 29 children for 6months. Onset of age of walking in the two groups was measured by the (PDMS-II) at 18 months of corrected age. Survival analysis of the distribution of age of walking showed that full term infants (median 12months, range 10-14.5months) achieved walking significantly earlier in age than preterm infants (median 12.5months, range: 9.8-16.5 months)(Jeng et al., 2008).

A retrospective cohort study in USA was conducted with 48 preterm children and 920full term children with ages ranging from 2 to 60 months. They were classified by three age groups (i.e., 0-18months, 19-36 months and 37-60 months). Motor development was measured by MerrillPalnerR (MPR) score. The results showed that children who born in preterm have significantly lower score than those born full term in 0-18 months age group ($p<0.01$). Therefore preterm children had a significantly lower score of gross motor development than full term children in early age group than other age groups (Little et al., 2005).

Another longitudinal study was conducted with infants who were born at National Taiwan University Hospital from 2 months of age until 18 months children were selected (i.e., 22 full term, 22 preterm infants) to explore the association between age of walking attainment and birth weight. 60% of full term infants (n=13) could walk by 12months and 40% of full term infants (n=9) could walk within 12~18months of their age. But only 40% of preterm infants (n=9) attained walking by 12 months and 51% of preterm infants (n=11) achieved walking within12 to 18 months (Jeng et al., 2004).

A longitudinal study was conducted to determine the association between caregivers' behavior and infants' growth and motor development with full term (n=52) and preterm (n=47) infants. Motor development was examined at 12 months using the BSID-I. The BSID-1 score was smaller in preterm infants than full term infants and the standard deviation of BSID-1 was relatively larger in preterm infants (Pridham et al., 2002).

A longitudinal cohort study was conducted in Taiwan to compare the age of walking attainment between very low birth weight (VLBW)(n = 96) and full term infants (n = 82) from 6 to 18 months corrected age. The age of walking distribution was measured by the AIMS. Motor outcome was stratified into two categories: failed to attain walking (if infant is unable to walk at 18months of age), attained walking (if infant can walk prior to 18 months of age). There was a significant difference in the age of walking distribution between VLBW infants and the full term infants, even after the adjusting for parental education and occupation. The full term infants (median 12months, range: 9.5-16months) were significantly earlier in age of walking attainment than VLBW infants (median 14 months, range: 10-18months). Full term infants (p=0.001) showed significantly higher AIMS scores than VLBW infants. Results revealed that those with lower birth weight failed to walk within 6to 12 months of age (Jeng et al., 2000).

A cross sectional study in Tokyo was conducted with 395 children at day care centers from 11 months to 3 years old to explore the correlation between age at which children begin to walk and the following factors: birth weight, order of birth, frequency of being carried on the chest, season of birth, use of a walker, age of enrollment at a day-care center. The age range age at which children started walking alone was from 8 month to 17 months. 27.3% of children started walking at the age of 12 months and 95% of children attained walking before the age of 15months. Infants who had higher birth weight (3.5-4.0kg) tended to walk earlier than those who had a lower birth weight (Iwata et al., 1991).

A randomized case control study was conducted with 100 black preterm infants from 12-24 months of age to evaluate 12 gross motor milestone(MM) attainment compared to full term infants. The gross motor milestones were measured by the mean age of gross MM attainment at a certain age. Among black infants (69% of the preterm, 35% of the term group), term infants could sit without support earlier than preterm infants. Controlling for race, the result showed that the mean of age for sitting with or without aid was significantly greater in preterm infants than term infants Therefore, infants with higher birth weight were positively associated with achieving gross motor milestone at certain age compared to those with lower birth weight (Allen et al., 1990).

A cross sectional study was conducted in USA to compare the mean gross motor milestone development between premature infants (n=23) and full term infants (n=20) at 12 months of corrected age. The gross motor milestone achievement was measured by the PDMS. Age equivalent score of chronological age(CA) for both groups showed that the gross motor score was higher in full term infants than premature infants ($p<0.01$). The full term infants achieved higher mean PDMS raw score than premature infants. That means full term infants tended to have more advance level of motor development (Palisano et al., 1985).

A longitudinal study in Kingston, Jamaica was conducted with 300 infants from birth to 12 months to explore 14 gross motor behaviors. The gross motor milestone was measured by percentage of infants who achieved motor milestones at a specific point of time. This outcome was for children with different birth weight (1= above 2.5kg,
2= below 2.5kg). More birth weight infants achieved gross motor milestones at a certain age compared to those with lower birth weight. Among the Kingston infants with higher

birth weight (above 2.5kg), they could achieve over 70% of motor milestones at a certain age compared with % of normal white children (Gesell Developmental Schedules). However, among Kingston infants with lower birth weight (below 2.5kg), only 61% of infants achieved standing alone and 68% of those attained walk with aid at certain age compared with 100% of Gesell Schedules(Grantham-McGregor et al., 1971).

2) Negative association with Motor Milestone Development

A longitudinal study in Australia was conducted to compare the motor development of preterm (n=62) and full term birth (n=53) infants 4 to 8 months old. Gross motor milestones such as rolling, propping in prone and sitting were measured with the AIMS. Preterm infants (22%) achieved more rolling from prone to supine without rotation infants than full term infants (12%) at 4 months (Palisano et al., 1985).

3) No Association with Motor Milestone Development

A longitudinal study in Brazil was conducted to compare the gross motor development of preterm infants (PT; n=101) without cerebral palsy with healthy full-term (FT; n=52) infants. This study compared the age at which PT and FT infants walk without support using a monthly mean score of walking without s from the AIMS. The result showed that mean of the AIMS score was not different between PT and FT groups (Restiffe et al., 2012).

A cross sectional study in Turkey was conducted to find out the effect of some demographic, social and infant characteristics on the age at walking without support among healthy 12-23 months old children (n=1,553). The age of walking alone was measured by the mean age of attainment. There was no significant association between birth weight and children's age of walking without aid (Yalcin et al., 2012).

A retrospective cohort study in USA was conducted with 48 preterm children and 920 full term children with ages ranging from 2 to 60 months. They were classified by three age groups (i.e., 0-18months, 19-36 months and 37-60 months). Motor development was measured by Merrill Palner R (MPR) score. There was no significant difference in MPR score between preterm and full term children at 19-36 months and 37-60months (Little et al., 2005).

5. Maternal Dietary Status/ Dietary Intervention

Two studies demonstrated maternal dietary status including iron and other vitamins supplements can affect infants' growth and development (Yacin et al, 2012, Tofail et al, 2008). More specifically, maternal iron deficiency during pregnancy and even after delivery is a crucial factor for infant to attain a specific motor milestone at a certain age. These studies attempted to explore the association with maternal dietary status and infant's motor milestone development (Yacin et al, 2012, Tofail et al, 2008). The maternal dietary status can be measured by a frequency questionnaire regarding history of iron or other vitamin supplement but also by directly taking a blood sample to examine the anemia status (Yalcin et al., 2012).

Table 6 Association between Children's Motor Milestone Development and a Maternal Dietary Intervention.

References	Positive Association	Negative Association	No Association
Yalcin et al., 2012	✓		✓
Tofail et al.,2008	✓		
Oken et al., 2008	✓		
Kirksey et al., 1994		✓	

1) Positive Association with motor milestone development

A study was conducted in Turkey with healthy 12-23 months old children(n=1,553)to find out the effect of some demographic, social and infant characteristics, such as infant's physical growth, presence of anemia, and family characteristic on the age at walking without support. The age of walking without support was measured by the mean of age attainment from maternal recall. The results showed that children with mothers who had iron supplementation in past during gestational period achieved walking alone at earlier age (12.34, n=1,042) than those with mother did not have any iron supplemented (12.57, n=511) regardless regions (Yalcin et al., 2012).

A large, randomized, controlled trial of pregnancy supplementation was conducted in Bangladesh infants (n =2,853) were assessed. Gross motor milestone development was measured by the BSID-II. All enrolled pregnant women were encouraged to consume the supplements under supervision 6 d/wk at the local community nutrition center. The number of packets taken by the mothers was recorded during monthly home visits.Three types of micronutrients were provided for daily supplementation from week 14 of gestation until delivery; they included MMs, 60 mg Fe (fumarate)+400 ug folate (the Fe60 group), and 30 mg Fe (fumarate) + 400 ug folate (the Fe30 group). The MM group received 15 different vitamins and minerals, developed by the United Nations Children's Fund (UNICEF). Women were divided into 2 groups according to their BMI on enrollment at8–10wk of pregnancy the better-nourished (BMI>=18.5) and the undernourished (BMI < 18.5) groups. Infants with maters had higher BMI (>=18.5) showed higher PDI score than those of undernourished mothers (BMI <18.5) (P= 0.003) (Tofail et al., 2008).

A longitudinal study in Denmark was conducted with children at 6 and 8 mo. (n=25,446) to explore the association between maternal fish intake and children motor milestone development by using the sum of passed items. Mother reported questionnaires (yes or no) of following motor milestones: hold up with head, sit with a straight back, roll back to front, sit alone and walk alone. The results showed that higher maternal fish intake was positively associated with children motor milestone development at 6 mo. and 18 mo. after adjusting parents and child characteristics (Oken et al., 2008).

2) Negative Association with motor milestone development

A longitudinal study in Egypt was conducted with women (n=50) after 6 mo. of pregnancy and first 6 mo. of lactation to explore the association between maternal zinc intake and infants' motor milestone development. Gross motor milestone development was measured by the BSID-I at 6 mo. of ages. Maternal intake of zinc, dietary fiber, phytate and protein intake were collected by weekly recall. There was negative association with maternal intake (zinc, fiber and phytate intake but lower vitamin C) and infants' motor milestone development (Kirksey et al., 1994).

3) No Association with motor milestone development

A cross sectional study was conducted in Turkey with healthy 12-23 months old children(n=1,553) to find out the effect of some demographic, social and infant characteristics, such as infant's physical growth presence of anemia including family characteristic on the age at walking without support. The age of walking alone was measured by the mean of age attainment. There was no significant difference between maternal history of anemia or the history of iron and vitamin supplementation during the first year and infants' age of walking without support (Yalcin et al., 2012).

6. Maternal Health Affected by Environmental Factors

Maternal exposure to drugs, smoke, alcohol or medical treatment may affect the infant's health and development. Some studies reviewed that women who used opium during their pregnancy can experience neonatal withdrawal and potential harm infants after birth. Long-term studies of maternal exposure to opiate, cocaine, and alcohol during the period of pregnancy and delivery showed a negative association with infant's mental and gross motor milestone attainment (Harolyn M E et al., 1999). Additionally, maternal Thyrotropin hormone and corticosteroids treatment (Crowther etal., 1997) can be a potential factor of preterm delivery and cause children to have a negative health outcome. Prenatal and postnatal exposure to environmental pollutants such as Polychlorinated biphenyls (PCBs) and dioxins (Nakajima et al., 2006) can have harmful effects on infant's health and development as well as other psychological health outcomes. The degree of chemical or drug exposure was measured by a maternal blood sample or frequency questionnaire. Results revealed that environmental or maternal exposure could delay the age of children's gross motor milestone achievement.

Table 7 Association between an Children's Motor Milestone Development and Maternal Exposure to Polydrugs, Smoking (tobacco, cocaine), and Medical Treatment (hormone therapy), Mental Stress, Organic solvent, DEX, MDMA, MA, Cell phone use

References	Positive Association	Negative Association	No Association
Kankova et al, 2012		✓	✓
Laslo-Barker et al, 2012			✓
Singer et al., 2012		✓	✓
Smith et al., 2011			✓
Divan et al., 2011			✓
Tofail et al., 2009			✓
Punamaki et al., 2006			✓
Nakajima et al., 2006		✓	
Huizink et al., 2002		✓	
Meyer-Bahlburg et al., 2004			✓
Harolyn et al., 1999		✓	✓
Fetter et al., 1998		✓	
Crowther et al.,1997		✓	

Richardson et al., 1995		✓	✓
Reid et al., 1991	✓		

1) Positive Associations with Motor Milestone Development

A longitudinal study was conducted to explore the difference in motor development with children (n=90) at 6, 10 and 15 months depends on cocaine exposure during prenatal period through pregnant mother. The children were identified as cocaine exposure (n=15) and cocaine free group (n=15) at each month. Overall gross motor development was measured by the BSID-I and IMSEL. The results showed that there was significant different between two groups (<0.05). The mean of the BSID score in cocaine exposure children was 33 whereas control group was 30. There was difference between control and exposure group at each age groups. The BSID score was proportionate with children exposed with cocaine and as age increased compared to control. The IMSEL test also showed the significant difference in motor development between two groups (<0.05). The mean of the Infant Mullen Scale of early learning gross motor subtests (IMSEL) score in exposure and control group were 17 and 15 respectively. The mean score of the IMSEL was increased by age. Similarly, cocaine exposed group showed higher IMSEL score compared to control at all age groups (Reid et al., 1991).

2) Negative Associations with Motor Milestone Development

A retrospective cohort study was conducted in Czech Republic to explore the relation between maternal exposure to latent toxoplasmosis during pregnancy and postnatal motor development from birth to 18 months old. Among 351 questionnaires, 54 of them were Toxoplasma-positive women and 10 of women gave a birth twins. The influence of latent toxoplasmosis on the motor development of children was measured by the mean age of the first time (months) motor milestones achievement (e.g. lift to head, turn over from supine to prone positions, sit, crawl and walk alone). The results showed that maternal exposure to Toxoplasma was negatively associated with postnatal motor development. Therefore infants with mothers exposed to latent toxoplasmosis were significantly delayed in the age of achieving a head lift or roll (from supine to prone position, 0.44 months) or crawl (0.19 months) (Kankova et al., 2012).

A cohort study in London was conducted to explore the effect of infant's polydrugs exposure on their motor milestone attainment. The targeted subjects were mother used recreational drugs (e.g., MDMA (3, 4-methylenedioxymethamphetamine) or Ecstasy, Tabasco, Cannabis, Alcohol and Cocaine) during pregnancy. The study was conducted with infants with MDMA exposed (n=28) and non-MDMA exposed infants (n=68). The gross motor milestone was measured with the AIMS, the BSID-I and Motor quality score at first and four months. At 4 months, MDMA exposed infants showed lower the AIMS and motor quality score compared to non-exposed infants. Thus, the gross motor milestone achievement was negatively associated with delayed motor movement in MDMA exposed infants (Singer et al., 2012).

A cohort study was conducted with 134 Japanese pregnant women and their 6 month old infants to examine the influence of prenatal exposure to Polychlorinated Biphenyls (PCB) and Dioxins on infant's neurodevelopment. Motor and metal score was measured by using the mean score of the BSID-II. The MDI and the PDI scores were measured based on the calibration scale from raw score and index scores. The mean score of MDI and PDI were 91.9 ± 5.8 and 89.3 ± 10.5, respectively. Both values were lower than the standard of MDI and PDI scoring (100 ±- 15) among infants who had prenatal exposure to Polychlorinated Biphenyls (PCB) and Dioxins (Nakajima et al., 2006).

A prospective longitudinal study in Netherlands was conducted with assessments at15–17 weeks (early pregnancy), 27–28 weeks (mid pregnancy), and 37–38 weeks of gestation (late pregnancy), and at 10 days and at 3 and 8 months following birth. Self-report data about daily hassles, pregnancy-specific anxiety and perceived stress, salivary cortisol levels and Adrenocorticotropic hormone (ACTH) levels were collected in nulliparous women throughout pregnancy. Infant development was measured at 3 and 8 months by means of the BSID. At 24 weeks of gestation, 30 ml of venous antecubital blood was collected for assessment of adrenocorticotropic hormone (ACTH) in a subsample of subjects ($n = 43$). The examinations were performed by a psychologist who was blinded to the data on stress during pregnancy. Strong fear of giving birth in mid pregnancy was associated with lower MDI and PDI scores at 8 months ($F = 5.58$, $p < 0.05$ and $F = 7.67$, $p < 0.01$, respectively). High cortisol was related to lower MDI scores at 3 months of age ($F = 6.38$, $p < 0.05$) and lower PDI scores at both 3 and 8 months of age ($F = 9.15$, $p < 0.005$; and $F = 9.38$, $p < 0.005$) (Huizink et al., 2002).

A randomized home based nursing intervention trial was conducted with 157 newborn infants (follow up at 3 months (n=118), 6 months (n=124) and 12 months (n=77). The purpose of this study was to explore an association between a maternal polydrugs (e.g. cocaine and opiate) exposed population and a non-exposed population during gestational period and an infant gross motor milestone attainment. Percentage of age (months) of motor milestones achievement was measured at 12 months to compare the populations exposed and not exposed to a polydrugs .There was a negative association between maternal exposure to polydrugs during gestational period and the age at which infants attained rolling both prone to supine and supine to prone ($P<0.001$) and walking ($P<0.05$) (Harolyn et al., 1999).

A longitudinal study was conducted to explore the prenatal polydrugs exposure and infants' motor development. The participants were recruited from three different hospital at Brigham, Women’s' and Beth, Israel and Boston, USA .The study sample consisted of maternal exposed (n=28) of polydrugs (e.g., opiates, cocaine, alcohol, tobacco and marijuana) during pregnancy and compared to unexposed group (n=22).The motor milestone was measured by the AIMS, the Movement Assessment of Infants (MAI) and the PDMS. The AIMS score was measured at 1, 4, 7 and 15 months for assessing prone, supine, sitting and standing. The result showed that the AIMS were lower than un-exposed group. The prone and standing sub score of AIMS were significantly different at 7 months between two groups ($p<0.01$). Over all, the sub score of the AIMS in prone, sitting and standing at each age were lower in exposed group than unexposed group ($p<0.01$).The prone scale showed that four out of twenty one items were significantly different at 7 months ($p=0.05$) (Fetter et al., 1998).

A 12 month double-blinded randomized controlled trial was conducted in Oxford, UK to show the efficacy of 200 μg Thyrotropin-releasing hormone (TRH) in combination with glucocorticoids in order to preventing from the neonatal lung disease. Results were collected using a questionnaire. 1,042 infants participated (hormone infants=531, control infants=511) in the survey. In the study, the motor milestone scores were measured by the mean age of attainment. Seven gross motor milestones (sit to walk) were measured by mean of the gross motor milestones to define the motor delay and infants whose mothers received TRH treatment had an increased risk of delayed motor milestones compared to those who did not received TRH(OR, 1.51, $p=0.004$) (Crowther et al., 1997).

A longitudinal cohort study of the effects of prenatal moderate alcohol and marijuana (or tobacco) use was conducted with 829 women (Average age = 23 y). A total of 763 infants participated in the cohort study (At Phase IV: 737 of the 763 infants were eligible for assessment but 719 of the 763 infants were eligible at Phase V). The study measured the infants' mental and motor development using the BSID-I. In terms of alcohol effects, controlled for first trimester marijuana and tobacco use. The marijuana was controlled for first trimester alcohol and tobacco use, and the tobacco was controlled for first trimester alcohol and marijuana use. The Phase IV MDI and PDI analyses also included control for age of the child at examination, current maternal work/school status, current infant weight, and gender. The Phase V MDI was controlled for the number of toys in the household, age at examination, gender, and race. Children of women who smoked (1>=packs per day throughout pregnancy) had an adjusted mean MD1 score of 104.5 at Phase V compared with an adjusted mean of 110 for the offspring of nonsmokers ($p = 0.03$).The results showed that third trimester marijuana use is related to lower MDI scores at 8 months old (Richardson et al., 1995).

3) No Association with Motor Milestone Development

A study was conducted to explore the association between maternal (n=351) exposure to latent toxoplasmosis during pregnancy and postnatal motor development from birth to 18 months old. There was no associated between latent toxoplasmosis and the age of sitting and walking (Kankovaet al., 2012).

A cohort study was conducted in Canada explored the association between prenatal exposure to organic solvents and motor development using the BSID-II in two groups : 48 children between ages 18 months and 2 years and 11 months (toddler group) and 32 children between ages 3 years and 8years 11months (child group). There were no significant differences in PDI scores in the age of attainment for selected motor milestones (sit, crawl, stand and walk) regardless exposure of organic solvents regardless any age groups (Laslo-Barker et al., 2012)

A cohort study in London was conducted to explore the effect of infant's polydrugs exposure on their motor milestone attainment. The targeted subjects were mother used recreational drugs (e.g., MDMA (3, 4-methylenedioxymethamphetamine) or Ecstasy, Tabasco, Cannabis, Alcohol and Cocaine) during pregnancy. The study was conducted with infants with MDMA exposed (n=28) and non-MDMA exposed infants (n=68). The gross motor milestone was measured with the AIMS, the BSID-I and Motor quality score at first and four months. In the first month, there was no significant different between groups. At 4 months, MDMA exposed infants showed no difference in the Bayley score compared to non-exposed infants (Singer et al., 2012)

A longitudinal study in USA was conducted to explore the effect of prenatal exposure of MA (Methamphetamine) on gross motor milestone development at 1 to 3 years. The recruited sample included MA exposed infants and mothers (n=179) and non-MA used during pregnancy (n=177). The data was collected by visiting when the child was 1, 12, 24, 30 and 36 months of age. The motor and cognitive development was measured with the BSID-II or the PDMS-II at 1 and 3 year of study visit. The results showed that there was no significant different in fine or gross motor score between two groups at 1 and 3 years. There was no difference in motor scores that measured by the PDMS and the BSID-II between MA exposed and control group at any age (Smith et al., 2011).

A Danish National cohort study was conducted to determine the association between maternal cell phone use during pregnancy and infant motor development. The gross motor milestone development was assessed by phone interview around 100,000 mothers when their infants turned between 6 and 18 months. In the 6 months, the motor development was assessed by a series of six questionnaires (e.g., hold up head, sit with back straight, roll from back to front, sit up right on the floor, grab objects out of reach and crawl on stomach). In the period, if infants had motor score between 0 and 6, it classified as delayed development. In 18 months interview, five questionnaires contained motor delay. Two questions assessed age of sit or walk without support. If infants can sit alone more than 9 months or can walk alone more than 16 months, that infants can be classified as delayed development (0-5 points, yes or no). Therefore there was no associated with parental cell phone use and infant motor milestone development (Divan et al., 2011).

A large population based study in Bangladesh was conducted with 1,799 infants who had mothers exposed to high arsenic contaminated drinking water during pregnancy. It assessed the cognitive and motor development of those infants at 7 months using the BSID-II: Psychomotor Development Index (PDI) and the Mental Development Index (MDI). The results demonstrated no association between maternal arsenic exposure during pregnancy and the infant development score when adjusting activity, emotion and sex (Tofail et al., 2009).

A longitudinal study was conducted to examine the effects of prenatal and prenatal mental health or medical condition, and assisted reproduction treatment (ART) on infants developmental and health status at 12 months. 520 Finnish mothers completed questionnaires during 2nd trimester (T1), and then again at 2 months (T2) and 12 months (T3). An infant's motor (e.g. yes or no for standing to walking with or without support) and was measured at with a mean score of achievement (i.e., sum of passed score). The results showed that maternal depression and prenatal anxiety as well as ART affected neonatal health, but it did not affect a child's development and health at 12 months old (Punamaki et al., 2006).

A cohort study was conducted in USA with children between 1month-5 year and 6-12 year who were with or without CAH and Congenital adrenal hyperplasia among DEX exposure stauts.174 prenatally DEX-exposed children (including 48 with CAH, 126 without CAH) and 313 unexposed children (including 195 with CAH, 118 without CAH). The children motor development was measured by the Kent Infant Development Scale (KIDS). The KIDS were designed with 252 item questionnaires for the age group 0-15months and age-based normalized standard score for five developmental subscales and a composite. The Revised Pre-screening Developmental Questionnaire (RPDQ or Revised Denver: four age specific form with 105 items) was used for birth to 6 year. Age-Based delay score were classified with three groups (no delay, one delay, more than two delays). The study compared between DEX-unexposed (Non-DEX) and DEX-exposed (DEX) with or without CAH (age group, 0–15 months). The result showed that there was no significant different in motor development between prenatally DEX-exposed children and unexposed group (Meyer-Bahlburg et al., 2004).

A randomized home-based nursing-intervention trial was conducted with 157 newborn infants (follow up at 3 months (n=118), 6months (n=124) and 12 months (n=77)to find an association between maternal polydrugs (e.g. cocaine and opiate) exposure during gestational period and an infant's gross motor milestone attainment at a certain age. The mean of age (months) of achievement of motor milestones was measured at 12 months to compare polydrugs exposed and non-drug exposed groups. The type of drug exposure reported by mothers' self -report and after toxicology screens, they classified into three groups: cocaine only, opiates only (heroin and/or methadone exposure), and cocaine plus opiates exposure. There was no association between maternal polydrugs exposure during pregnancy and the age at which children could sit independently, crawl and cruise (Harolyn et al., 1999).

A longitudinal study examined the effects of prenatal exposure to moderate alcohol and marijuana (or tobacco) on an infant's mental and motor development using the BSID-I. The results showed no difference between groups. Thus, maternal prenatal alcohol, marijuana and tobacco exposure did not have any association with the MDI northe PDI score at 8 months and 18 months. The result of regression analysis showed that prenatal alcohol and tobacco use during pregnancy was not associated with MDI and PDI scores at 8 months old. Prenatal alcohol, marijuana and tobacco use didn't affect MDI or PDI score at 18 months (Richardson et al., 1995).

7. Children's Environmental Factors

Several environmental factors such as space for physical activity, caregivers' ratio and interaction between caregivers and children in daycare center can influence child's motor milestone development. For example, the age at which children enroll in day care center (Iwata et al., 1991, Mulligan et al., 1998, Yalcin et al., 2012) can affect a child's development (Iwata et al., 1991, Mulligan et al., 1998) and age of specific gross motor milestone attainment. Using a walker (Garrett et al.2002, Siegel et al., 1999) to help children walk independently is not always effective due to chance of injury. Some longitudinal observation study showed that parent's motivation to move toward their children (Einyet al., 2013) and their level of education could affect the age of motor milestone attainment.

Table 8 Association between Children's Motor Milestone Development and Environmental Factors (e.g., daycare center, intervention between caregiver and infant and walker used), Home activity, Exercise intervention

Reference	Positive Association	Negative Association	No Association
Osnat et al., 2013	✓		
Yalcin et al., 2012	✓		✓
Miquelote et al., 2012	✓		
Doralp et al., 2010	✓		✓
Karasilk et al., 2008	✓		
Pridham et al., 2002	✓	✓	
Garrett et al., 2002		✓	✓
Siegel et al., 1999		✓	
Mulligan et al., 1998	✓		✓
Iwata et al., 1991	✓	✓	
Porter et al., 1972	✓		

1) Positive Associations with Motor Milestone Development

A longitudinal observation study in USA was conducted with 27 infants (17 males, 10 females) ages 7 to 12 months to explore the relation between motor development and motivation to move. The onset of four motor milestones (e.g., sitting, pulling to stand, crawling and cruising) and infant's overall motor development were measured using the AIMS. Thirteen gross motor milestones from rolling to cruising were observed based on the WHO 2006 guideline. The results demonstrated that those infants with mothers encourage moving achieve four motor milestones in their earlier age than those with little to no motivation to move. Over all, higher the AIMS score was correlated with a higher motivation to move. Infants with early and late in development that were based on upper or lower 25th percentile of AIMS respectively, and these were regrouped to evaluated inter individual difference. AIMS score between early crawler (i.e. defined as below the median, n=12) and later crawler (i.e., defined as above the median, n=12) showed that there was significant difference in motivation to move scores between early and late crawlers. Early crawler infants had higher motivation scores than those with late crawlers (Osnat et al., 2013).

A cross sectional study in Turkey was conducted with healthy 12-23 months old children (n=1,553) to find out the effect of some demographic, social and infant characteristics, such as infant's physical growth and presence of anemia. It was included family characteristic related to the age at walking without support. The age of walking alone was measured by the mean of age attainment. Children whose mothers had a greater number of years of schooling (>8yr) and absence of parental consanguinity achieved walking at earlier age than those with mother less education level (<8yrs) and parental consanguinity present (Yalcin et al., 2012).

A longitudinal study was conducted in Brazil with 32 infant's age 6 months or 9 months to explore the association between home environment and infants' motor development. The gross motor milestone development was measured by the Bayley Scales of Infant and Toddler Development (Bayley-III). The results showed that there were significant positive correlations between the dimensions of the home (daily activities and play materials) and motor development (Miquelote et al., 2012)

A cross sectional study was conducted in Canada with full-term infants between the ages of 4 and 10 months of age were recruited from the Ontario Early Years Centers (n=189, boys (n=102), girls (n=87) to investigate whether the Daily Activities of Infants Scale (DAIS), Environmental Opportunities Questionnaire (EOQ) and The Infant Characteristics Questionnaire (ICQ) related to infants' motor development. The motor development was measured by using the Alberta Infant Motor Scale. The result showed that the Opportunities in the Play space (B = 0.49) was related to the infants' motor developmental scores.

Therefore, physical space of the play environment was positively associated with the infants' motor development (Doralp et al., 2010).

A cross sectional was conducted with mothers who have 12 month or 18 month old infants (n=28) to explore infants' crawl and walk ability under conditions of potential physical risk in a laboratory motor task. Mothers encouraged or discouraged (i.e., emotional, verbal and gestural communication) infants to crawl or walk down on a sloping walkway. The gross motor milestones (e.g., crawling and walking) were measured by the mean age of month achievement. The results showed that maternal encouragement was positively associated with gross motor milestones achievement (Karasilk et al 2008).

A cross sectional study was conducted in USA with full term (n=52) and preterm (n=47) infants to determine the association between caregivers' behavior and infants' growth and motor development. The motor development was examined at 12 months using the BSID-I. The quality of infant affect and behavior during feeding was examined using the Parent–Child Early Relational Assessment. The quality of each mother's feeding behavior was assessed with the 16-item PCERA scale, Mother's Positive Affect and Behavior (MPAB), and the Mother's Regulation of Negative Affect and Behavior (MRNAB) were examined. Infants' caloric intake and protein intake were assessed with a 4-day food record kept by the mother. The results showed that the BSID-1 score was smaller in preterm infants than full term infants (n=52) and the standard deviation of BSID-1 was relatively larger in preterm infants. Full term infants seemed not to be affected by mothers' feeding behavior along with the calorie intake. However, the motor development was positively associated with mothers' responsiveness in full term infants (Pridham et al., 2002).

Another longitudinal observational study was conducted in healthy children (n=48) who were enrolled child care center to explore the effect of physical activity and environmental factors (e.g. caregiver ratio, level of interaction, use of seat, swing and walkers and frequency of using gross motor room) on infant motor development, activity level and body composition. Motor development was measured at 6, 9 and 12 months of age by using the BSID-I. Infant's activity rating scales was used to measure the children's activity level and intensity of physical activity. The result showed that higher caregiver ratio level and lower level of interaction was positively associated with motor development, activity level and body composition at age of 6 months old. The PDI level was increased if infants had lower interaction level at 12 months. Infants' physical growth was affected environmental condition such as space or chance to access gross motor room at 12 months. Particularly, when infants were exposure to little space and lower chance to access gross motor room it was related to overweight due to increasing in body fat composition. The gross motor development was associated with activity levels and body composition at 6 and 12 months. Higher frequency of using the gross motor room and having access to enough space could decrease body fat composition. Consequently it could increase the motor development at 6 and 12 months (Mulligan et al., 1998).

A cross sectional study in Tokyo and Chiba was conducted with children (n=395) who were at day care centers from 11 months to 3 years old. The purpose of study was to explore the association the age of begin to walk with following factors: birth weight, order of birth, frequency of being carried on the chest, season of birth, use of a walker, age of the first enrollment at a day-care center. The age of walking alone was measured with distribution of age in months at which the subjects started walking. The children (63%) started walking between 8-11months (W0 group), if they were born in winter, walker used and children who enrolled at a day care centers after 12months of their age(Iwata et al., 1991).

A longitudinal case control study was conducted with 94 normal healthy full term infants' age between 4 and 40 weeks in Philippines to explore the association between exercise and motor development. Infants were randomly assigned into control and exercise groups and each group had Forty-seven infants (female 23, males 24). Participants in the exercise group did upper and lower limbs exercise for 5 minutes each morning and afternoon with 5 minutes rest time for 6 days per week. This intervention study was held for 2 months in a supine position in a flat surface. Motor development was assessed with the motor development quotient score in pretest, mid-test and posttest. The results showed that the mean of motor development quotient in control and experimental group in pretest were 92.89 (130.93-58.57) and 94.40 (160-66.67) respectively. There was significant difference between two group (14.53, p=0.0046) in the mid-test. The motor development quotient in control and experimental groups was 1.40 and 15.55. Similarly, in the posttest, the motor development quotients in two groups were 12.01 and 29.03 respectively. There was significant difference between two groups (17.02, p=0.0001). Therefore exercise was positively associated with infants' motor development (Porter et al., 1972).

1) Negative Association with Motor Milestone Development

A cross sectional study was conducted in USA with full term (n=52) and preterm (n=47) infants to determine the association between caregivers' behavior and infants' growth and motor development. The motor development was examined at 12 months using the Bayley Psychomotor Scale of Infant Development (BSID-I).The quality of infant affect and behavior during feeding was examined using the Parent–Child Early Relational Assessment. The quality of each mother's feeding behavior was assessed with the 16-item PCERA scale, Mother's Positive Affect and Behavior (MPAB), and the Mother's Regulation of Negative Affect and Behavior (MRNAB) were examined. Infants' caloric intake and protein intake were assessed with a 4-day food record kept by the mother. However, in preterm infants, there was negatively associated between infants' calorie intake and maternal education level as well as mothers' feeding behavior. Therefore, mothers negative affect and behavior indirectly contributed negatively impact on infants' growth (weight for age Score) and motor development. Preterm infants' motor development can be directly affected by illness acuity, maternal responsiveness, and caloric intake (Pridham et al., 2002)

Another cross sectional study was conducted to compare the mean age of motor milestones attainment between baby walker users (n=102) and non-users (n=88). It was targeting healthy term infants from 26-54weeks who attend daycare centers registered with the Foyle Health and Society Services Trust. Parents recorded the mean age of their children to achieve a specific motor milestone. The result showed significant differences in the age of attaining roll over ($p<0.0001$), crawling ($p<0.0001$), standing ($p<0.0001$) and walking alone ($p=0.0002$) between two groups: walker users and non-walker users. The mean age of attainment was significantly earlier among baby walker users compared to non-users for rolling over (-2.9days), crawling (-3.9days), standalone (-3.3days) and walk alone (-3.0days group) (Garrett et al., 2002).

A retrospective cohort longitudinal study was conducted to compare the effect of motor and mental development between infants (n=109) ages of 6, 9 and 12 months with or without walker experience. The motor and mental development was measured by the BSID-I. The result showed that infants who used walkers, had a lower PDI score and delayed sitting ($p=0.001$), crawling ($p=0.03$) and walking ($p=0.02$)compared to those non-walker used group(Siegel et al., 1999).

A cross sectional study in Tokyo and Chiba was conducted with children (n=395at day care centers from 11 months to 3 years old) to explore the association of the age of begin to walk with other factors: birth weight, order of birth, frequency of being carried on the chest, season of birth, use of a walker, age of the first enrollment at a day-care center. The age of begin to walk alone was measured with distribution of age in months at which the subjects started walking. The result showed that only 60% of children started walking at the age between 12- 17months, if they were third or the fourth born child, born in summer, enrollment at a day-care center (before 6 months of age), walker not used, and higher frequency of being carried piggyback (Iwata et al., 1991).

2) No association with Motor Milestone Development

A cross sectional study in Turkey was conducted with healthy 12-23 months old children (n=1,553)to find out the effect of some demographic, social and infant characteristics, such as infant's physical growth presence of anemia including family characteristic related to the age at walking without support. The age of walking alone was measured by the mean of age attainment. There was no significant different regarding to maternal age, paternal occupation, family type presence of social security of family, number of household members or presence of any sibling <5yr.Order of Birth and birth interval was not associated with walking age(Yalcin et al., 2012).

A cross sectional study was conducted in Canada with full-term infants between the ages of 4 and 10 months of age were recruited from the Ontario Early Years Centers (n=189, boys (n=102), girls (n=87)to investigate whether the Daily Activities of Infants Scale (DAIS), Environmental Opportunities Questionnaire (EOQ) and The Infant Characteristics Questionnaire (ICQ) related to infants' motor development. The four motor milestones (prone, supine, sitting and standing) were measured by using the AIMS. Four subscale scores and a total score are calculated, which are converted to a percentile rank according to the infant's age. The AIMS showed that an average percentile rank was 39.29%, which is below average. The weighted scores for the DAIS had an average score of 128.7 with a range of 69 to 219. Therefore there was no significant difference found in the infants' daily activity and the infants' motor development (Doralp et al., 2010).

Across sectional study in Netherlands was conducted to compare the age of motor milestones attainment between baby walker users (n=102) and non-users (n=88).
It was targeting healthy term infants from 26-54weeks who attend day care center. Parents recorded the mean age of their children to achieve a specific motor milestone. There was no significant difference in the mean age of attainment for raises head, sitting with or without support, standing holding on and walking holding on regardless walker used (Garrett et al., 2002).

A longitudinal observational study was carried with healthy children (n=48) who were enrolled child care center to explore the effect of physical activity and environmental factors (e.g. caregiver ratio, level of interaction, use of seat, swing and walkers and frequency of using gross motor room) on children motor development, activity level and body composition. Motor development was measured at 6, 9 and 12 months of age by using the BSID-I. Children's activity rating scales was used to measure the children's activity level and intensity of physical activity. At 6months PDI (Psychomotor Development Index) score was not associated with other day care centers and motor activity. It was also not significant different with other centers at 9 months and 12months. The use of seats swings and walkers were not associated with motor development, activity level or body composition at any age (Mulligan et al., 1998).

8. Sleep Position (prone, supine) or Awake time

Many studies have showed that infants who sleep prone position could achieve several motor milestones earlier than those supine sleepers. (Fetters et al, 2007, Baschat et al., 2009, Bartlett et al., 2008, Einy et al., 2013). For instance 6 month old term infants who had non-prone sleeping positions were reported to have lower motor development scores when compared with those with prone sleeping position (Fetters et al., 2007, Bartlett et al., 2008). These reports demonstrated that prone sleeping position was positively associated with motor milestone achievement such as head control, rolling, tripod sitting, creeping, crawling, and pulling to stand. Additionally prone sleeping infants could achieve significantly higher gross motor score on the Denver Developmental Screening Test than supine sleeping infants (Fetters et al., 2007). Some longitudinal studies of pregnancy and childhood also showed that infant who were prone sleeper at age between 6 and 18 months of age had higher scores in gross motor, social skills and overall development at 6 months but not at 18 months. (Fetters et al, 2007, Bartlett et al, 2008).

Table 9 Association between Children's Motor Milestone Development andChildren's Sleeping and Awake Position Compared between pronepositions vs. supine or mixed position)

References	Positive Association	Negative Association	No Association
Lewycky et al., 2009			✓
Ohman et al., 2009	✓		
Davis et al., 2008	✓		✓
Fetters et al., 2007	✓	✓	
Salls, et al., 2002	✓		✓
Jantz et al., 1997	✓		✓
Iwata et al., 1991			✓

1) Positive Association with motor milestone development

A longitudinal study was conducted in Sweden with infants aged 2 to 10 months to explore infants (n= 82, 35 females and 47 males) with CMT (Congenital Muscular Torticollis) effect on motor milestone development compared to normal healthy infants (n=40: 18

females, 22 males) and also the study was to investigate association of motor development with the time spent in prone position and plagiocephaly. The motor milestone development was measured by the AIMS. It assessed every four months (e.g., 2, 6,10 months).The CMT infants showed significantly lower the percentile rank of motor development (i.e., AIMS) at 2 months ($p=0.02$) and 6 months ($p<0.004$) compared to control group. The result showed that infants who spent more time daily prone (more than three times)position when awake, had significantly higher the AIMS score than those who spent less time prone at 2 months ($p=0.0001$), 6months ($p<0.001$) and 10 months ($p<0.001$) of age (Ohman et al., 2009).

A cohort study in USA was conducted to compare the difference in age of attainment of motor milestones between prone and supine sleeping infants (n=276). The study was conducted with infant's age 2 to 15 months. The motor milestones were measured by the mean age of each motor milestone attainment. The result showed that there was a significant difference ($p =0.05$) between prone and supine sleeping infants in the age of 8 months for attaining the motor milestones (rolling prone to supine, tripod sitting, creeping, crawling, and pulling to stand). Generally, prone sleeper infants could achieve motor milestones at an earlier age than those supine sleepers. Mixed or side sleepers also achieved most motor milestones in an earlier age than supine sleepers. The longer playtime with prone position was positive associated with earlier attainment of the following milestones: tripod sitting, sitting alone, crawling, and pulling to stand ($p =0.05$). However, when adjusting for maternal education, race, gender, birth weight, and number of older siblings, there was a significant difference only for the "pull to stand" milestone ($p=0.01$) (Davis et al., 2008).

Another longitudinal study that was conducted among infants who were recruited from the nurseries at Brigham and Women's, and Beth-Israel Hospitals in Boston, MA, USA also explored the association between sleeping position and children's gross motor attainment. The study participants were 68 infants who included 30 preterm infants born at very low birth weight (VLBW) with white matter disease (PTWMD); 21 preterm infants born VLBW without WMD (PT); and 17 term infants (Term). The gross motor performance was measured by the Alberta Infant Motor Scale pass or fail score of 58 items The result showed that infants who preferred sleeping or playing position with prone tends to have higher the AIMS scores at all ages (1, 5 and 9months). Particularly, prone sleepers were positively associated with motor development at 1 and 5 months regardless groups. At 9 months, prone sleeping infants in PT group had higher the AIMS score compared to PTWND group. The sleeping and playing prone position was positively associated with the AIMS score at 5 months in term infants compared to PTWND (Fetters et al., 2007).

A third longitudinal study was conducted in the USA among infants who were 2.0 (n = 23), 4.1 (n = 26), and 6.0 (n = 17) months of age to explore association with gross motor development related to sleep position (supine and side) and awake time in prone position. Motor development was measured using the Denver II Gross Motor Sector (pass and fail distribution scores). Each gross motor milestone within sampled population (number of supine and side sleeping infant) compared to normative population (i.e., average ages at 25%, 50%, 75%, and 90% of infants passed a given milestone). Regarding awake-time (< 15 min or > 15 min) in prone categories, there was significant difference between normative and sampled population. At 2 month old, infants who spent greater than 15 min. of awake-time in prone infants showed similar pass-fail distribution as the normative population regarding three gross motor milestones(Head up 45º or 90º and sit–head steady) achievements. However, those infants who spent less than 15min., of awake-time in prone at 2 months of age, 44% of infants passed head up 45º and 13% passed head up 90º by and 19% for sit–head steady compared to the normative population. Therefore, head up 45º and 90º and sit–head steady could achieve by 75%, 50%, and 50%, respectively in that category group compared to normative population. Thus, two-month-old infants spending less than 15 min., of awake-time in prone passed the gross motor milestones at significantly lower percentages than the normative population (Salls et al., 2002).

Jantz et al (A study was conducted with infant (n=343 full term infants) at 4 or 6 months of age to evaluate association with sleeping position and gross or fine motor milestones development. At 4months of age, following motor milestones (e.g., rolling over, pulling to sit without head lag, grasping a rattle and reaching for object) were measured. At 6 month, passing a toy from hand to hand, sitting upright and taking 1 cube in each hand were evaluated. The gross and fine motor milestones were measured by The Denver Developmental Screening Revised Test (% of pass or fail score). The result showed that there was significant difference found between the infants who had supine and prone position ($p<0.01$). Infant who slept in the prone position more likely to roll over at the 4 months compared to those with side or supine sleeping position (Jantz et al., 1997).

2) Negative Association with motor milestone development

A longitudinal study was conducted to explore the association with sleeping position and children gross motor attainment. The participants in this study were 68 infants (30 preterm infants born very-low birth weight (VLBW) with preterm with white matter disease (PTWMD), 21 preterm infants born VLBW without WMD (PT) and 17 term infants (Term). The gross motor performance was measured by the AIMS. Among prone position of sleeping and playing group, there were significantly lower the AIMS scores reported with preterm infant with WMD than term infants at 5months (p=0.005) (Fetters et al., 2007).

3) No association with Motor Milestone Development

A longitudinal study was conducted in Canada with healthy infants between 2-3 months (n=102, female =47, males=53) who did not achieve rolling over until they reach 6 months in order to measure the awake time in the prone position and age of first rolling (e.g., supine to prone, prone to supine) was the mainly focused in the study. The study randomly assigned into two groups: control (n=61)and experimental group (n=41). The gross motor milestone (i.e., roll over) was measured by the mean age of month achieved (by parents' report or observation date).The results showed that experimental group was reported 22 minutes of awake time in the prone position per day. However, control group was reported to be 11minutes. Additionally, prior to first roll, all parents participated in online questionnaire after enrolled in the study for eight week. Daily experience (e.g., sleep position, awake time in the prone position, breastfeeding etc.) and time spending in order to checking parents got proper instruction of prone awake time to their infants. There was no significant different between awake prone position and the age of rollover (Lewycky et al., 2009)

A prospective practice base longitudinal study conducted to compare the difference in age of attainment of motor milestones between prone and supine sleeping infants (n=276) with age of 2 months infants up to 15 months. The motor milestones were measured by the mean age of each motor milestone attainment. There was no significant association with the age at which the infants sitting without supported and walked alone and infant sleeping position (e.g., prone or supine) (Davis et al., 2008).

A longitudinal pilot study was conducted with infants (n= 66 infants 2.0 (*n* = 23), 4.1 (*n* = 26), and 6.0 (*n* = 17) months) to explore association with gross motor development related to sleep position (supine and side)and awake –time in prone. Age of months gross motor milestone attainment was measured by using the Denver II Gross Motor Sector (pass and fail distribution scores). Each gross motor milestone within sampled population (number of supine and side sleeping infant) compared to normative population (average ages at 25%, 50%, 75%, and 90% of infants passed a given milestone). There was no significant difference between supine and side sleeping position regarding pass or fail distribution on the gross motor milestones (head up 45 degree, head up 90 degree, sit head steady, chest up arm support, roll over, pull to sit-no head lag, sit no support). There was no significant difference found in those infants at 4.1 and 6 months of age related to awake-time (< 15 min or > 15 min) in prone position with gross motor milestone attainment (Salls, et al., 2002).

Jantz et al (1997) evaluated if supine sleeping position was associated with gross or fine motor milestones development at 4 and 6 months of age in a longitudinal study of 343 full term infants. The gross and fine motor milestones were measured by The Denver Developmental Screening Revised Test (% of pass or fail score). There was no difference in the attainment of motor milestones such as pulling to sit without head lag, grasping a rattle and reaching for objects related to sleeping position(Jantz et al., 1997).

A cross sectional study in Tokyo and Chiba was conducted with children (n=395: at day care centers from 11 months to 3 years old) to explore the association with age of walking alone and sleeping position. The gross motor milestone achievement was measured with distribution of age in months at which the subjects started walking. For sleep position: most of babies who were in daily care centers slept on their back (78.5%) and others slept on their stomach (15.9%). There was no significant association with age of start walking and sleeping position (Iwata et al., 1991).

9. Related Other Motor Milestones

Some studies attempted to explore how the age of children attainment for crawling, sitting alone and standing alone effected on the age of the first start walking. These demonstrated the correlations between the age of each milestone and age of achieving later gross motor milestone (Kimura-Ohba et al, 2011, Jaffe et al, 1996, Bottos et al, 1989). Kimura-Ohba et al., study also evaluated the age at which milestones were attained and distribution of motor milestone passed score and body position as well as motor milestone deviation.

Table 10 Association between Children's Age of Walking and Children's Other Motor Milestone Attainment

References	Positive Association	Negative Association	No Association
Kimura-Ohba et al., 2011	✓	✓	
Jaffe et al., 1996	✓		
Bottos, et al., 1989	✓		
Touwen et al., 1971	✓		

1) Positive with Motor Milestone Development

A longitudinal cohort Japan observed study, (n=290 healthy term infants born in a district of Osaka City age at 4-9months) was conducted to determine if gross motor milestone attainment is related to the age of walking. The infants 'age of walking was reported by their parents at 18 and 27 months. The gross motor milestones (rolling over, crawling and sitting) were measured by % of capability of rolling at 4 month, crawling and sitting at 9 months. The mean of age of walking achievement related to % of those three gross motor milestone attainments was measured. The median age of walking alone was 12months (range 7~21months).The result showed that children who could roll over at 4 months, and sit and crawl 9months were able to walk earlier than those could not achieve those three gross motor milestones (Kimura-Ohba et al., 2011).

A prospective cohort longitudinal study in Israel was conducted to explore the relationship between parachute response and the mean age of independent walking. There were three hundred sixty infants were participated in the study. To assess the mean age of appearance of the parachute reaction (e.g., lower and upper parachute reactions), infants were divided into three groups based on the age of sitting and walking such as, (NSNW: Normal sitters-normal walker, n=182), (LSNW: Late sitter- normal walker, n=115) and (LSLW: Late sitters-late walkers, n=63). The gross motor milestone was measured by the Denver Developmental Screening Test (DDST). The results showed there was close correlation between the mean age of parachute reaction and the mean age of sitting alone and walking alone. Therefore, when children achieved sitting alone at an earlier age, they achieved walking alone and parachute reaction. It means parachute reaction would be good indicator of predicting the mean age of walking alone in infants (Jaffe et al., 1996).

A longitudinal case control study was conducted in Italy to explore the age of walking related to five different locomotors pattern (e.g., crawlers on hands and knees, early crawlers, late crawlers, stomach creepers and shufflers). The participants who were less than 16 months divided into two groups such as, index group and control group. The index group (n=270) was recruited from the neonatal unit and control group (n=154) from nursery. There was significantly different between age at independent walking and locomotors patterns. 37 percent of index group and 35 percent of control group were early walkers which can walk alone less than 10 months age. Early walkers resulted from infants who could creep or shuffle in the beginning of the study (Bottos et al., 1989).

A longitudinal study in Dutch was conducted with infants (n=50: 27 boys and 23 girls) from birth until they walk independently in order to demonstrate the relationship between prone (creeping, crawling and sitting) and walking without support. The gross motor milestone was measured by the mean age of achievement. There were five crawling behaviors were assessed: (1) wriggling or pivoting movements without efficient use of the arms and legs; (2) crawling with help of the arms only; (3) crawling with help of the arms and legs; (4) creeping on all fours with frequent return to abdominal creeping; (5) consistently creeping on all fours. The results showed that there was close relationship between prone (i.e., crawling) and walking independent. Thus, when infants achieved crawling at an earlier age, they could start to walk earlier. The sitting up without support and the age of walking alone was statistically significant. Therefore, children who could sit at an earlier age could walk faster than other. But there was no association between abdominal creeping and walking without support. There was no relationship between time of onset of the development of grasping and the age of walking without support (Touwen et al., 1971)

2) Negative association with motor milestone development

A study was conducted to determine the relation toother gross motor milestones attainment and age of walking. It was targeted for 290 healthy and term infants in Osaka, Japan and observed three gross motor milestones at 4 and 9 months. The age of walking was reported by their parents at 18 and 27 months. The gross motor milestones (rolling over, crawling and sitting) were measured by % of capability of rolling at 4 month, crawling and sitting at 9 months. The mean of age achievement for those three gross motor milestones were also assessed. The age of walking could be delayed depends on the pattern of crawling at

9months compared to those with normal crawlers. For instance if children who were creeping or unable to move forward at 9 month, they could delay of walking for 1 month or 2 moths respectively compared to normal crawlers. Children who were not able to sit independently reported to delay the age of walking compared to children who could sit alone (Kimura-Ohba et al., 2011).

10. Children's Health Status

Some studies showed that children's gross motor milestone development can be affected by the children's health condition (e.g., clubfoot, IQ retardation, Congenital Muscular Torticollis and Down syndrome). Therefore, children with these kinds of health condition, infants may achieve certain gross motor milestone later age compared to normal healthy infants (Garcia et al, 2011, Ohman et al, 2009, Haley et al, 1986, Tenbrinck et al, 1974). However, if IQ retardation condition is not severe enough, it will not be associated with delaying infants' gross motor milestone development (Tenbrinck et al., 1974).

Table 11 Association between Children's Health Status and Motor Milestone Developments (Down syndrome, IQ, Clubfoot, CMT)

References	Positive Association	Negative Association	No Association
Garcia et al., 2011		✓	✓
Olney et al, 2007		✓	
Haley et al., 1986		✓	
Tenbrinck et al 1974		✓	✓

1) **Negatively associated with motor milestone development**

A longitudinal study was conducted in USA with fifty two babies (26 were treated for idiopathic clubfoot (12 with the Ponseti treatment method, 9 with the French physical therapy technique, and 5 with a combination of both methods) and 26 were healthy babies.

The gross motor rolling front to back, rolling back to front, sitting alone for 10 seconds, crawling, pulling to stand and walking alone was measured by the AIMS. The results showed that clubfoot condition was negatively associated with infants' gross motor milestones (e.g., crawling, pulling to stand, and walking), achievement at 9 and 12 months. Thus, the babies with clubfoot attained gross motor milestone significantly later than the control group. Additionally, twenty-one babies with clubfoot were not walking at or before 12 months, so they did not complete the study at that time and had an AIMS assessment at the 15-month period. Therefore, the level of clubfoot condition was related to not able to walking at 12 months or earlier (i.e., 81% of the clubfoot group 21 of 26) and it was significantly higher than control group babies (48%, P = 0.014). Constantly, twelve healthy infants only 48% (12 out of 25could not walk before 12 months). The mean age of parent-reported attainment of independent walking in the clubfoot group was 13.9 months, whereas in the control group it was 12.0 months (Garcia et al., 2011).

A community based, randomized double-blind trial with 771 children aged
5–19 months who received any daily iron supplements groups [iron+folic acid(FeFA; 125.mg +50ug), zinc(10mg), iron+folic acid+zinc (FeFA+Zn)] for 1 year was performed to determine percent of 14 gross motor milestones attainment and the highest motor milestones score was recorded by observation. Locomotion was compared the attained motor milestone among crawler and walker groups. The gross motor milestone development was measured by the percentage of achievement. The results showed that malaria infection was negatively associated with infants had lower Total Motor Activity (TMA) score after controlling other factors among crawler group. That was related to lower percentage of achieving walking alone in a certain age (Olney et al., 2007).

Another longitudinal study was conducted in USA with 40 full term (>37weeks) non-handicapped infants aged 2-10months (males 33, females 17) and compared with 20 infants with Down syndrome aged 2-24months (males 7, females 13). Ten infants comprised each 2 months by age group. (2-4, 4-6, 6-8, 8-10 months). They recruited from King County, Washington areas. (age groups: 2-7, 7-12, 12-18, 18-24). This study was conducted to explore the postural reaction and two gross motor milestones achievement (e.g., sitting and prone position). The gross motor milestone was measured by the BSID-I. The postural reaction was measured by the movement Assessment of Infants (MAI). The BSID-I consisted of three components such as the raw score from the motor scale (i.e., number of passed items), the Age Equivalent Index (i.e., age at raw score is considered a norm) and the Development Quotient. The results showed that the mean of Motor Milestone score was increased with age in the first three aged group among infants with DS but not in 8-10 months group. All the age group in non-handicapped group also linearly trend of the mean of Motor Milestone score. The Developmental Quotient was greater in non-handicapped infants than infants with DS. There was highly correlated with right and protective reaction and prone position among non-handicapped infants than infants with DS. Therefore, non-handicapped infants had higher level of postural reaction and motor milestone development compared to infants with DS (Haley et al., 1986).

A retrospective cohort study was conducted with 200 children from 1to 10 years old to explore the level of retardation (i.e., IQ) related to sit, stand and walk. Children were classified with level of IQ scores such as, not retarded (if IQ was between 78-100), mildly retarded (if IQ was between 52-68), moderated retarded (if IQ was between 36-51), severely retarded (if IQ was between 20-35), profoundly retarded (if IQ was below 19) and postnatal infections. The gross motor milestones (e.g., sit, stand alone, and walk) were measured by the mean of age month achieved and distribution. The result showed that standing was delayed if IQ level was at least moderately retarded. Walking also delayed in the moderately retarded (Tenbrinck et al., 1974).

2) No associations with motor milestone development

A longitudinal study was conducted in USA with fifty two babies (26 were treated for idiopathic clubfoot (12 with the Ponseti treatment method, 9 with the French physical therapy technique, and 5 with a combination of both methods) and 26 were healthy babies. The gross motor rolling front to back, rolling back to front, sitting alone for 10 seconds, crawling, pulling to stand and walking alone was measured by the AIMS. The results showed that there was no significant difference in the AIMS scores between clubfoot and control groups at 3and 6 months. When comparing babies who underwent Ponseti treatment to those who underwent French treatment, there were no significant differences at any age tested. There were no significant differences in attainment of rolling in either direction and sitting alone (Garcia et al., 2011).

A retrospective cohort study was conducted with 200 children from 1to 10 years old to explore the level of retardation (i.e., IQ) related to sit, stand and walk. Children were classified with level of IQ scores such as, not retarded (if IQ was between 78-100), mildly retarded (if IQ was between 52-68), moderated retarded (if IQ was between 36-51), severely retarded (if IQ was between 20-35), profoundly retarded (if IQ was below 19) and postnatal infections. The gross motor milestones (e.g., sit, stand alone, and walk) were measured by the mean of age month achieved and distribution. The result showed that sitting was not delayed if the IQ level was not severe condition (Tenbrinck et al., 1974).

11. Other Factors

Demographic and Health surveys in low and middle income countries demonstrated that higher prevalence of stunting rate was related to poverty level (Stanitski et al., 2000). Many other studies supported those children in the lower income countries correlated to significantly lower consumption of protein source foods such as meat, fish, poultry and egg compared to those from wealthy developed countries. This revealed that poverty level will be an important factor that can influence food capability, accessibility as well as food security. Consequently that is affected to children's growth as well as gross motor milestone development. Socioeconomic status (Stanitski et al., 2000) was measured by an occupation, education and household condition (Yacin et al. 2012)

Table 12 Association between Children's Motor Milestone Developments with Other Factors (socioeconomic factor, parental' educational level, birth length, season of birth, gender)

References	Positive Association	Negative Association	No Association
Restiffe et al.,2012			✓
Yalcin et al., 2012	✓		✓
Kimura-Ohba et al., 2011			✓
Ohman et al., 2009			✓
Oken et al., 2008	✓		✓
Kuklina et al, 2004			✓
Stanitski et al., 2000	✓	✓	
Iwata et al., 1991		✓	✓
Bottos, et al., 1989			✓
Capute et al., 1985	✓		
Palisano et al., 1985	✓		✓
Grantham-McGregoret al 1971			✓

1) Positive associations with motor milestone development

A cross sectional study in Turkey was conducted with children (n=1,553) age 12-23months from health centers. The study was to explore the association with the mean age of walking without aid and family characteristics. The result showed that there was positive association with age of walking without aid and maternal (8-14year level) and paternal education (11-14years level). In terms of gender, female infants could walk earlier than male infants. Additionally, in the absence of parental consanguinity and higher maternal education level (≥8years) and longer breastfeeding (≥ 6months) could be positively associated with earlier age of walking (Yalcin et al., 2012).

A longitudinal study in Denmark was conducted with children at 6 and 8 mo. (n=25,446) to explore the association between maternal fish intake and children motor milestone development by using the sum of passed items. Mother reported questionnaires (yes or no) of following motor milestones: hold up with head, sit with a straight back, roll back to front, sit alone and walk alone. There was positive associated with longer breastfeeding (more than 10 mos. or less than 1 mo.) and children motor milestone development at 18 mo. (Oken et al., 2008).

A longitudinal cohort study was conducted with 986 children (575 male, 471 female). The study was carried out to find out the association age of walk alone with socioeconomic status, birth order, race (black, white and others), and gender for 6 months. The age of children start walk independently was measured with the mean of walking age by each ethnical background infants along with other factors. Regarding socioeconomic status (SES), infants who were from lower income household, started walk 5months earlier than those from higher income household. Considering SES level associated with race, the average household income for blacks was significantly lower than the White in this study. So, the study supported that SES and race was the important factors that could influence on the age of walking alone (Stanitski et al., 2000).

A cross sectional study was conducted in USA to compare the mean gross motor milestone development between premature infant (n=23) and full term infants (n=20) at 12 months. The gross motor milestone achievement was measured by the PDMS. Female infants had higher the PDMS score than male infants among preterm infants (Palisano et al., 1985).

A longitudinal study in USA was conducted with 381 children born at term and had Bayley mental and motor indices beyond 68. The gross motor milestones (e.g., roll prone to supine, roll supine to prone, sit with or without aid, creep get to sit, crawl, pull to stand, cruise, walk, walk backward and run) were assessed at 2 weeks, 2, 4, 6, 12, 15, 18 and 24 months. The gross motor milestones were measured by the mean age and percentage of attainment base on the parental reports. Male children tended to delay in early motor milestone but, they achieved creep earlier age than female children. Similarly, male children could walk and run at 0.4 months and 0.6 months earlier than female children. Among the White, male children achieved most of motor milestone in advanced than female children. However, in the Black children, female children could achieve gross motor milestones earlier than male children. For SES status (range 1 to 5 level), the Black children showed lower motor gradient as SES level increased (Capute et al., 1985).

2) Negative association with motor milestone development

A cohort study was conducted with 985 children (510 males, 475 females). The participants of the study were 529 Black and 456 were White for 6months. The study attempted to explore the association between the mean age at which children walk alone and socioeconomic status, birth order, race (black, white and others), and gender. The age at which children start walking independently was measured by the mean age of walking among infants from various ethnic backgrounds. Infants from higher income households were more likely to start walking at a later age than infants from lower income households (Stanitski et al., 2000).

A cross sectional study in Tokyo and Chiba was conducted with children (n=395: at day care centers from 11 months to 3years old) was conducted to explore the association between the age at which children begin to walk and the following factors: birth weight, order of birth, frequency of being carried on the chest, season of birth, use of a walker, age of enrollment in a daycare center. The age of walking alone was measured by distribution of age in months at which the subjects started walking. There was negatively association were found between the age of walking and the third or fourth child born, born in summer, and had a high frequency of being carried piggyback (Iwata et al., 1991).

3) No Association with motor milestone development

A cross sectional study in Turkey was conducted with children (n=1,553) age 12-23 months from health centers. The study was to explore the association with the mean age of walking without aid and family characteristics. The result showed that birth order, birth interval, birth weight, paternal occupation were no association with infant age of walking without aid. There was also no significant difference found in mean age of walking between family type, presence of social security, number of members in the household and presence of any sibling <5yr(Yalcin et al., 2012).

A longitudinal study was conducted to compare the gross motor development with preterm infants (PT; n=101) without cerebral palsy and infants who are full-term and healthy (FT; n=52). This study compared the age of walking without support between PT and FT infants by a monthly mean score using the AIMS. There was no association between socioeconomic variable and walking attainment (Restiffe et al., 2012).

Another longitudinal cohort study in Japan was conducted with healthy term infants (n=290) born in a district of Osaka City, age at 4-9months to determine the association with gross motor milestone attainment and gender. The gross motor milestone achievement was measured by the mean age of achievement. There was no association found with the age of walking independently and gender difference (Kimura-Ohba et al., 2011).

A longitudinal study in Denmark was conducted with children at 6 and 8 mo. (n=25,446) to explore the association between maternal fish intake and children motor milestone development by using the sum of passed items. Mother reported questionnaires (yes or no) of following motor milestones: hold up with head, sit with a straight back, roll back to front, sit alone and walk alone. There was no association with longer breastfeeding (more than 10 mo. or less than 1 mo.) and children motor milestone development at 6 mo. (Oken et al., 2008).

Another longitudinal study in Guatemala was carried out among children 3 months of age to 3years old to determine relation between nutritional factor (physical growth and dietary intake) and age of walking. 17 gross motor milestones measured the Gross Motor Development Scale. The median and range of age of walking alone were 15 and 10-24 months respectively. Birth length was not significantly associated with age of walking. There were also no associations between age of walking without support and birth order, gender, community, maternal age and level of education, and socioeconomic status (Kuklina et al., 2004).

A study in Tokyo and Chiba was conducted with children (n=395: at day care centers from 11 months to 3years old) was conducted to explore the association between the age at which children begin to walk and the following factors: birth weight, order of birth, frequency of being carried on the chest, season of birth, use of a walker, age of enrollment in a daycare center. The age of walking alone was measured with distribution of age in months at which the subjects started walking. There was no association with age at which children start walking and the type of feeding. Japanese study of children who were enrolled in daycare center showed that there was no association between order of birth, manner of feeding, frequency of being carried piggyback and the age at which walking is attained (Iwata et al., 1991).

A longitudinal study in USA was conducted with 381 children born at term and had Bayley mental and motor indices beyond 68. The gross motor milestones (e.g., roll prone to supine, roll supine to prone, sit with or without aid, creep get to sit, crawl, pull to stand, cruise, walk, walk backward and run) were assessed at 2 weeks, 2, 4, 6, 12, 15, 18 and 24 months. The gross motor milestones were measured by the mean age and percentage of attainment base on the parental reports. There was no statistically significant different between male and female children. When controlling for race, there was no statistically significant different between sexes and gross motor milestone achievement (Capute et al., 1985).

A longitudinal study in Italy was conducted to explore the age of walking related to five different locomotors pattern (e.g., crawlers on hands and knees, early crawlers, late crawlers, stomach creepers and shufflers). The participants who were less than 16 months divided into two groups such as, index group and control group. The index group (n=270) was recruited from the neonatal unit and control group (n=154) from nursery. There was no association of age of walking with sex, gestational age, birth weight or family and environmental variable (Bottos et al., 1989).

A cross sectional study was conducted in USA to compare the mean gross motor milestone development between premature infant (n=23) and full term infants (n=20) at 12 months. The gross motor milestone achievement was measured by the PDMS. There was no significant different between gender among full term infants (Palisano et al., 1985)

A longitudinal study in Kingston, Jamaica was conducted with 300 infants from birth to 12 months to explore 14 gross motor developments. Gross motor milestone was measured by percentage of infants who achieved a specific motor milestone at a particular point in time and compared to normal white infants (Gesell Developmental Schedules). There was no association with socioeconomic status and infant’s ability to walk at 8 months, 10 months and 12 months (Grantham-McGregor et al., 1971).

Result Part II: Gross Motor Milestone Measurement Scales

Motor milestones development can be assessed by various kinds of scales. Scales such as the Alberta Infant Motor Scale (AIMS), the Bayley Scales of Infant Development (BSID), and the Peabody Developmental Motor Scales (PDMS) as well as the Denver can be used for assessing children's motor milestone attainment. The percentage of age month or mean age of month specific motor milestone achievements and the sum of pass or fail scores can be used for measuring a child's gross motor milestone attainment. This literature review describes the main characteristics of each assessment scale and demonstrates how these scales have been used in many studies.

Table.13 Measurement Tools for Assessing Children's Gross Motor Milestone Development

Type	The mean age	% of gross motor achievement	Bayley Scale of Infant Development (BSID-I or BSID-II)	Alberta Infant Motor Scale (AIMS)	Peabody Developmental Motor Scale (PDMS)	Denver Developmental Screening Test (DDST)	Sum of pass score	Others*
	Surkan et al., (2013)	Kimura-ohba et al.,(2011)	Barker et al., (2012)	Osnat et al., (2013)	Smith et al., (2011)	Meyer-Bahlburg et al., (2004)	Divan et al., (2011)	Naqvi et al., (2012)
	Yalcin et al., (2012)	Katz et al., (2011)	Miquelote et al., (2012)	Restiffe et al., (2012)	Dorrah et al., (2009)	Salls et al., (2002)	Angulo-Barroso et al., (2010)	Little et al., (2005)
	Restiffe et al., (2012)	Jeng et al.,(2008)	Singer et al.,(2012)	Singer et al., (2012)	Jeng et al., (2008)	Jantz et al., (1997)	Oken et al., 2008	Meyer-Bahlburg et al., (2004)
	Kankova et al., (2012)	Afarwoah et al., (2007)	Smith et al., (2011)	Garcia et al., (2011)	Shafir et al., (2008)	Jaffe et al., (1996)	Punamaki et al., (2006)	Reid et al., (1999)
	Kimura-ohba et al., (2011)	Olney et al., (2007)	Tofail et al., (2009)	Dorlap et al., (2010)	Nixon-cave et al., (2001)	Stewart et al., (1981)		
	Katz et al.,(2010)	Kelly et al., (2006)	Tofail et al., (2008)	Luo et al., (20009)	Fetter et al., (1998)			
	Lewycky et al., (2009)	Kariger et al., (2005)	Nakajima et al., (2006)	Ohman et al., (2009)	Palisano et al., (1985)			
	Karasilk et al., (2008)	Siegel et al., (2005)	Huizink et al.,(2002)	Pin et al., (2009)				
	Davis et al., (2008)	Jeng et al., (2004)	Pridham et al., (2002)	Fetters et al., (2007)				

	Siegal et al., (2005)	Kuklinea et al., (2004)	Harahap et al., (2000)	Jeng et al., (2000)				
	Kuklina et al., (2004)	Nelson et al., (2004)	Jahari et al., (2000)					
	Nelson et al., (2004)	Bentley et al., (1997)	Siegel et al., (1999)					
	Huizink et al., (2002)	Iwata et al., (1991)	Mulligan et al., (1998)					
	Garrett et al., (2002)	Allen et al., (1990)	Richardson et al., (1995)					
	Stanitski et al., (2000)	Bottos et al., (1989)	Kirksey et al., (1994)					
	Harolyn et al., (19999)	Haley et al., (1986)	Reid et al., (1991)					
	Crowther et al., (1997)	Capute et al., (1985)	Capute et al., (1985)					
	Jaffe et al., (1996)	Noller et al., (1984)	Phatak et al., (1969)					
	Hopkins et al., (1989)	Grantham-McGregor et al., (1971)						
	Capute et al., (1985)							
	Tenbrinck et al., (1974)							
	Porter et al., (1972)							
	Touwen et al., (1971)							
Total	**23**	**19**	**18**	**11**	**7**	**5**	**3**	**4**

*Others: Naqvi et al., (2012): Battele Developmental Inventory Screening Test(BDIS), Little et al., (2005): Merril-Palmer Revised Score, Meyer-Bahlburg et al., (2004): Kent Infant Development Scale (KIDS), Reid et al., (1999): Infant Mullen Scale

Proportion (%) of Age month of Gross Motor Attainment

This measurement can be compared with the norm or standard population in order to determine the distribution of children who are delayed or on the in their motor milestone development.

Examples of Studies using % of age months for Assessing Attainment of a Specific Gross Motor Milestone

A study by Kankova et al. specific motor milestone (e.g., lift head, turn over from supine to prone positions, sit, crawl and walk alone) is achieved was measured by using percentage. The gross motor milestones (rolling over, crawling and sitting) were measured by percentage of capability of rolling at 4 months, crawling and sitting at 9 months (Kimura-Ohba et al., 2011). Motor milestones were measured by percentage age attainment (Katz et al., 2010). Three intervention groups were compared to non- intervention group to determine the percentage age of walking without support (Adu-Afarwuah et al., 2007).

In the U.K., motor milestone development was measured as a percentage of passed scored at a specific motor milestone at a certain age (Kelly et al., 2006). Harolyn et al.'s randomized control study also measured the percentage of age (months) achievement of motor milestones.

Bentley et al. study used percentage month of infant's gross motor milestone achievement was measured following milestones (sitting, crawling, standing and walking) at 3 and 7 months. The ages of walking alone were also measured with the percent of age in months at which the subjects started walking (Iwata et al., 1991).Noller et al.'s study used percentage of children who achieved the following motor milestones: stands on one foot, walks independently, walks with arms at low guard, walks on tiptoes and rises from floor to standing without support, and stands from supine without rotation. The result showed that if infants' age level and assessment similar there was no significant difference with the reference study. The gross motor milestones were measured by percentage of infants who achieved motor milestones at a specific point of time (Grantham-McGregor et al., 1971).

Mean Age of Gross Motor Milestone Attainment

The age of achieving each gross motor milestone can be measured by the mean age of attainment. The outcome of mean ages of gross motor milestones can be compared with the normal population at a certain age.

Examples of Studies Using Mean of Age Groups for Assessing Attainment of a Specific Gross Motor Milestone

The motor milestone score was measured by the mean age achievement (Surkan et al., 2013). The age of walking alone was measured by the mean age of attainment(Yalcin 2012).Motor milestones were measured by the mean age of attainment (Katz et al., 2010,Davis et al, 2008).An infant's motor milestones (standing to walking with or without support) were measured by the mean age of achievement (Punamaki et al., 2006, Garrett et al, 2002).
The age at which children started walking independently was measured by the mean of the walking age attainment (Stanitski et al., 2000). Seven gross motor milestones (sit to walk) were measured by the mean age of the gross motor milestones to define the motor delay (Crowther et al., 1997). 12 gross motor milestones (MM) was measured by the mean age of attainment and compared with the normal population (Allen et al., 1990). Three gross motor milestones such as sitting, crawling and walking alone were measured by mean age in months attainment (Hopkins et al., 1989).

Sum of the Passed Scores

Gross motor milestones scores can be measured with the sum of the passed scores for each gross motor milestone attainment (e.g., 19 items) at a certain age. A higher sum will be defined by better achievement of the general gross motor milestone compared to other groups.

Examples of Studies Using the Sum of Passed Scores for Gross Motor Milestone Attainment

The 19 gross motor milestones were measured by the sum of passed (pass=1, fail=0) scores from sit to run position (Angulo-Barroso et al., 2010). The gross motor milestones (hold up head, sit with back straight, roll from back to front, sit up right on the floor, grab objects out of reach and crawl on stomach)were measured by the passed or fail scores (Divan et al., (2011). Infants' motor (standing to walking with or without support) were measured by the pass or fail scores (Punamaki et al., 2006)

The Alberta Infant Motor Scale (AIMS)

The AIMS is an observational assessment scale constructed to measure gross motor maturation in infants from birth through walking without support. In many other studies, 58 items were generated and organized into four positions: prone, supine prone, supine, sitting and standing. The scores of the different activities are added together to form an overall index that ranges from 0 to 100. The AIMS focus on weight bearing, postural alignment and antigravity movement that can contribute to motor skill (Ungerer et al., 1983). Reliability and validity for the AIMS estimation were assessed through use with Canadian infants, but it can be used for measuring certain motor milestones without concern for ethnic background. The AIMS provides information that can help to identify the missing components of motor tasks and for intervention strategies for therapeutic purposes. The normative data from the AIMS will determine if children's motor performance is normally developed. The AIMS has a high degree of test or retest, intra- and inter- reliability when it is applied to normal full term infants (i.e., reliability > 0.85). The correlation between the AIMS and other tests, such as the Bayley Motor Scale and the Peabody Gross Motor Scale, is high when they are applied to infants at risk and expected to be motor delayed. The AIMS has been applied broadly, but test results can be influenced by some culturally specific factors (Ungerer et al., 1983). For instance, infants in Asia and Europe mostly sleep with supine position, unlike those in North

America, which could lead to a delay in the age of motor milestone attainment (e.g., rolling over and sitting up).

Examples of Studies Using AIMS for Assessing Gross Motor Milestone Attainment

The onset of four motor milestones (i.e., sitting, pulling to stand, crawling and cruising) and infants' overall motor development was measured by using the AIMS. The age of walking without support between PT and FT infants by a monthly mean score using the AIMS(Restiffe et al., 2012).The gross motor milestones, such as rolling, propping in prone and sitting were measured by the AIMS (Pin et al., 2009).

The gross motor performance was measured by the AIMS pass or fail score of 58 items (Fetter et al., 2007). The age of walking was also measured by the AIMS(stratified into two categories: failed to attain walking if infant is unable to walk at 18 months of age and attained walking if infants can walk prior to 18 months of age) (Jeng et al., 2000).

Bayley Scales of Infant Development (BSID)

The BSID-I is one of the most widely used infant developmental assessment tools both in research and clinical practice since 1969 (Garrett et al., 2002). The scale comprises a mental and behavior record and covers 81developmental motor milestones for children age 2-30months. Each item such as crawling, sitting, walking and grasping is scored pass or fail based on standardized administration and scoring guidelines (i.e., instruction and manual). The majority of items are gross motor milestones but some cover fine motor milestones (combining, ball throwing). The BSID scale has been used in much research related to both high risk and handicapped infants. Because the BSID normative data is out-of-date, the scale needs to be updated based on recent normative data. The Bayley Motor Scale is also used to assess children's motor milestone attainment. However, the Bayley Motor Scale is less sensitive to identifying early signs of cerebral palsy due to shortcomings in the measurement of qualitative movement (Garrett et al., 2002).

Second Edition of the BSID (BSID-II)

The BSID-II is updated with new materials and standards in order to extend the age range as well as to improve clinical utility, reliability and validity.

Examples of Studies Using the BSID for Assessing Gross Motor Milestone Attainment

The Bayley Scale of Infant Development-II (BSID-II) Psychomotor Development Index (PDI) and the Mental Development Index (MDI) were used to determine children's development (Tofail et al., 2009).The gross motor scores were determined by using the mean score of the BSID-II (Nakajima et al., 2006).Gross motor milestones were measured by the Bayley Psychomotor Index with 17 item scales (Siegel et al., 2005).Infants' motor development was measured by using the BISD-I (Harahap et al., 2000). The motor milestones of infants from 12 to 18 months were also assessed by using the BISD-I (Jahari et al., 2000). The development scores of children's motor and mental milestones were measured by the BISD-I (Siegel et al., 1999). Motor development was measured at 6, 9 and 12 months of age by the BISD-I (Mulligan et al., 1998). Infants' mental and motor development were measured by using the BISD-I (Richardson et al., 1995).

Peabody Developmental Motor Scales (PDMS)

The Peabody Developmental Motor Scales **(**PDMS), which were published in 1983, standardized the norm-reference gross and fine motor scale that was developed by an educator (Adu-Afarwuah et al., 2007, Aburto et al., 2007, Schroeder et al., 2002,Garrett et al., 2002). The PDMS has been broadly used and normative data were collected more recently than the Bayley Motor Scale. The normative data were collected in 1981-82 with stratified samples from 617 children 1 to 83 months in order to establish the PDMS. The PDMS consists of both gross and fine motor scales from birth to 7 years old and has been used broadly by physical therapists in pediatrics. The PDMS consists of 112-170 items and each item is scored on a three-point scale (0 = unsuccessful; 1 = clear resemblance to item criterion, but criterion not fully met; 2 = successful performance, criterion met), whereas the Bayley Motor Scale uses a nominal scale of pass or fail. The reliability of the PDMS is high in both inter-rater and test-retest ($r \geq 0.80$). The Peabody Fine Motor Scale scores were correlated significantly with the Bayley Mental Scale (BSID). However, some developmental sequences are not corrected, such as skipping preceding galloping, and there was poor quality of testing with this material. Despites the deficiencies, the PDMS and the BSID continue to be useful tools for identifying and measuring infants' movement and motor development.

Examples of Studies Using the PDMS for Gross Motor Milestone Attainment Measurement

The age of onset of walking was measured by the using the PDMS-II (Jeng et al., 2008). The gross motor milestones were measured by the PDMS (Dorrah et al, 2009, Shafir et al, 2008, Palisano et al, 1985). Gross motor milestones such as sitting, crawling and walking were measured by the PDMS (Nixon-Cave et al., 2001). Gross motor development was measured by the PDMS-II (Smith et al., 2011). The children's motor development at 15 months was measured by the PDMS (Fetter et al., et al 1998)

Denver Developmental Screening Test (DDST)

The DDST is the one of the screening tools that is frequently used by occupational therapists and pediatricians in order to assess infant's motor milestone achievement. It was standardized in 1988 and measures seven specific gross motor milestones (i.e., head up 45º, head up 90º, sit–head steady, chest up–arm support, roll over, pull to sit–no head lag, and sit–no support) using pass or fail scores of the sample population. The scores are compared to the average age at which25%, 50%, 70% and 90%ofthe normal population can pass a specific motor milestone. This screening tool is easy and effective to use (Salls et al., 2002, Frankenburg et al., 1992).

Example of Studies Using DDST for Gross Motor Milestone Attainment

Seventeen gross motor milestones were measured by using the Gross Motor Development Scale (Kuklina et al., 2004).Gross motor development was measured by using the Denver II Gross Motor Sector (pass and fail distribution scores (Salls et al., 2002).Gross motor milestones (rolling over, pulling to sit without head lag, grasping a rattle and reaching for object) at 4 months and sitting upright at 6months were measured by the Denver Developmental Screening Revised Test (Jantz et al., 1997). 105 items of gross motor development was measured by the Denver (Meyer-Bahlburg et al, 2004, Stewart et al, 1981). The gross motor milestone was measured by the DDST (Jaffe et al., 1996)

Other Gross Motor Milestone Scales:

The Gross Motor Function Measure (GMFM)

The Gross Motor Function Measure **(**GMFM) is a standardized observational tool for children with cerebral palsy used to measure the change of gross motor function over time. This test is only used for evaluating gross motor milestones. There is no age limitation in the GMFM scale, but it generally covers up to 5 years old with normal motor ability. The GMFM is useful for older children; however, the usefulness depends on the relative abilities and disabilities of their gross motor milestones. There are 88 items and grouped into five different gross motor functions (lying, rolling, sitting, crawling and kneeling, standing, walking, running and jumping). Each item is scored with 4 point scale (Bril et al., 1986).

The Motor Age Test (MAT)

The MAT test is divided into two tests: one for upper extremities (i.e., visual motor tracking and bilateral coordination activities) and other for lower extremities (i.e., standing, jumping and hopping). Neither normative studies nor formal assessment of reliability and validity has been conducted (Harahao et al., 2000).

The Motor Development Checklist (MDC)

The Motor Development Checklist (MDC) was designed to evaluate the spontaneous motor behavior of children with severe developmental disabilities. The MDC uses a 4-point scale from 0 to 3 based on spontaneous action. The items covered are rolling, head lifting, crawling, kneeling, sitting, walking and climbing. The MDC is high when the test is applied by trained, experience therapist, but the degree of validity of MDC is not known (Davis et al., 1998, Fung et al., 1985)

Example of Studies Using Other Measurement Tools

These motor milestones were scored with three point scoring scales (zero to two). These scores were compared with other norm assessment devices such as the Milani-Comparetti, the Developmental Programming for Infants and Young Children (DPIYC), the Erhardt Developmental Prehension Assessment and Gesell (Noller et al., 1984), Grantham-McGregor et al., (1971) was compared with normal white infants (Gesell Development Schedules).

Table 14 Summaries of Studies: Positive, Negative and No Association of Eleven Factors Associated with Motor Milestone Development

No.	Factors	Positive association	Negative association	No association	Total
1	Children's nutritional status (micronutrient supplement, breast feeding, iron deficiency)	10	1	6	17
2	Physical growth (weight and length: stunting, wasting, underweight)	7	1	0	8
3	Cultural difference (ethnic background: maternal behavior, motivation)	10	1	2	13
4	Birth weight (full term vs. preterm including premature)	12	0	3	15
5	Maternal nutritional status (iron deficiency, micronutrient supplements)	3	1	1	5
6	Maternal exposure to environmental factors (polydrugs, chemical, cell phone, hormone therapy, mental stress)	1	8	10	19
7	Children's exposure to environmental factors (daycare center)	9	4	4	17
8	Children's sleeping and playing position (supine and prone)	5	1	5	11
9	Attainment of other motor milestones (sitting vs. walking, crawling vs. walking)	4	1	0	5
10	Children's health status	0	4	2	6
11	Other factors (SES, parental educational level, birth weight and season of birth, gender)	5	2	10	15
Total		66	24	43	132

Discussion

Overall, this study demonstrated eleven factors that can influence children's gross motor milestone attainment. In terms of association, Figure 4 shows how these factors (e.g., children's nutritional intake, birth weight, chemical exposure and sleeping position)are directly associated with children's gross motor milestone development. Figure 2 also shows how a single factor can be correlated to other additional factors in order to achieve children's gross motor milestones. For instance, some factors, such as physical growth, maternal nutritional status, cultural difference and other motor milestones can be correlated to each other, and have an influence on children's overall gross motor milestone development. Table 15 provides information regarding children's motor milestone development by each factor in a chronological order.

The majority of other systematic review studies focuses on only single factor associated with gross motor milestone development and compared the studies' design and the results on children's motor development. However, this study explored eleven main factors that relate to children's motor milestone development. Thus, these findings will provide essential factors to be considered prior to conducting an intervention study about infants' motor milestone development in the future. This can be a useful guideline for both healthcare professionals and caregivers to help infants achieve optimal motor milestones at certain ages. In addition, this study focused on infants and their development between the age of birth and twenty-four months, which helps understand specific motor milestone attainment during this time period. These are all strong points in this systematic review study.

<u>Children's Nutritional Factors</u>

Ten out of seventeen studies (59%) showed a positive association between motor milestone achievement and infant nutritional factors, whereas one study showed a negative association and six studies showed no association. In order to measure the infants' motor milestone development related to nutritional factors, seven of the studies used the percentage of motor milestone attainment, and three studies used the mean age of motor milestone achievement. In addition, two studies used the BSID, one study used the PDMS, and one study used the sum of the pass score of motor milestone attainment.

A randomized clinical trial (Bentley et al., 1997) suggests zinc supplement can assist infants in attaining specific motor milestones (e.g., sitting, crawling, standing and walking) at three and seven months. Their studies state that micronutrients (e.g., zinc and iron with essential fatty acids) can be helpful for improving infants' gross motor milestone achievement (Shafir et al., 2008). The Olney et al., 2007 study, maintains that iron supplements for children could have a beneficial effect on their ability to achieve walk. The effect will have a strong impact on children who had IDA (iron deficiency with anemia) at the baseline. These findings support that it is essential for infants to be free of iron deficiencies, without anemic conditions, to be able to achieve standing and walking milestones at certain ages.

The results suggest that a nutrition intake is an important predictor to determine infants' gross motor milestone achievement. Specifically, energy, essential fatty acids and protein, plus essential micronutrients (e.g., iron, zinc, and folic acid) are essential nutritional factors in order to achieve normal growth as well as gross motor milestone achievement (Seth Adu-Afarwuah et al., 2007).These findings state that iron supplementation through a protein source like meat or a pill, along with enough energy consumption will be a good intervention for infants, providing sufficient iron levels, reducing anemia, and thus allowing them to achieve gross motor milestones at the proper ages. The results also suggest that a balanced diet with energy, protein, fat, and carbohydrates plus micronutrient supplements can contribute to children achieving their growth and gross motor milestone development.

However, one study pointed out that there was negative effects on the combination of iron, zinc, and folic acid supplementation for achieving walking at a certain age (Katz et al., 2010, Shafir et al., 2008). These results demonstrate that a combined micronutrient supplementation program (e.g., iron, zinc, and folic acid) may not effectively reduce the prevalence of iron deficiencies without careful monitoring of the program (i.e., caregivers' support, adherence of supplementation).

On the other hand, 36% of studies (six out of eighteen studies) showed no association with infants' nutritional status and infants' gross motor milestone development. Some studies did not show any association with zinc, iron, and folate supplements and infants' gross motor milestone development (Surkan et al., 2013, Katz et al., 2010, Harahap et al., 2000). Katz et al., (2010) suggests that micronutrients (e.g., zinc, iron, folic acid) were not effective in improving children's motor milestones. Additionally, zinc supplements alone (Katz et al., 2000, Bentley et al., 1997) or iron without energy supplements (Harahap et al., 2000)did not have any beneficial effects on achieving gross motor milestones after age 20 months.

These findings from studies (Katz et al., 2000, Bentley et al., 1997) suggest that micronutrients without other elements (e.g., energy, protein, and essential fatty acids) will not have any effect on improving infants' gross motor milestone achievements even though micronutrient supplements are very important for children's development when they are young. Additionally, Harahap et al., (2000) suggests that if the participants are over 20 months old, or if the participants are not severely iron deficient, a nutritional intervention (i.e., iron supplement), will not find any significant differences between the intervention groups and the control.

Children's physical growth

Seven studies showed a positive association between infants' gross motor milestone attainment and physical growth, whereas one study showed a negative association (Kuklina et al., 2004). In order to measure the motor milestone development related to infants' physical growth factors, three studies used percentage of motor milestone attainment, and two studies used mean age of motor milestone achievement. In addition, one study used the BSID.

There were seven out of eight (88%) studies showing that positive physical growth was closely related to infants' gross motor milestone development. The age of being able to walk alone was associated with both weight and height for age z-score (Yalcin et al., 2012). Micronutrients, energy, and protein supplements could all contribute to increasing infants' weight and height for age z-score and consequently could lead to infants having higher percentages of walking alone compared to those with insufficient energy supplements (Adu-Afarwvah et al., 2007). Furthermore, Olney et al., (2007) suggests that zinc, folic acid and iron supplementation from birth through the first year is essential for infants to have more length for their age and sufficient hemoglobin levels in order to achieve walking alone by a certain age.

A review study (WHO, 2006[3]) also supports that anthropometric indicators (i.e., weight and height) correlate to certain ages during infants' motor milestone achievement. For instance, children in some developing countries begin to walk one and a half to three months later than well-nourished American or European infants (Groos et al., 1991, Cheung et al., 2001). In a cross-sectional study, infants with stunted development were associated with delaying certain gross motor milestones (e.g., crawling, walking) compared with other healthy population samples in the United States (Pollitt et al., 1994).Similarly, Zanzibari and Nepali children, who were stunting, were delayed in walking without support (Siegel et al., 2005, Walka et al., 2000) and other motor developments (Kariger et al., 2005).

Regarding caregivers' feeding behavior, Black et al, (2014) states that period from birth to twenty four months is an important period to achieve normal growth and gross motor milestones. During this period, children learn and experience various things, such as feeding behavior. Thus, Black et al., (2014) suggests that caregivers need to make more effort to provide integrated breastfeeding and complementary feeding for infants at an early age. WHO (2005) reports that infants from six to twenty four months old can grow remarkably fast, but they can also have excessive weight gain. Therefore, unresponsive caregiver's feeding practices (e.g., poor food quality and irregular infant feeding) can contribute to infants being underweight or overweight (Mitchell et al., 2013, Scwartz et al., 2011).

In addition, the age of walking was related to dietary intake, especially protein (i.e., meat) consumption, helping infants have improved physical growth (i.e., weight and length). Additionally, increased physical activity was related to lower fat consumption and could result in achieving increased motor milestone development at six and twelvemonths (Mulligan et al., 1998). Furthermore, appropriate height and weight for their age group are closely related to attaining gross motor milestones (e.g., walking without aid)at certain ages (Siegel et al., 2011, Olney et al., 2007). Therefore, these finding suggest that sufficient energy and micronutrient supplements can have a beneficial effect on improving children's weight and height, but children need to maintain normal weight and height when they are young.

However, being overweight did not have any beneficial effect on infants' motor milestone attainment (Siegel et al., 2011, Angulo-Barroso et al., 2010). In terms of children's physical growth, Mulligan et al., (1998) suggests that infants are influenced by the opportunity to experience various kinds of activities and space availability. Thus, if infants do not have enough activities, this could lead to weight gain as well as a delay in achieving infant's gross motor milestones (Kuklina et al., 2004). Consequently, these studies suggest that normal physical growth can contribute to children having higher percentage of motor milestone attainment.

Cultural Differences

In terms of cultural and ethnic differences, ten studies demonstrated a positive association between ethnic background and infants' gross motor milestones achievement. However, three of the studies did not show any association with this factor. In order to measure the infants' motor milestone development related to cultural differences, five studies used mean age of motor milestone achievement, while three studies used percentage of motor milestone attainment. In addition, one study used the BSID, one study used the PDMS, one study used the sum of the pass score of motor milestone attainment, and one study used the Battle Developmental Inventory Screening for infants' motor development assessment.
Ten out of fourteen (71%) studies showed positive associations with infants' gross motor milestone development and cultural differences. Many studies demonstrated that African infants were dominant in achieving gross motor milestones at an earlier age compared with those of other ethnic backgrounds (Angulo-Barroso et al., 2010, Stanitski et al., 2000, Capute et al., 1985, Grantham-McGreger et al., 1971). Similarly, the Kelly et al., (2006) study maintains that the black Caribbean children who were born in the UK achieved most motor milestones at earlier ages than those with other races. The Nixon-Cave et al., (2001) study suggests that parents' attitudes and beliefs are different depending on their ethnic backgrounds, and these attitudes influence development. For example, African-American parents encourage their children to achieve gross motor milestones as soon as possible and encourage them to learn through experience. Similarly, the Hopkins et al., (1989) study maintains that Jamaican mothers encourage and expect their children to achieve motor milestones at an earlier age than mothers who were from different ethnical backgrounds.

Conversely, European and Hispanic parents waited until their children learned gross motor milestones skills by themselves or naturally (Nixon-Cave et al., 2001).

Adolph et al., (2003) maintains that there are significant differences in age of gross motor milestone achievement between European and Asian infants. Mayson et al., (2007) suggests that genetic differences (e.g., skin color, lineage standing in for genetic assays) including child rearing practices will impact children's gross motor milestone attainment. For example, Asian parents tried to overprotect children from getting injured when they were young. The Adolph et al. (2003) study points out those Asian infants had less chance to be exposed to lying in prone and upright positions, causing a difference in the sleeping environment. In addition, types of clothing might have made it easier or more difficult to move. For these reasons, Asian infants often achieve gross motor milestones in later periods than European infants. The Mayson et al., (2007) review study points out that infants from Hong Kong achieved their first milestone of rolling from supine to prone first, which contrasted with infants in Canada. Therefore, these findings suggest that parent' motivations, perceptions and beliefs (i.e., encouragement or discouragement) and rearing practices can positively or negatively impact infants achieving gross motor milestones.

In contrast, there were two out of thirteen studies showing that there is no association with cultural difference in terms of mothers' beliefs and knowledge with infants' gross motor milestones (Naqvi et al., 2012). Certain gross motor milestones (e.g., rolling from supine to prone, crawling, pulling up to standing) will not differ, regardless of race (Allen et al., 1990). The findings above provide useful evidence that cultural differences can affect infants' gross motor milestone achievement. Specifically, black parents encourage and expect their children to achieve gross motor milestones at earlier ages. In addition, under the cultural differences, factors such as maternal child bearing practices, gender, SES levels and environmental factors can contribute to different outcomes, depending on the infants' country of origin or country they live in (Angulo-Barroso et al., 2010, Stanitski et al., 2000, Capute et al., 1985, Grantham-McGreger et al., 1971).

Birth Weight

Twelve studies showed a positive association between infants' gross motor milestone achievement and birth weight. However, three studies (Yalçın et al., 2012) showed no association between birth weight and achieving gross motor milestones. In order to measure the infants' motor milestone development related to birth weight, five studies used the mean age of motor milestone achievement, four studies used the AIMS, and three studies used the percentage of motor milestone attainment. In addition, one study used the BSID, two studies used the PDMS, and one study used the Merill Palner Program (MPP) for infants' motor development assessment.

Twelve out of fifteen (80%) studies suggest that full term infants had better gross motor milestone development compared to preterm infants (Restiffe et al., 2012,Luo et al., 2009, Pin et al., 2009, Jeng et al., 2000, Palisano et al., 1985). For example, full term infants could walk alone earlier than preterm infants (Restiffe et al., 2012, Jeng et al., 2004, Jeng et al., 2000, Iwata et al., 1991). In terms of other motor milestones such as sitting with or without support (Allen et al., 1990), standing alone and walking alone (Grantham-McGregor et al., 1971), full term infants achieved these at an earlier age compared to preterm infants. The Jeng et al. (2008) study states that full term infants could walk within twelve months, compared to preterm infants. In addition, full term infants could achieve sitting without arm support earlier than preterm infants (Pin et al., 2009).

However, the Restiffe et al., (2012) study argues that the difference in the AIMS between preterm and full term gradually decreases from the twelfth to sixteenth months. Additionally, the age of walking alone was not different from the twelfth to twenty third months regardless of birth weight (Yalcin et al., 2012). Another study supports that there is no significant difference between birth weight and infants' gross motor development after nineteen months (Little et al., 2005).The Restiffe et al., (2012) study points out that the period between eight to twelve months is the most important for infants in achieving most gross motor milestones. Restiffe et al., (2012) suggests that the AIMS may be the only appropriate measurement tool to distinguish infants' motor ability levels in the middle range. This is because during the first three months, few motor milestones (e.g., prone and supine position) can be observed, and only standing can be accomplished after twelve to sixteen months. The Yalçın et al., (2012) study also argues that birth weight could affect motor milestone development if very low birth weight and premature infants are included.

Maternal Dietary Status

Five studies showed the maternal dietary status associated with children's motor milestone development. Three studies showed positive maternal dietary status association one study showed negative association and the other study showed no association. In order to measure the infants' motor milestone development related to maternal dietary factors, two studies used the mean age of motor milestone achievement; two studies used the BSID and one study used the sum of passed item.

Yalcin et al., (2012) suggests that the age children began walking was achieved earlier when mothers received iron supplementation during the first trimester pregnancy. In particular, maternal micronutrient supplements (e.g., iron and folic acid) during pregnancy from week fourteen until delivery could contribute to infants having higher the BIDS. Mothers who had reasonably higher BMI scores would contribute to their infants' development (Tofail et al., 1998).

Yalcin et al., (2012) suggests that prenatal iron supplementation may influence infants' ability to walk without support at earlier ages than others. The World Health Organization states that the prevalence of 41% of maternal iron deficiency anemia is due to lack of iron intake. The WHO report also states that maternal iron deficiency (ID) during pregnancy can be directly related to preterm birth. Preterm birth can be a cause of delaying infants' gross motor milestone attainment (Stoltzfus et al., 2011). The Tran et al., (2014) study also supports that maternal anemia in early pregnancy is directly associated with a higher risk of preterm birth (i.e., lower birth weight) and that preterm birth can contribute to a delay in infants' gross motor milestones at certain ages. The Tran study also points out that maternal low hemoglobin levels in late pregnancy were negatively associated with infants' motor milestone development at six months clinical study in China (Zeng et al., 2001) demonstrates that iron with a folic acid supplement during pregnancy could be essential to prevent preterm birth.

On the other hand, the Kirksey (1994) study argued that plant zinc source is negative effect on maternal phytate –zinc ratio. This study suggests that women in Egypt intake most of energy (80%) from plant source. This was resulting in high amount of phytate (1,582mg) and fiber (33g/d) as well as phytate-zinc ratio (15.2) compared to USA women. The increase of phytate-zinc ratio was negatively impacted on impaired zinc and other micronutrients' utilization. This will be caused of micronutrient deficiency during pregnancy and it affects infants' motor milestone development.

However, the Yalcin et al., (2012) study argues that there is no association between maternal anemia treated with iron and vitamin supplementation, and the age infants walk without aid. The result may be influenced by the type of questions or level of maternal iron supplement intake. The Tran et al., (2014) study suggests that levels of iron intake need to be improved in order to increase the effectiveness of maternal iron supplementation.

In addition, the Stoltzfus et al.,(2011) study argues that many studies are focused on maternal iron deficiency in relation to infant's development but, maternal iron deficiency has remained a global problem that needs to be solved, especially in developing countries.

Moreover, there are not enough studies showing the association of maternal intake of other micronutrient supplements (e.g., zinc, folic acid) with infants' gross motor milestone achievement. A systemic review by Zhou et al., (2013) also points out that there are not enough studies to support evidence that a maternal iodine supplement can contribute to children's gross motor milestone achievement.

Maternal Environmental Exposure

Maternal exposure to polydrugs (e.g., cocaine, opium), smoking and medical treatment during pregnancy can be negatively associated with infant's gross motor milestone achievements. There were eight out of nineteen studies (42%) showing that prenatal exposure negatively impacts infants, causing lower birth weights related to preterm births and delays in motor milestone development. However, ten out of nineteen studies report that maternal environmental exposure is not associated with development of certain motor milestones. In order to measure the infants' motor milestone development related to maternal environmental exposures, eight studies used the BSID. In addition, two studies used the AIMS, two studies used the PDMS, one study used the sum of the pass score of motor milestone attainment, one study used mean age of motor milestone achievement, and one study used the percentage of motor milestone attainment for assessment.

Maternal polydrugs or other chemical exposure during pregnancy was negatively associated with infants' gross motor milestone development. For instance, maternal exposure of

Toxoplasma, PCB and other polydrugs was related to delaying certain motor milestone achievements. Kankova et al., (2012) demonstrates that prenatal infants exposed to Toxoplasma showed delays in achieving certain motor milestones (e.g., head lift, roll, and crawl) compared to unexposed infants. Similarly, maternal PCB or MDMA exposure, as well as ACTH and TRH treatments could delay infants' motor milestone achievements (Nakajima et al., 2006, Huizink et al., 2002, Crowther et al., 1997). Additionally, some polydrugs studies (Singer et al., 2012, Harolyn et al., 1999, Fetters et al., 1998, Richardson et al., 1995) show that maternal exposure to polydrugs such as opiates, cocaine, alcohol, tobacco and marijuana could delay certain motor development (e.g., sitting, standing ans rolling over).

The Fetter et al., (1998) study suggests that infants exposed to polydrugs showed poor motor performance at an earlier age. He suggests that poor motor performance such as lying prone can impact other motor functions later on. He reports infants who were exposed to polydrugs often experienced muscle weakness and lack of muscle tone. This could lead to infants having weak postural control against gravity and cause difficulty in achieving a prone position. Thus, abnormal motor performance will be another good indicator to determine if the children are in normal or abnormal status (Fetter et al., 1998).

A longitudinal study (Huizink et al., 2002) suggests that cortisol levels increased in late pregnancy are related to increased stress levels at twenty four weeks of gestation. That prenatal maternal stress had a negative effect on the development and temperament of infants at age three and eight months. In addition, the Kankova et al., (2012) study demonstrates that maternal latent toxoplasmosis exposure was associated with negative motor development. The study points out that latent Toxoplasma positive mother often failed to follow the home physiotherapy exercise program compared to others. That was related to infants weight gain and delayed infants' motor development.

However, ten out of nineteen (53%) studies report that maternal environmental exposure is not associated with certain motor milestone development. The Kanokova et al., (2012) study suggests that there are no associations between maternal toxoplasmosis exposure and the mean age of achieving sitting and walking. Furthermore, organic solvent exposure during pregnancy does not affect infants' motor development (Lasio-Barker et al.,2012). Another maternal MDMA exposure study (Singer et al., 2012) states that there are no effects associated with infants' motor development at the earlier age of birth to four months. Similarly, prenatal exposure to MA (Smith et al., 2011) did not demonstrate any direct association with infants' motor development between one and three years. The Tofail et al., (2009) study supports that maternal exposure to arsenic contaminated drinking water during pregnancy does not affect development.

Some polydrugs exposure studies do not show any association with certain motor milestone achievements such as sitting alone, crawling and cruising (Haroly et al., 1999) and may not impact infants' motor development between eight and eighteen months (Richardson et al., 1995). Singer et al., (2012) suggests that polydrugs exposure would not affect infants' motor milestone development after they reach one year. Fetter et al., (1998) also supports that there is no difference in infants' motor development regardless of maternal chemical exposure in infants more than fifteen months old.

A national Danish cohort longitudinal study shows that there is not enough evidence of association with parental cell phone use and infant motor development (Davian et al., 2011). This study argues that the results could be due to the fact that participants in the study reported relatively low frequency of cell phone use. Moreover, the distance between the interviewer and the participants was too far to assess the exact infants' motor milestone achievement. Therefore, the report could be under or overestimating cell phone usage during pregnancy. Moreover, when cell phone records (billing or subscription) were assessed, it was found that individuals tended to overestimate the call duration and underestimate the number of calls. Also eighteen months (19-22%) of data were missing. Therefore, this finding suggests that consistency of data collection will need to be improved in order to avoid systemic errors and selection bias (Davian et al., 2011).

Internal Environmental Exposure

In terms of infants and their surrounding environmental factors (i.e., childcare centers and the use of walkers), there were nine studies (Osnat et al., 2013, Yalcin et al., 2012, Mulligan et al., 1998 and Iwata et al., 1991) showing positive association with infant's gross motor milestone achievements. However, four studies (Garrett et al., 2002, Siegel et al., 1999, L Mulligan et al., 1998 and Iwata et al., 1991) showed negative association. Four studies (Yalçın et al., 2012, Siegel et al., 1999 and Mulligan et al., 1998) did not show any association with infant's gross motor milestone achievement in consideration of environmental factors. In order to measure the infants' motor milestone development related to environmental exposure factors, five studies used the BSID. In addition, three studies used mean age of motor milestone achievement, two studies used the AIMS, one study used the percentage of motor milestone attainment, and one study used the Motor Development Quotient for infants' motor development assessment.

Nine out of seventeen (53%) studies showed positive associations with infants' environmental exposure and gross motor milestone development. For instance, if infants received more motivation from their mothers to move, they achieved more motor development (Osnat et al., 2013). Children, who were encouraged by their mothers to move, achieved crawling and walking milestones earlier than others (Karasilk et al., 2008).

In addition, Pridham et al., (2002) reports that caregivers' positive feeding behavior could also be positively associated with infants' motor development, especially with preterm infants. The Pridham et al., (2008) study also points out that mothers' higher educational levels are related to positive feeding behaviors and consequently, positive physical growth as well as assisting infants in achieving higher motor developmental scores. The Yalcin et al., (2012) study demonstrates that infants of mothers with higher education levels (more than eight years) walk earlier than those of mothers with lower education levels (less than eight years).

Furthermore, environmentally, infants need enough space to do physical exercise, which leads to increased daily activity levels. This factor could contribute to infants having higher motor development scores (Miqvelote et al., 2012, Doralp et al., 2010, Porter et al., 1972). Additionally, Mulligan et al., (1998) also supports that appropriate space and opportunity for infants to have physical activities and exercise positively impacts increased motor milestone development at six and twelve months of age (Mulligan et al., 1998, Bottos et al., 1989). Studies also show that higher caregiver ratios in daycare centers, (with lower interaction with caregivers) increases infants' developmental and physical activity levels at six months old. Iwata et al. (1991) states that infants enrolled in daycare after six months would be benefit in achieving motor development at earlier ages.

However, some studies suggest that babies who use walkers would be negatively associated with crawling, sitting, rolling over, standing alone and walking alone milestones. (Garrett et al., 2002, Siegel et al, 1999).Generally, walkers are used to assist children in learning to walk sooner, but also may cause injury so that it can have a negative impact on infants walking at certain ages (Garrett et al., 2002, Siegel et al., 1999). In addition, the maternal depression level in early pregnancy is also associated with delayed infants' motor development at six months (Tran et al., 2014). Therefore, these findings suggest that baby walkers and maternal depression will negatively affect infants' motor milestone development. On the other hand, the Mulligan et al., (1998), study shows that there is no association between walkers, seats and swings, and infants' motor development. Furthermore, the mother's age, parental occupations, family type, and number of household members including the presence of siblings under five years old would not be a big concern for infants' motor development (Yalcin et al., 2012).

Sleeping and Playing Positions

There were eleven studies demonstrating the association between infants' sleeping and playing positions and motor milestone development. Five out of eleven studies showed that prone sleeping and playing positions would positively affect infants' motor milestone development compared to those who had supine positions. However, five of the studies did not show any association between sleeping or playing positions and motor milestone development. In order to measure the development in relation to sleeping and playing positions, two studies used the AIMS, two studies used the DDST, and two studies used the mean age of motor milestone achievement. In addition, one study used percentage of motor milestone attainment for assessing development.

In terms of positive association with this factor, infants who spent daily time in prone positions could achieve higher motor milestone development at two, six, and ten months of age (Ohman et al., 2009, Fetters et al., 2007). Additionally, infants who are prone sleepers could achieve certain gross motor milestones at earlier ages than supine sleepers (Davis et al., 2008). Another study (Salls et al., 2002) supports that infants who spent more than fifteen minutes in the prone position could achieve certain motor milestones (e.g., 45 and 90 degree head up) at two months old. Jants et al., (1997) also points out that prone sleepers had higher percentages of rolling over at four months. However, prone positions would not benefit preterm infants in achieving certain gross motor milestones (Fetters et al., 2007).

In addition, infants with CMT (Congenital Muscular Torticollis) have been known to be at risk of delaying early motor milestones. It could be that infants with CMT tend to spend less time in prone positions when awake due to the muscular imbalance in the neck Ohman et al., 2009). But since this study was conducted after the “Back to Sleep” campaign in Israel, that campaign would influence the delaying of motor development regardless of the CMT condition. This finding suggests that more time spent in a prone position may greatly impact early motor milestone achievement in infants with CMT. Thus, infants with CMT need to be encouraged to spend more time in a prone position in order to improve their motor milestone development.

An additional study, Salls et al., (2002) argues that the "Back to Sleep “campaign seemed to result in significant differences in gross motor milestone achievement. This may due to less developed neck extensors and shoulder muscles. Before the "Back to Sleep” campaign, infants tended to roll from prone to supine. However, after the “Back to Sleep” campaign, the majority of infants rolled from supine to prone, which might be related the fact that caregivers tried to avoid having infants spend time in prone positions. The Salls et al., (2002) study points out that there were cultural differences regarding sleeping positions. For instance, American infants showed more advanced prone skills than English infants (i.e., sleeping in supine positions).

On the other hand, Lewycky et al., (2009) reports that time awake in the prone position was not associated with the age of rolling over. Salls et al., (2002) suggests that time awake (more than 15 minute and less than 15 minutes) at four and six months would not show any difference in achieving certain motor milestones if the sample sizes are too small in the age groups. Davis et al., (2008) suggests that there is no association between sleeping positions and certain motor milestone (e.g., sitting alone and walking alone) achievement. Additionally, the Iwata et al., (1991) study also supports that there is no significant correlation between sleeping position and achieving the ability to walk alone. Therefore, these findings suggest that certain motor milestones will not be influenced by any sleeping or playing positions and a reasonable sample size will be necessary for further testing.

Other Motor Milestone Achievements

There were five studies showing motor milestone achievement in correlation to other motor milestone attainment. For instance, the age of the child in achievement of some later motor milestones would depend on the child's age in achievement of some early motor milestones (e.g., rolling over and crawling).Four out of five studies showed early stage motor milestone achievement was positively related to the period of later motor milestone development. But one out of five studies showed negative associations. In order to measure infants' motor milestone development in relation to other later motor milestone attainment, three studies used mean age of motor milestone achievement, and two studies used percentage of motor milestone attainment. In addition, one study used the DDST for assessing infants' motor milestone development.

In terms of positive association with other motor milestone development, Kimura-Ohba et al., (2011) suggests that if infants could roll over at four months and crawl or sit at nine months, those same infants could walk at earlier ages than others. Additionally, the Jaffe et al., study (1996) maintains that those infants who achieved sitting alone in earlier ages correlated with walking alone at earlier ages. Bottos et al., (1989) states that age of children's walking alone relates to their age of creeping or shuffling. Touwen et al., (1971) supports that crawling and sitting at an earlier age is closely related to walking without support at an earlier age.

Furthermore, Bottos et al., (1989) argues that hypotonic is the most important factor in distinguishing between crawlers and non-crawlers. Botto believes that hypotonic crawlers tend to creep and roll over before crawling, leading to delays in the mean age of walking. The Robinso et al., (1984) study suggests that non-crawlers without hypotonia can shuffle at eleven months before walking alone but, with hypotonia, infants can shuffle at sixteen months. Therefore, the mean age of shuffle will be an important indicator in predicting the mean age of walking alone.

Moreover, by the time children can use their elbows and start pulling with their hands, the sitting position is easy to assess. Therefore, when children show signs of sitting ability, it can be a positive predictor of the age of walking without support (Touwen et al., 1971). This study suggests that comprehensive longitudinal assessment of motor behaviors can help evaluate infants' motor development rather than a cross sectional study. Kimura-ohba et al., (2011) points out that infant who could creep, but not move forward or could not sit at nine months, would be delayed in walking alone. Therefore, these findings suggest that earlier achievement of foundational motor milestones (e.g., creeping, crawling, and shuffling) can be associated with earlier attainment of walking alone.

In addition, the parachute reaction is described by(Jaffe et al., 1996) “equilibrium reaction which serves as a defense against injury when the balance is upset". The study compares the parachute reaction based on the mean age of sitting alone and walking alone. The result suggests that the late sitting and walking-alone group achieved parachute reactions later. Therefore, when children cannot attain a parachute reaction by ten months, it indicates that those infants failed to sit alone by nine months and this related to their delay in walking alone until fifteen months (Jaffe et al., 1996).

Children's Health Status

There were six studies demonstrating the relationship between infants' health status and motor milestone development. There were four studies showing negative associations with infants' abnormal conditions and motor milestone development, but there were two studies that did not show any association. In order to measure the infants motor milestone development in relation to their environmental exposure factor, two studies used the AIMS, and two studies used the percentage of motor milestone attainment. In addition, one study used the BSID and one study used the mean age of motor milestone achievement for assessment.

In terms of children's health factors, without any health status such as clubfoot, CMT (Congenital Muscular Torticollis) or Down syndrome, with normal IQ conditions, infants should have normal motor milestone development. Infants with CMT showed lower motor milestone development at two and six months compared to normal infants (Ohman et al., 2009). Additionally, infants with Down syndrome experience motor milestone retardation compared to normal infants (Haley et al., 1985). Another study (Tenbrinck et al., 1974) maintains that infants with moderately retarded IQ levels related to delays in the ages of standing and walking. Garcia et al., (2011) suggest that babies with clubfoot conditions have delays in motor development at nine and twelve months. Lastly, infants who have had malaria infections have been negatively affected in their TMA (Total Motor Activity) score, relating to delays in the age of walking alone (Olney et al., 2007).

However, regarding clubfoot and non-clubfoot infants, there was no significant difference in achieving rolling over and siting alone at three and six months (Garcia et al., 2011). In addition, children's with clubfoot was not a big issue in motor milestone development at fifteen months. This could be due to the fact that infants achieve most motor milestones at fifteen and eighteen months (Garcia et al., 2011). In addition, if infants were severely or profoundly retarded (i.e., IQ level below 52) then, those infants could not walk after two years. Therefore, these finding suggest that certain motor milestones (e.g., sitting, standing, and walking) can be predicted within the first eighteen months related to children's health conditions. There was no association with infants' IQ levels and sitting, standing and walking if the IQ retardation was not severe.

<u>Others Factors (e.g., SES and gender)</u>

Fifteen studies reported additional factors related to infants motor milestone development. Five of these studies demonstrated additional factors that positively or negatively affect infants' motor milestone development. However, ten out of the fifteen studies showed no association of infants' motor development in relation to other factors including: SES levels, gender differences, birth length, and seasons of birth. In order to measure motor milestone development related to these other factors, six studies used the mean age of motor milestone achievement, and three studies used the percentage of motor milestone attainment. In addition, three studies used the AIMS and two studies used the PDMS.

In terms of birth weight differences (i.e., full term vs. preterm birth), Restiffe et al., (2012) suggests that lower neonatal nursery stays would have a beneficial effect on increasing the odds of walking. Palisano et al., (1985) suggests that among premature infants, female infants could achieve motor milestones earlier than male. Yalcin et al., (2012) also supports that female infants could achieve most motor milestones earlier than male infants. Braine et al., (1966) supports that in black premature infants, female infants had higher motor development scores than male infants. Hanzik et al., (1965) also argues that female premature infants achieve advanced motor development over male premature infants. It could be due to the different maturation rate between female and male.

In terms of gender difference, race would be another factor which is related to infants' motor milestone development (Capute et al., 1985).For instance, in white infants, males achieved most motor milestones (e.g., creep, walk, and run) earlier in age than females. In contrast, black female infants achieved most motor milestones earlier than males.

Additionally, in terms of household income level and race, Stanitski et al., (2000) suggests that lower income levels would positively impact black infants to achieve motor milestones but, not white infants (Stanitski et al., 2000).It could be the participants in the Capute et al., (1985) study were mainly black with lower socioeconomic status. In contrast, the population in Gesell's study was mostly upper-middle class white. In addition, the age limit in Gesell's study which measured infants' ability to sit was ten months, whereas it was eight months in Capute's study. Therefore, with these findings, it suggests that SES levels may not have an impact on infants' motor milestone achievement between black and white infants, but, it will be the cause of differences between traditional and contemporary references in terms of upper age limit levels.

On the other hand, nine out of seventeen (53%) studies show no association of infants' motor development with other factors including SES levels, gender difference, birth length, and seasons of birth. In terms of birth weight, three studies show that there is no association with SES and infants' attaining the ability to walk unassisted (Restiffe et al., 2012, Kuklina et al., 2004, Grantham McGregor et al., 1971). Regarding gender and difference, five studies report that there is no association with infants' motor development.(Kimura-ohba et al., 2011, Kuklina et al., 2004, Bottos et al., 1989, Capute et al., 1985, Palisano et al., 1985). In particular, the Capute study suggests that there is no difference between gender and certain motor milestone achievements. Furthermore, some studies show that other factors, including maternal age, type of feeding, birth order, and frequency of carrying piggyback is not associated with the age of beginning to walk alone (Kuklina et al., 2004, Iwata et al., 1991).

This systematic review study discusses each factor associated with infants' gross motor milestone development. It also states positive, negative and null association with each factor relating to infants' gross motor milestone development. It compares the measurement tools used for assessing infants' motor development as well.

However, this systemic review study has certain limitations. There are additional factors not demonstrated in this study that can impact infants' motor milestone development. For example, under the cultural difference factor, women who live in certain regions or countries are faced with a lack of food security, affecting their intake of iron rich foods (Border et al., 2007) and it can be related to delay infants' motor development (Cook et al., 2006). Environmentally, women and children can suffer from poor water and sanitation that is negatively affecting their ability to maintain a health due to intestinal and infectious disease (Ngure et al., 2014). These basic factors will be essential to include in the intervention study. However, this study does not explore these points related to infants' motor milestone development.

Furthermore, gross motor milestone development in infants is related to the central nervous system and large muscle movement (Gerber et al., 2010). This systemic review study did not include the relationship of the brain or muscle movement in the study criteria. Thus, this study cannot suggest or determine the impact of brain and muscle movement on infants' motor milestone development.

In addition, the outcome results can be varied depending on the study design, assessment tool, sample size, and environmental conditions. Therefore, some studies may provide similar results relating to factors, but other studies may not show any association with factors and infants' motor development. Thus, it will be another limitation to determine each factor associated with infants' motor milestone development.

Conclusion

These eleven factors associated with infants' motor milestone development suggest that a balanced diet is important to assist children in achieving gross motor milestones at a certain age. In order to achieve normal motor milestones, earlier nutritional intervention programs are necessary for children, in order to prevent infant gross motor milestone retardation. In terms of the relationship of mothers 'feeding behaviors, some studies state that mothers with higher education levels will correlate to positive maternal feeding practices. These suggest that caregiver's feeding and rearing practices are essential factors to be considered in assisting infants in achieving motor milestones at certain ages. In addition, caregiver will have a larger impact on preterm infants than on full term infants. Many studies maintain that preterm infants are vulnerable in their ability to achieve normal motor milestones compared to full term infants. Therefore, preterm infants need special care from caregivers, by their feeding practices, and also physical activity, especially between the ages of eight to twelve months, because most motor milestones are achieved in that period.

Regarding environmental factors, ample space where children can practice physical exercise will be helpful but also in achieving motor milestones at certain ages. Many studies suggest that caregivers should encourage children to move and should provide opportunities for children to experience various kinds of physical activity. In addition, it is very beneficial for infants to spend time in prone positions (i.e., more than15 minutes). This has been shown to have positive impact onachieving gross motor milestones. Furthermore, children will benefit by being in daycare after six months and they should avoid using a baby walker in order to prevent injuries. However, overprotective caregivers' behavior can lead to limiting infants' movements, and thus delaying motor milestone development.

In order to avoid preterm birth, women need iron supplements plus a nutritional diet before and after pregnancy. Thus, maternal nutritional factors relate to the improvement of infants' physical growth and consequently, it's impact on infants' motor milestone attainment. However, there were not enough studies to conclusively support the maternal nutritional factor associated with infants' motor milestone development. Plus comprehensive maternal nutritional programs such as maternal education in micronutrient supplements during pregnancy, breast feeding, positive feeding behaviors are important but, it needs to be determined if any barriers or limitations will need to be further explored while conducting the program. Then, with this program in place, it will contribute to decreased preterm birth rates and improved prenatal growth rates. Both of these factors contribute to infants' reaching gross motor milestones at certain ages.

Furthermore, maternal toxic chemical exposure and depression are related to preterm birth rates. Some studies suggest that even though certain chemical or polydrugs exposures will not have an impact on the early period of motor milestone development, it will affect infants' later period. Therefore, women need to be aware of any harmful chemical exposure during pregnancy because it can impact their children during later periods of motor performance such as in bicycle riding or other physical activities. In particular, organic chemical solvent (PVC, MA) exposure is a potential risk factor for children's motor development and MA combined with other polydrugs such as cocaine will increase the risk of delaying motor development later on.

However, many studies could not find any association between certain factors and infants' motor milestone achievements; such as if the target population had low birth weight compared to higher birth weight children. In addition, there are certain limitations to determining the significant difference in gross motor milestone achievements if the children are over twenty months old (since most motor milestones are achieved before twenty months) or if the children are severely iron deficient. Healthy infants can achieve most motor milestones earlier in age compared to infants with Down syndrome and/or lower IQ levels. But, there is no association with infants' motor milestone development if the IQ retardation is not severe.SES level, gender difference, birth length, and seasons of birth are not important factors that can be associated with infants' motor milestone achievement. Cultural differences may not be an important predictor if other factors such as birth weight and nutritional factors are adjusted at the same time.

In terms of study design and method, longitudinal studies will work better compared to cross-sectional studies. In order to assess infants' motor milestone development, appropriate measurement tools need to be selected. For instance, the AIMS cannot assess all gross motor milestone achievements from birth to two years but it is appropriate to use during the middle period, between eight and twelve months. The BSID is useful to use when assessing cognitive development. Overall, infants' motor development can be predicted by considering certain motor behaviors.

Recommendation

Because by 20 months most motor milestones should by achieved, studies to assess milestone development should be conducted in young children. There are pros and cons of each measurement scale so these points are needed to be consider prior to study.

Bibliography

A BASCHAT, R. M. VISCARDI, B. HUSSEY-GARDNER, N. HASHMI and C. HARMAN Infant neurodevelopment following fetal growth restriction:relationship with antepartum surveillance parameters, *Ultrasound Obstet Gynecol* 2009; 33: 44–50

AB Jahari, C Saco-Pollitt, MA Husaini1 and E Pollitt, Effects of an energy and micronutrient supplement on motor development and motor activity in undernourished children in Indonesia, European Journal of Clinical Nutrition (2000) 54, Suppl 2, S60-S68

Amiel-Tison C, Grenier A. (1986) *Neurological Assessment During the First Year of Life*. New York: Oxford University Press.— Dube R, Garel M, Jequier JC. (1983) Outcome at age five years offull-term infants with transient neurologic abnormalities in thefirst year of life. In: Stern

L, Bard H, Friis-Hansen B, editors.*Intensive Care IV.*New York: Masson. p 247–58.

Ana P. Restiffe, José Luiz D. Gherpelli,, Differences in walking attainment ages between low-risk preterm and healthy full-term infants,Arq Neuropsiquiatr 2012;70(8):593-598

Andrea C. Siegel, Roger V. Burton, Effects of Baby Walkers on Motor and MentalDevelopment in Human Infants, 1999, Vol. 20(5), 355-361

Barfield, Relationship of Factors Affecting Age of Onset of Independent Ambulation, J Pediatr Orthop, Vol. 20, No. 5, 2000

Bayley, N. (1965). Comparisons of mental and motor test scores for ages 1–15 months by sex, birth, order, race, geographical location, and education of the parents. Child Development, 36, 379–411.

Bertenthal, B. I., Campos, J. J., & Barrett, K. C. (1984). Selfproduced locomotion: An organizer of emotional, cognitive, and social development in infancy. In: R. Emde,& R.Harmon (Eds.), Continuities and discontinuities in development (pp. 175–210). New York: Plenum.

Beth Ellen Davis, Rachel Y. Moon, Hari C. Sachs and Mary C. Ottolini, Effects of Sleep Position on Infant Motor Development, *Pediatrics* 1998;102;1135

Black, R.E., L.H. Allen, Z.A. Bhutta, *et al*. Maternal and child under nutrition: global and regional exposures and health consequences. *Lancet* 371: 243–260. 2008.

Borders, A.E.B., Grobman, W.A., Amsden, L.B., & Holl, J.L. (2007). Chronic stress and low birth weight neonates in a low-income population of women. *Obstetrics and Gynecology, 109,* 331-338.

Brian Hopkins, Tamme Westra, MATERNAL EXPECTATIONS OF THEIR INFANTS' DEVELOPMENT: SOME CULTURAL DIFFERENCES,Developmental Medicine and Child

Neurology, 1989, 31, 384-390

Bril, B. (1986). Motor development and cultural attitudes, Themes in Motor Development, 35, 297–313.

Brook[SM] Rehabilitation, A Guide To Your Child's Gross & Fine Motor Development, 1- 24p), website at BrooksRehab.org
Bryant GM, Davies KJ, Newcombe RG. The Denver Developmental Screening Test: achievement of test items in the first year of life byDenver and Cardiff infants. *Dev Med Child Neurol.* 1974; 16:475– 484.

Bushnell, E. W., & Boudreau, J. P. (1993). Motor development and the mind: The potential role of motor abilities as a determinant of aspects of perceptual development. Child Development, 64, 1005–1021.

Caroline Anne Crowther, Janet Esther Hiller, Ross Roger Haslam, Jeffrey Samuel, Robinson and the ACTOBAT Study Group, Australian Collaborative Trial of Antenatal Thyrotropin-Releasing Hormone: Adverse Effects at 12-Month Follow-up, *Pediatrics* 1997; 99; 311

Cheung YB, Yip PS, Karlberg JP. Fetal growth, early postnatal growth and motor development in Pakistaniinfants. Int J Epidemiol 2001; 30: 66-72.

Cintas, H. M., Cross-cultural variation in infant motor development. Physical and Occupational Therapy in Pediatrics, 8(4), 1988, 1–20.

Clark, J. E, On becoming skillful: Patterns and constraints. Research Quarterly for Exercise & Sport, 66(3), 1995 173–183.
Cook, Frank, Leveson, Neault, Heeren, Black, Berkowitz, Casey, Meyers, Cutts, and Chilton (2006) Child food insecurity increases risks posed by household food insecurity to young children's health. *Journal of Nutrition*, 136, 1073-1076.

David Pyle, Tricia Tibbetts, Assessment of Active, Experiential Training on Program Expansion: Living University in the Positive Deviance/ Hearth Program in Vietnam , BASICS II 2002 report

David R. Marsh, Helena Pachón, Dirk G. Schroeder, Tran Thu Ha, Kirk Dearden, Tran ThiLang, Nguyen Dhanh Hien, Doan Anh Tuan, Tran Duc Thach, and David Claussenius, Design of a prospective, randomized evaluation of an integrated nutrition program in rural VietNam, *Food and Nutrition Bulletin*, vol. 23, no. 4, 2002

de Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J. The WHO Multicenter Growth Reference Study: planning, study design, and methodology. Food Nutri Bull. 2004 Mar; 25(1Suppl): S15-26

de Onis M, Onyango AW, Borghi E, Garza C, Yang H, Comparision of World Health Organization (WHO) Child Growth Standards and the National Center for Health Statistic/WHO interactional growth reference: implication for child health programmes. Public Health Nutr. 2006 Oct; 9(7): 942-7

De Onis, Mercedes, Edward A. Frongillo and Monika Blossner., "Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980." *Bulletin of the World Health Organization* 2000, 1222–1233.

Deanna K. Olney, Ernesto Pollitt, Patricia K. Kariger, Sabra S. Khalfan,Nadra S. Ali, James M. Tielsch, Sunil Sazawal, Robert Black, Lindsay H. Allen, Rebecca J. Stoltzfus, Combined Iron and Folic Acid Supplementation with or without Zinc Reduces Time to Walking Unassisted among Zanzibari Infants 5- to 11-mo old, J. Nutr. 136: 2427–2434, 2006.

Deborah F. Stanitski, Paul J. Nietert, Carl L. Stanitski, Richard K. Nadjarian, William Barfield, Relationship of Factors Affecting Age of Onset of Independent Ambulation, J Pediatr Orthop, Vol. 20, No. 5, 2000

Diana Kuh, Rebecca Hardy, Suzanne Butterworth, Lucy Okell, Marchus Richarads, Michael Wadsworth, Cyrus Cooper, Avan Aihie Sayer, Developmental Origins of Midlife Physical Performance: Evidence from a British Birth Cohort, Am J Epidemiol 2006;164:110–121
Dirk G. Schroeder, Helena Pachón, Kirk A. Dearden, Tran Thu Ha, Tran Thi Lang,and David R. Marsh, An integrated child nutrition intervention improvedgrowth of younger, more malnourished children in northern Viet Nam, *Food and Nutrition Bulletin*, vol. 23, no. 4 (supplement) 2002, 50-59

Domenico MM Romeo, Matteo Cioni, Mariacristina Scoto, Filippo Palermo, Alessandra Pizzardi, Anna Sorge, Mario G Romeo, Development of the forward parachute reaction and the age of walking in near term infants: a longitudinal observational study, *BMC Pediatrics* 2009;9, 1-7

Doreen J Bartlett, Jamie Kneale Fanning , Linda Miller , Angela Conti-Becker ,Samantha Doralp, Development of the Daily Activities of Infants Scale: a measure supporting early motor development, Developmental Medicine & Child Neurology 2008, 50: 613–617

E Pollitt, A developmental view of the undernourished child: background and purpose of the study in Pangalengan, Indonesia, European Journal of Clinical Nutrition (2000) 54, Suppl 2, S2-S10

Elena V. Kuklina, Usha Ramakrishnan, Aryeh D. Stein, Huiman H. Barnhart, Reynaldo Martorell, Growth and Diet Quality Are Associated with the Attainment of Walking in Rural Guatemalan Infants, J. Nutr. 134: 3296–3300, 2004.

Emily H. Siegel, Rebecca J. Stoltzfus, Patricia K. Kariger, Joanne Katz, Engle, P.L. & G.H. Pelto. 2011. Responsive feeding: implications for policy and program implementation. *J. Nutr*. 141:508–511

Engle, P.L. & L. Lhotska. 1999. The role of care in programmatic actions fornutrition: designing programmesinvolvingcare. *Food Nutr. Bull*. 20: 121–114.

Engle, P.L., M. Bentley & G. Pelto. 2000. The role of care in nutrition programmes: current research and a research agenda. *Proc. Nutr. Soc*. 59: 25–35.

Fahmida Tofail, Marie Vahter, Jena D. Hamadani, Barbro Nermell, Syed N. Huda, Mohammad Yunus,1 Mahfuzar Rahman, and Sally M. Grantham-McGregor, Effect of Arsenic Exposure during Pregnancy on Infant Development at 7 Months in Rural Matlab, Bangladesh,*Environ Health Perspect* 117:288–293 (2009)
Frongillo, E.A., F. Tofail, J.D. Hamadani, *et al*. 2014. Measures and indicators for assessing impact of interventionsintegrating nutrition, health, and early childhood development.*Ann. N. Y. Acad. Sci.* 1308: 68–88.

Fung KP, Lau SP. Denver Developmental Screening Test: culturalvariables [letter]. *J Pediatr.*1985; 106:343.

GALE A. RICHARDSON, NANCY L. DAY AND LIDUSH GOLDSCHMIDT Prenatal Alcohol, Marijuana, and Tobacco Use: Infant Mental and Motor Development, Neurotoxicology and Teratology, Vol. 17, No. 4, pp. 479-487, 1995

Gerber R Jason, Wilk Timothy, Erdie-Lalena Christine, Developmental Milestones: Motor Development, Pediatr. Rev. 2010; 31: 267-277

Gogia S, Sachdev HS, Zinc supplementation for mental and motor development in children (Review), Cochrane review, 2012,Issue 12

Grantham-McGregor, S., Y.B. Cheung, S. Cueto, *et al*..Developmental potential in the first 5 years for children in developing countries.*Lancet* 369: 60–70. 2007

Gressens P, Kosofsky BE, Evrard P. (1992) Cocaine-induced disturbances of corticogenesis in the developing murine brain.*Neuroscience Letters* 140: 113–6.

Groos AD. Delayed motor development in relation to nutritional status among children under two years of age in two districts of Simbu Province. P N G Med J 1991; 34: 238-245.

Gudrun Schwarzer, Claudia Freitag, Rebecca Buckel, Annika Lofruthe, Crawling is Associated withMental RotationAbility by 9-Month-Old Infants, Infancy, 18(3), 432–441, 2013

H Harahap, AB Jahari1, MA Husaini, C Saco-Pollitt, E Pollitt, Effects of an energy and micronutrient supplement on iron deficiency anemia, physical activity and motor and mental development in undernourished children in Indonesia, European Journal of Clinical Nutrition (2000) 54, Suppl 2, S114-S119

Hadeed AJ, Siegel SR. (1989), Maternal cocaine use during pregnancy: effect on the newborn infant. *Pediatrics* 84: 205–10.
Harolyn M E , Bruce K Shapiro, Mary Leppert , Arlene M Butz , Sherry Sellers , Ellen Arch, Ken Kolodner Margaret Pulsifer , Mary Kathleen Lears, Walter E Kaufmann, Sequential neuromotor examination in children with intrauterine cocaine/polydrug exposure, *Developmental Medicine & Child Neurology* 1999, 41: 240–246

Henderson J, Gray R, Brocklehurst P, Systemic review of effects of low-moderate prenatal alcohol exposure on pregnancy outcome, BJOG 2007; 114:243-252

Hiroko IWATA, A STATISTICAL ANALYSIS OF THE FACTORS THAT DETERMINE THE AGE AT WHICH BABIES START WALKING, J. Human Ergol., 20: 27-40,1991

Hong-Ji Luo, Pei-Shan Chen, Wu-Shiun Hsieh, Kwan-Hwa Lin, Tung-Wu Lu, Walking Attainment in Preterm and Full-Term Infants Associations of Supported Treadmill Stepping With *PHYS THER.* 2009; 89:1215-1225

J. R. Simons, MaryBeth Mandich, Susan K. Ritchie,Martha D. Mullett, Assessment of Motor Development in Very Low BirthWeight Infants, Journal of Perinatology 2000; 3:172–175

James M. Tielsch,Sunil Sazawal, Robert Black, Darrell Mast, Lindsay H. Allen, Rebecca J. Stoltzfus, Young Zanzibari Children with Iron Deficiency, Iron Deficiency Anemia, Stunting, or Malaria Have Lower Motor Activity Scores and Spend Less Time in Locomotion, J. Nutr. 137: 2756–2762, 2007

Joanne Katz, Subarna K. Khatry, Steven C. LeClerq, Luke C. Mullany, Elizabeth L. Yanik, Rebecca J. Stoltzfus,Emily H. Siegel, James M. Tielsch, Daily Supplementation with Iron Plus Folic Acid, Zinc, and Their Combination Is Not Associated with Younger Age at First Walking Unassisted in Malnourished Preschool Children from a Deficient Population in Rural Nepal, J. Nutr. 140: 1317–1321, 2010.

Jonathan W. Jantz, Christopher D. Blosser; Lynne A. Fruechting, A Motor Milestone Change Noted With a Change in Sleep Position, Arch Pediatr Adolesc Med. 1997;151:565-568

Kariger PK, Stoltzfus RJ, Olney D, et al. Iron deficiency and physical growth predict attainment of walking butnot crawling in poorly nourished Zanzibari infants. J Nutr 2005; 135: 814–819.

KATHLEEN NOLLER, DENNIS INGRISANO, Cross-Sectional Study of Gross and Fine Motor Development Birth to 6 Years of Age, *PHYS THER.*1984; 64:308-316.
Kim Nixon-Cave et al, Influence of Cultural/Ethnic Beliefs and Behaviors and Family Environment on the Motor Development of Infants 12-18 Months of Age in Three Ethnic Groups: African-American, Hispanic/Latino and Anglo-European, 2001, Temple University, Doctoral Dissertation

Kimberly Van Den Wymelenberg, Jean Crosetto Deitz, Susan Wendel, Deborah Kartin, Early Intervention Service Eligibility: Implications of Using the Peabody Developmental Motor Scales, *American Journal of Occupational Therapy, 60*, 327–332

Kirsten R Heineman, Arend F Bos, Mijna Hadders-Algra, The Infant Motor Profile: a standardized and qualitative method to assess motor behavior in infancy, *Developmental Medicine & Child Neurology* 2008, 50: 275–282

KIRSTEN R HEINEMAN, SACHA LA BASTIDE-VAN GEMERT, VACLA FIDLER, KARIN J MIDDELBURG AREND F BOS,MIJNA HADDERS-ALGRA, Construct validity of the Infant Motor Profile: relation with prenatal, prenatal, and neonatal risk factors, Developmental Medicine

& Child Neurology 2010, 52: e209–e215

KR Heineman1,2, KJ Middelburg1, M Hadders-Algra, Development of adaptive motor behaviour in typically developing infants, Acta Pædiatrica/Acta Pædiatrica 2010 99, pp. 618–624(Aburto 2007)

Laila de Groot, Cees J. de Groot and Brian Hopkins, An Instrument To Measure Independent Walking: Are There Differences Between Preterm and Fullterm Infants? *J Child Neurol* 1997 12: 37

Lana B. Karasik, Catherine S. Tamis-LeMonda, and Karen E. Adolph, Transition From Crawling to Walking and Infants' Actions With Objects and People, Child Development, July ⁄ August 2011, Volume 82, Number 4, Pages 1199–1209

Lim HC, Chan T, Yoong T. Standardisation and adaptation of theDenver Developmental Screening Test (DDST) and Denver II for usein Singapore children. *Singapore Med J.* 1994;35:156 –160

Linda Fetters, Hsiang-han Huang, Motor development and sleep, play, and feeding positions in very-low-birth weight infants with and without white matter disease, *Developmental Medicine & Child Neurology* 2007, 49: 807–813
Lizanne Mulligan, Bonny L. Specker, Donna D.Buckley, Lisa S. O'Connor, Mona Ho, Physical and Environmental Factors Affecting Motor Development, Activity Level, and Body Composition of Infants in Child Care Centers, Pediatr Phy Ther 1998;10:156-161

M Garrett, A M McElroy, A Staines, Locomotor milestones and baby walkers: cross sectional study, BMJ VOLUME 324 22 JUNE 2002

M. Black, Kathryn G. Dewey, Promoting equity through integrated early child development and nutrition interventions, Ann. N.Y. Acad. Sci. 1308 (2014) 1–10 C

M.W. Clearfield, The role of crawling and walking experience in infant spatial memory, J. Experimental Child Psychology 89 (2004) 214–241WHO MULTICENTRE GROWTH REFERENCE STUDY GROUP

MA Marín Gabriel, CR Pallás Alonso , J De La Cruz Bértolo3, S Caserío Carbonero1, M López Maestro1, M Moral Pumarega, C Alonso Díaz, D Lora Pablos, Age of sitting unsupported and independent walking in very low birth weight preterm infants with normal motor development at 2 years, Acta Pædiatrica ISSN 0803–5253

Margaret E. Bentley,Laura E. Caulfield, Malathi Ram, Maria Claudia Santizo, Elena Hurtado, Juan A. Rivera, Marie T. Ruel, Kenneth H. Brown, *Community and International Nutrition:* Zinc Supplementation Affects the Activity Patterns of Rural Guatemalan Infants, J. Nutr. 127: 1333–1338, 1997

Marilee C. Allen, Greg R. Alexander,Gross motor milestones in preterm infants: Correction for degree of prematurity,J PEDIATR 1990; 146:955-9

Maureen M. Black, Neurocognitive Function and Trace Elements: The Evidence Linking Zinc Deficiency with Children's Cognitive and Motor Functioning, J. Nutr. 133: 1473S–1476S, 2003

Melissa W. Clearfield,Infant Behavior and Development: Learning to walk changes infants' social interactions,Infant Behavior & Development 34 (2011) 15–25

Michael Maia Schlüssel, Elton Bicalho de Souza, Michael Eduardo Reichenheim, Gilberto Kac, Physical activity during pregnancy and maternal-child health outcomes: a systematic literature review, Cad. Saúde Pública, Rio de Janeiro, 24 Sup 4:S531-S544, 2008
Mitchell, G. *et al.* 2013. Parental influences on children'seating behavior and characteristics of successful parentfocusedinterventions. *Appetite* 60: 85–94

Nancy Jennings Aburto, Rafael Flores, Reynaldo Martordl, Aryeh Stein, Physical Activity and Exploration in Mexican Children Less Than 18 Monthsof Age, 2007, Thesis of PhD paper, Emory University

Ngure FM, Reid BM, Humphrey JH, Mbuya MN, Pelto G, Stoltzfus RJ, Water, sanitation, and hygiene (WASH), environmental enteropathy, nutrition, and early child development: making the links,Ann N Y Acad Sci. 2014 Jan;1308:118-28

NIN/UNICEF.National vitamin A deficiency and protein-energy malnutrition prevalence survey. Hanoi:National Institute of Nutrition and UNICEF, 1999.

Ora Oudgenoeg-Paz, M. (Chiel) J.M. Volman, Paul P.M. Leseman, Attainment of sitting and walking predicts development of productive vocabulary between ages 16 and 28 months, Infant Behavior & Development 35 (2012) 733– 736

Orton Jane, Spittle Alica, Doyle lex, Anderson Peter, Boyd Roslyn, Do early intervention programmes improve cognitive and motor outcomes for preterm infants after discharge? A systemic review, Developmental Medicine & Child Neurology, 2009; 51: 851-859

Osnat Atun-Einy, Sarah E. Berger, Anat Scher, Assessing motivation to move and its relationship to motor development in infancy, Infant Behavior & Development 36 (2013) 457– 469

Pamela J. Surkan , Emily H. Siegel , Shivani A. Patel, Joanne Katz , Subarna K. Khatry, Rebecca J. Stoltzfus , Steven C. LeClerq, James M. Tielsch , Effects of zinc and iron supplementation fail to improve motor and language milestone scores of infants and toddlers, Nutrition 29 (2013) 542–548

Patrice L Engle*, Maureen M Black*, Jere R Behrman, Meena Cabral de Mello, Paul J Gertler, Lydia Kapiriri, Reynaldo Martorell, Mary Eming Young,Child development in developing countries 3 Strategies to avoid the loss of developmental potential inmore than 200 million children in the developing world *Lancet* 2007; 369: 229–42

Patricia K. Kariger, Rebecca J. Stoltzfus, Deanna Olney,Sunil Sazawal, Robert Black,James M. Tielsch, Edward A. Frongillo, Sabra S. Khalfan, Ernesto Pollitt, Iron Deficiency and Physical

Growth Predict Attainment of Walking but Not Crawling in Poorly Nourished Zanzibari Infants, J. Nutr. 135: 814–819, 2005.

Pelletier DL, Frongillo EA Jr, Schroeder D, Habicht JP. The effects of malnutrition on child mortality in developing countries. *Bulletin of the World Health Organization* 1995;73: 443–48.
Pollitt E, Husaini MA, Harahap H, Halati S, Nugraheni A, Sherlock AO. Stunting and delayed motor development in rural West Java. Am J Hum Biol 1994; 6: 627–636.

R.M. Angulo-Kinzler , P. Peirano , E. Lin , C. Algarin , M. Garrido , B. Lozoff, Twenty-four-hour motor activity in human infants with and without iron deficiency anemia, Early Human Development 70 (2002) 85–101

Rafaela s. Moreira, Livia C. Magalhaes, Claudia R.L.Alves, Effect of preterm birth on motor development, behavior, ad school performance of school-age children: a systematic review, J Pediatr (Rio J). 2014; 90(2):119-134

Raija-Leena Punamaki , Leena Repokari , Sirpa Vilska , Piia Poikkeus Aila Tiitinen , J. Sinkkonen , Maija Tulppala, Maternal mental health and medical predictors of infant developmental and health problems from pregnancy to one year: Does former infertility matter? Infant Behavior & Development 29 (2006) 230–242

Raweewan Lekskulchai and Joan Cole, Effect of a developmental program on motor performance in infants born preterm, Australian Journal of Physiotherapy 2001 Vol. 47

Rebecca J. Stoltzfus, Iron Interventions for Women and Children in Low-Income Countries [1-2], America Society for Nutrition, 141: 756S-762S, 2011

Regina T. Harbournea, Michele A. Lobob, Gregory M. Karstc, James Cole Galloway, Sit happens: Does sitting development perturb reaching development, or vice versa? Infant Behavior & Development 36 (2013) 438– 450

Ritesh Tripathi, Abraham M. Joshua, M. Shashidhar Kotian,, Jaya Shanker Tedla, Normal Motor Development of Indian Children on Peabody Developmental Motor Scales-2 (PDMS-2), Pediatr Phys Ther 2008;20:167–172)
Rosa M. Angulo-Barroso, Lauren Schapiro, Weilang Liang, Onike Rodrigues, Tal Shafir, Niko Kaciroti, Sandra W. Jacobson, Betsy Lozoff, Motor Development in 9-Month-Old Infants in Relation to Cultural Differences and Iron Status, Developmental Psychobiology, 2010;(September)196-210

Ross G. Use of the Bayley scales to characterize abilities of premature infants. Child Dev 1985; 56:835–42.

S. M. Grantham-McGregor, E. H. Back, Gross Motor Development in Jamaican Infants, Develop. Med. Child Neirrol.1971,13. 79-87

S. Songül Yalçın, Kadriye Yurdakök, Basak Tezel, Sema Özbas, Family and infant characteristics in relation to age at walkingin Turkey, The Turkish Journal of Pediatrics 2012; 54: 260-268

Saigal S, Rosenbaum P, Stoskopf B et al. Follow-up of infants 501 to 1500 g birth weight delivered to residents ofa geographically defined region with perinatal intensive care facilities. J Pediatr 1982; 100:606–13.

Salls, J. S., Silverman, L. N., & Gatty, C. M. (2002). Brief Report—The relationship of infant sleep and play positioning to motor milestone achievement. American Journal of Occupational Therapy, 56, 577–580

Šárka Kaňková , Jan Šulc , Romana Křivohlavá , Aleš Kuběna , Jaroslav Flegr, Slower postnatal motor development in infants of mothers with latent toxoplasmosis during the first 18 months of life, Early Human Development 88 (2012) 879–884

Satoko Yanagiya, Yasuhito Sengoku, Takao Iida, Fumihiro Sata, and Reiko Kishi Effects of Prenatal Exposure to Polychlorinated Biphenyls and Dioxins on Mental and Motor Development in Japanese Children at 6 Months of Age, *Environ Health Perspect* 114:773–778 (2006).

Scwartz, C. *et al.* 2011. Development of healthy eating habitsearly in life. Review of recent evidence and selected guidelines.

Seth Adu-Afarwuah, Anna Lartey, Kenneth H Brown, Stanley Zlotkin, André Briend, and Kathryn G Dewey Randomized comparison of 3 types of micronutrient supplements for home fortification of complementary foods in Ghana: effects on growth and motor development, *Am J Clin Nutr* 2007;86:412–20

Shao J Zhou, Amanda J Anderson, Robert A Gibson, and Maria Makrides, Effect of iodine supplementation in pregnancy on child development and other clinical outcomes: a systematic review of randomized controlled trials, Am J Clin Nutr 2013;98:1241–54.

Shihoko Kimura-Ohba, Akiko Sawada,Yuka Shiotani,1 Shigeyuki, Matsuzawa,1Tomonari Awaya,Hiroko Ikeda, Masako Okada1 and Kiyotaka Tomiwa, Variations in early gross motor milestones and in the age of walking in Japanese children, *Pediatrics International* (2011) 53, 950–955

Siegel EH, Stoltzfus RJ, Kariger PK, et al. Growth indices, anemia, and diet independently predict motormilestone acquisition of infants in south central Nepal.J Nutr 2005; 135: 2840–2844.

Sonomi Nakajima, Yasuaki Saijo,1 Shizue Kato, Seiko Sasaki, Akiko Uno, Nobuo Kanagami, Hironori Hirakawa, Tsuguhide Hori et al, Effects of Prenatal Exposure to Polychlorinated Biphenyls and Dioxins on Mental and Motor Development in Japanese Children at 6 Months of Age, Environmental Health Perspectives • Vol.,114 (5), May 2006

Subarna K. Khatry, Steven C. LeClerq, Ernesto Pollitt, James M. Tielsch, Growth Indices, Anemia, and Diet Independently Predict Motor Milestone Acquisition of Infants in South Central Nepal, J. Nutr. 135: 2840–2844, 2005

Suh-Fang Jeng , Kuo-Inn Tsou Yau, Hua-Fang Liao, Li-Chiou Chen, Pei-Shan Chen, Prognostic factors for walking attainment in very low-birth weight preterm infants, Early Human Development 59 (2000) 159–173

Suh-Fang Jeng , Tin-Wai Lau, Wu-Shiun Hsieh , Hong-Ji Luo,Pei-Shan Chen, Kwan-Hua Lin , Jeng-Yi Shieh, Development of walking in preterm and term infants: Age of onset, qualitative features and sensitivity to resonance, Gait & Posture 27 (2008) 340–346

Suh-Fang Jeng, Kuo-Inn Tsou Yau, Li-Chiou Chen, Shu-Fang Hsiao, Alberta Infant Motor Scale: Reliability and Validity When Used on Preterm Infants in Taiwan, *PHYS THER.* 2000; 80:168-178.

Suh-Fang Jeng, Li-Chiou Chen, Kuo-Inn Tsou, Wei J Chen and Hong-Ji Luo, Relationship Between Spontaneous Kicking and Age of Walking Attainment in Preterm Infants With Very Low Birth Weight and Full-Term Infants, *PHYS THER.* 2004; 84:159-172.

Suh-Fang Jeng, Li-Chiou Chen, Kuo-Inn Tsou, Wei J Chen and Hong-Ji Luo,Susan R Harris and Carolyn B Heriza , Measuring Infant Movement: Clinical and Technological Assessment Techniques, *PHYS THER.* 1987; 67:1877-1880

Syrengelas , T. Siahanidou , G. Kourlaba , P. Kleisiouni , C. Bakoula , G.P. Chrousos, Standardization of the Alberta infant motor scale in full-term Greek infants:Preliminary results, Early Human Development 86 (2010) 245–249

Tal Shafir, Rosa Angulo-Barroso, Agustin Calatroni, Elias Jimenez, Betsy Lozoff, Effects of iron deficiency in infancy on patterns of motor development over time,*Hum Mov Sci*. 2006 December ; 25(6): 821–838

Tal Shafir, Rosa Angulo-Barroso, Ann Arbor, Yuezhou Jing, Mary Lu Angelilli, Sandra W. Jacobson, Betsy Lozoff, IRON DEFICIENCY AND INFANT MOTOR DEVELOPMENT, Early Hum Dev. 2008 July ; 84(7): 479–485

Tamis Pin, Mary P Galea A review of the effects of sleep position, play position, and equipment use on motor development in infants, *Developmental Medicine & Child Neurology* 2007, 49: 858–867

TAMIS W PIN,TANYA DARRER, BEV ELDRIDGE, MARY P GALEA, Motor development from 4 to 8 months corrected age in infants born at or less than 29 weeks' gestation, Developmental Medicine & Child Neurology 2009, 51: 739–745

Ueda R. Standardization of the Denver Developmental ScreeningTest on Tokyo children.*Dev Med Child Neurol.* 1978;20:647– 656.

Ungerer HA, Sigman M. Developmental lags in preterm infants from one to three years of age. Child Dev 1983;54:1217–28.

Walka H, Pollitt E. A preliminary test of a developmental model for the study of undernourished children inIndonesia. Eur J Clin Nutr 2000; 54 (Suppl): S21–37.

Wei J. Chen, Suh-Fang Jeng, Associations of Supported Treadmill Stepping With Walking Attainment in Preterm and Full-Term Infants, *PHYS THER.* 2009, 89:1215-1225.

WHO MULTICENTRE GROWTH REFERENCE STUDY GROUP, Relationship between physical growth and motor development in the WHO Child Growth Standards, Acta Pædiatrica, 2006; Suppl 450: 96-101[3]

WHO MULTICENTRE GROWTH REFERENCE STUDY GROUP, Reliability of motor development data in the WHO Multicentre Growth Reference Study, Acta Pædiatrica, 2006; Suppl 450: 47-55[1]

WHO MULTICENTRE GROWTH REFERENCE STUDY GROUP, WHO Motor Development Study: Windows of achievement for six gross motor development milestones, Acta Pædiatrica, 2006; Suppl 450: 86-95[2]

Winhoven TM, de Onis M, Onyango AW, Wang T, Bjoerneboe GE, Bhandari N, et al. Assessment of gross motor development in the WHO Multicenter Growth Reference Study. Food Nutri Bull. 2004 Mar. 25(1 Suppl): S37-45

Wollinka O, Keeley E, Burkhalter BR, Bashir N, eds.Hearth nutrition model: Applications in Haiti, Viet Nam and Bangladesh. Arlington, Va., USA: BASICS, 1997

Yvonne Kelly,Amanda Sacker, Ingrid Schoon, James Nazroo, Ethnic differences in achievement of developmental milestones by 9 months of age: the Millennium Cohort Study, *Developmental Medicine & Child Neurology* 2006, 48: 825–830

Zeng L, Dibley MJ, Cheng Y, Dang S, Chang S, Kong L, Yan H. Impact of micronutrient supplementation during pregnancy on birth weight, duration of gestation, and perinatal mortality in rural western China: double blind cluster randomised controlled trial. BMJ 2008;337:a 2001

Appendix

WHO Windows of achievement

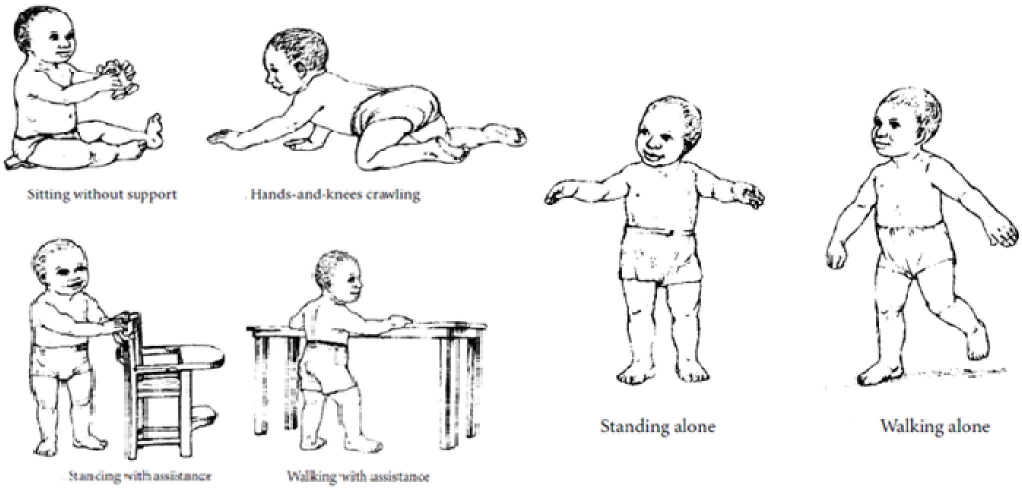
1. Conducted to review the methods for generating windows of achievement for six gross motor development
2. To compare the actual windows with commonly used motor development scales
3. Data was collected longitudinally to describe the 6 gross MM attainment with children aged 4-24 mo. in Ghana, India, Norway, Oman and USA.
4. Trained fieldworkers assessed 816 children by scheduled visits (monthly for 1st yr. bimonthly for 2nd yr.)
5. Caregivers also recorded ages of achievement
6. Constructed windows of achievement for each MM and bound by the 1st and 99th percentile.

Table 15 MGRS（Multicenter Growth Reference Study) Performance Criteria for Six Gross Motor Milestones

Gross Motor Milestone	MGRS Performance Criteria
Sitting without support	Child sits up straight with the head erect for at least 10 seconds. Child does not use arms or hands to balance body or support position
Hands-and-knees crawling	Child alternately moves forward or backward on hands and knees. The stomach does not touch the supporting surface. There are continuous and consecutive movements, at least three in a row.
Standing with assistance	Child stands in upright position on both feet, holding onto a stable object (e.g., furniture) with both hands without learning on it. The body does not touch the stable object, and the legs support most of the body weight. Child thus stands with assistance for at least 10 seconds
Walking with assistance	Child is in upright position with the back straight. Child makes sideways or forward steps by holding onto a stable object (e.g., furniture) with one or both hands. One leg moves forward while the other support part of the body weight. Child takes at least five steps in this manner
Standing alone	Child stands in upright position on both feet (not on the toes) with the back straight. The legs support 100% of the child’s weight. There is no contact with a person or object. Child stands alone for at least 10 seconds.
Walking alone	Child takes at least five steps independently in upright position with the back straight. One leg moves forward while the other supports most of the body weight. There is no contact with a person or object

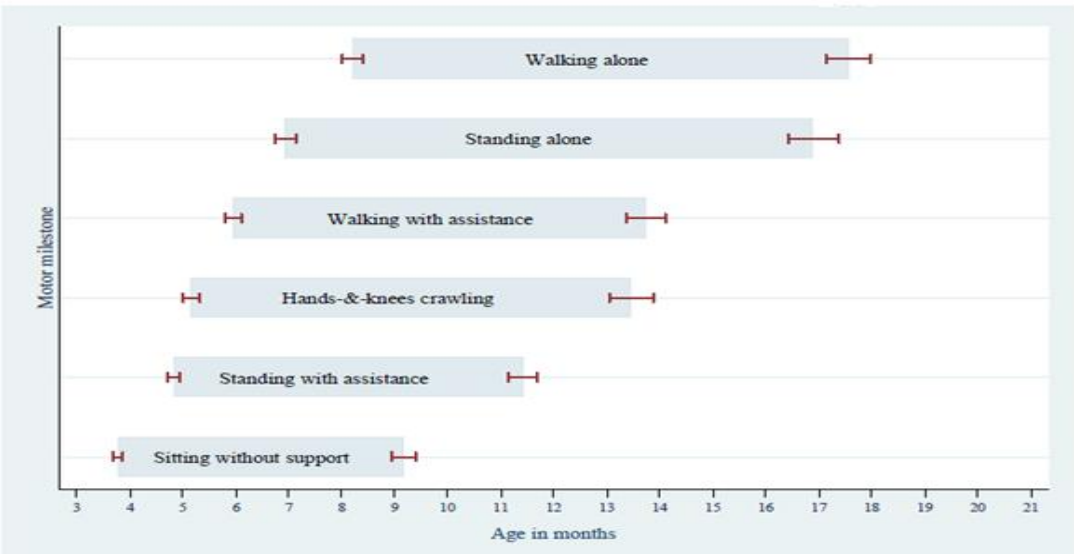
Reference: Winhoven et al., 2004 Assessment of gross motor development in the WHO Multicenter Growth Reference study, Food and Nutrition Bulletin Vol. 25 no.1
http://www.who.int/childgrowth/mgrs/en/fnb_motor_37_45.pdf?ua=1 (S38)

Figure 3 Pictures for six gross motor milestones in MGRS



Reference: Winhoven et al., 2004 Assessment of gross motor development in the WHO Multicenter Growth Reference study, Food and Nutrition Bulletin Vol. 25 no.1
http://www.who.int/childgrowth/mgrs/en/fnb_motor_37_45.pdf?ua=1 (S39-40)

Figure 4 Windows of milestone achievement expressed in months.



Reference: WHO Multicenter Growth Reference Study Group. WHO Motor Development Study: Windows of achievement for six gross motor development milestones. Acta Pediatric Supplement 2006; 450: 86-95
http://www.who.int/childgrowth/standards/mm_windows_graph.pdf?ua=1

The six windows have age overlaps but, range is difference depends on gross MM. The narrowest range is sitting w/o support (5.4 mo.) and widest are walking alone (9.4mo) and standing alone (10 mo.). WHO windows of achievement estimated 1st and 99th percentiles in months such as: Sitting w/o support (3.8, 9.2mo), Standing with aid (4.8, 11.4mo), Hands-and-knees crawling (5.2, 13.5mo), Walking with aid (5.9, 13.7mo) , Standing alone (6.9, 16.9mo) and Walking alone (8.2, 17.6mo).The windows represent normal variation in ages of milestone achievement among healthy children (WHO 2006).

Table 16 Summary of the Studies: Eleven Factors that Associated with Infants' Gross Motor Milestone Development

Factors associate MM	Researcher (Year)	Country of study	Sample size	Study design	Motor milestone achievement & measurement tool	Positive association	Negative association	No association
Children's nutritional factor	Surkan et al., (2013)	Nepal	554	Randomized placebo control and longitudinal study	Mean age in motor milestone score from visit 1 to visit 5			✓
	Yalcin et al., (2012)	Turkey	1,553	Cross sectional study	Walking alone (mean age of month achievement)	✓		✓
	Angulo-Barroso et al.,(2010)	Detroit,USA Beijing, China Accura,Ghana	209	Observational study	19 gross motor milestone from sit to run (Sum of pass score)	✓		
	Katz et al., (2010)	Nepal	3,264	Randomized control trial	Sitting, walking, running, jumping, standing on one leg (% and mean of age)		✓	✓
	Shafir et al (2008)	USA	106	Observational study	Standing and walking (Peabody Developmental Motor)	✓		
	Afarwuah et al., (2007)	Ghana	313	Intervention case control	Walking alone (percentage of achievement)	✓		
	Olney et al., (2007)	Tanzania	771	Cross sectional baseline analysis of the Child Development Sub study (CDS) Partly Randomized double blind trial (by observation)	From sit to walk (including creep, crawl, stand and walk (% motor milestone Achieved)	✓		✓
	Kariger et al., (2005)	Tanzania	646	Observational study	Pull to sit-stand alone n one feet (percentage of attainment)	✓		✓
	Siegel et al., (2005)	Nepal	485	Cross sectional, community-based study	14 MM 17 item scales walk1: walk with support walk 2 (can walk w/o aid): run, jump or stand on 1 foot No walker: able to stand with or w/o aid (stand1, stand2)(Proportion of	✓		

					walking)			
	Kuklina et al., (2004)	Guatemala	218	Longitudinal	Walking alone, (% of gross motor achievement)	✓		
	Jahari et al., (2000)		12 months(n=53), 18 months (n=83)	Randomized with 3 treatment (energy and iron supplement) by two cohort studies	From sit to run (Bayley scale)	✓		
	Harahap et al., (2000)[49]	Java, Indonesia	18	Randomly assigned to two different nutritional supplements(iron or energy) for 6 months	Mental and motor development was evaluated with the Bayley Scale).			✓
	Bentley et al., (1997)	Guatemala	85	Double blind clinical trial	Stand, crawl and walk (percentage of attainment)	✓		
Children's physical growth	Yalcin et al., (2012)	Turkey	1,553	Cross sectional study	Walking alone (age of month)	✓		
	Afarwuah et al., (2007)	Ghana	313	Intervention case control	Walking alone (percentage of achievement)	✓		
	Olney et al, (2007)	Tanzania	771	Cross sectional baseline analysis of the Child Development Sub study (CDS) Partly Randomized double blind trial (by observation)	From sit to walk (including creep, crawl, stand and walk (% of gross motor milestone Achieved)	✓		
	Kariger et al.,(2005)	Tanzania	646	Observational study	Pull to sit-stand alone n one feet (percentage of attainment)	✓		
	Siegel et al., (2005)	Nepal	485	Cross sectional, community-based study	Sit to run (Mean age of month walking)	✓		
	Kuklina et al., (2004)[72]	Guatemala	263	Longitudinal study (at 9 and 12 months)	17-milestone Gross Motor Development Scale: (median and mean of age of walking)	✓	✓	
	Mulligan et al., (1998) [83]	USA	48 (girls=25, boys=23)	Longitudinal Observational study (at 6, 9 and 12 months of age)	Motor development was measured at 6, 9 and 12 months of age by Motor Bayley Scale of	✓		

					Infant Development			
Children's ethnic background	Naqvi et al., (2012)	Tanzania	103(49 from urban, 54 from rural)	Cross sectional study (12-83months)	Battele developmental Inventory Screening Test			✓
	Angulo-Barroso et al., (2010)	China, Ghana, and USA	209	Observational study	19 gross motor milestone from sit to run (Sum of pass score)	✓		
	Kelly et al., (2006)[68]	UK	15 ,994(males: 8,212, females: 7,782)	Millennium Cohort Study with difference races (Indian, Black Caribbean, and Black African Children, Pakistan and Bangladeshi)	Overall gross motor milestones (% of attainment)	✓		
	Siegel et al.,(2005)	Nepal	485	Cross sectional, community-based study	Sit to run (Mean age of month walking)	✓		
	Nelson et al., (2004)	Hong Kong	72	Cross sectional study	Age of rolling over (mean age of roll over) depends on supine and prone		✓	
	Nixon-Cave et al., (2001)	USA	9 infants and their families, 5 males and 4 females from different ethnic background	Case control study (questionnaire)	sitting, crawling and walking for infants 12-18 months of age(the Peabody Developmental Motor Scales :PDMS)	✓		
	Stanitski et al.,(2000)	USA	986 children (575 male, 471 female	Cohort study	Walking (Mean age month of walking attainment)	✓		
	Allen et al., (1990)	Ghana	313	Randomized case control study	Walk independent (% of achievement)			✓
	Hopkins et al., (1989) [55]	UK	124	Observational study	Sitting, crawling and walking alone (mean of age achieved)	✓		
	Capute et al., (1985)	USA	381	Longitudinal study at 2, 4, 6, 12, 15, 18 and 24 months	Gross motor milestones (e.g., roll prone to supine, roll supine to prone, sit with or without aid, creep get to sit, crawl, pull to stand, cruise, walk, walk backward and run) by the Bayley mental and motor scale and mean age and percentage of attainment)	✓		
	Stewart et al., (1981)	USA	250	Cohort study	Gross motor milestones : (1-24 items: from prone to	✓		

					pedale trike) by Revised Denver Developmental Screening Test (RDDST; % of passing)			
	Grantham-McGregor et al., (1971)	Jamaica	300	Longitudinal study	Gross motor milestone: lift head to walk alone (% of achievement)	✓		
	Phatak (1969)	India	n=278, males 168, female 110) from 1 to 30 months	Longitudinal study	Motor development (67 points) by the Bayley Infant Scales	✓		
Children's birth weight	Yalçın et al., (2012)	Turkey	1,553	Cross sectional study	Walking alone (mean age of month)			
	Luo et al., (2009)	Taiwan	29 preterm infants and 20 full term	A cohort study with a longitudinal follow-up design	The age of walking attainment was measured by Alberta Infant Motor Scale (AIMS)	✓		
	Pin et al., (2009)	Australia	62 preterm and 53 term	Longitudinal study	Rolling, sitting and standing by the Alberta Infant Motor Scale (AIMS).	✓	✓	
	Jeng et al., (2008)	Taiwan	29 preterm and 29 term	Cross sectional study	Age of onset of walking in two groups at 18 month of corrected age was measured by Peabody Developmental Motor Scale (PDMS-II) and % of achievement	✓		
	Little et al., 2005	USA	preterm children (n=48) ages range from 2 to 35months and full term children (n=920)	Retrospective cohort study	Motor development by the mean of Merrill-Palmer-Revised score	✓		
	Jeng et al., 2004	Taiwan	(22 full term, 22 preterm infants)	Longitudinal study (Observation)	Walking alone (The distribution of age walking attainment)	✓		
	Pridham et al., 2002	USA	full term (n=52) and preterm (n=47)	Longitudinal, descriptive study	Gross motor development Bayley Psychomotor Scale of Infant Development (BSID-I)	✓		
	Jeng et al., 2000	Taiwan	VLBW preterm infants (n=96) and normal term (n=82)	Cohort Longitudinal study	Age of walking attainment by Alberta Infant Motor Scale (AIMS)	✓		

	Iwata et al., 1991[57]	Japan	395	Cross sectional study	The age of begin to walk (Distribution of age in months start walking)	✓		
	Allen et al., 1990	Ghana	313	Randomized case control study	Walk independent (% of achievement)	✓		
	Palisano et al.,1985	USA	premature infant(n=23) and fullterm infants (n=20)	Cross sectional study	Standing, creeping, cruising and walking alone by Peabody Developmental Motor Scale (PDMS)	✓		
	Grantham McGregor et al., 1971	Jamaica	300	Longitudinal study	Gross motor milestone: lift head to walk alone (% of achievement)	✓		
Maternal Nutritional status	Yalcın et al., 2012	Turkey	1,553	Cross sectional study	Age of walking (mean age of month)	✓		✓
	Tofail et al.,2008	Bangladesh	2,853	A large, randomized, controlled trial of pregnancy supplementation	Motor Index of the Bayley Scales of Infant Development	✓		
	Oken et al., 2008	Denmark	25,446	Longitudinal observation study	Sum of passed items (hold up with head, sit with a straight back, roll back to front, sit alone, walk alone) at 6 and 18 mo	✓		
	Kirksey et al., 1994	Egypt	50	Longitudinal observation study	BSID-I		✓	
Maternal exposed to environmental factors	Kaňková et al, 2012[63]	Czech Republic	351	Retrospective cohort study	Gross motor milestones (e.g. lift to head, turn over from supine to prone positions, sit, crawl and walk alone) by mean age of attainment		✓	✓
	Laslo-Barker et al, 2012	Canada	48	Cohort study	Sit, crawl, stand and walk by the Bayley Scales of Infant Development			✓
	Singer et al., 2012	UK	MDMA exposed (n=28) and non-MDMA exposed infants (n=68)	Cohort study	Overall gross motor milestone birth to 4months by the Bayley Mental and Motor Development Scales (MDI, PDI), and the Alberta Infant Motor Scales (AIMS)		✓	✓
	Smith et al., 2011	USA	MA exposed group (n=179) and non-exposed	Longitudinal study and partly cross sectional	The motor and cognitive development was measured with BSID-II (The Bayley			✓

		group (n=177).	study	Scales of Infant Development II) or PDMS(Peabody Developmental Motor Scales)-2		
Divan et al., 2011	Denmark	100,000	Danish National cohort study and Longitudinal study	Gross motor milestones: hold up head, sit with back straight, roll from back to front, sit up right on the floor, grab objects out of reach and crawl on stomach) by 0-5 scale points (sum of pass or fail)		✓
Tofail et al., 2009	Bangladesh	1,799	A large population-based study	Motor development of those infants at age of 7 months by Bayley Scale of Infant Development-II (BSID-II) Psychomotor Development Index (PDI) and the Mental Development Index (MDI).		✓
Punamaki et al., 2006	Finland	520	Longitudinal study	Sitting to walking with or without support by the mean score of achievement (pass or fail score)		✓
Nakajima et al., 2006	Japan	134	Cohort study	Motor and metal score was measured by using mean score of Bayley Scales Development (BSID-II; MDI and PDI). Mental developmental Index (MDI) and Psychomotor developmental Index (PDI) scores were measured based on the calibration scale from raw score and index scores.	✓	
Huizink et al., 2002	Netherland	43	Prospective Longitudinal study and Observation	3 and 8 months by means of the Bayley Scales of Infant Development (BSID).	✓	
Meyer-Bahlburg et al., 2004	USA	174 prenatally DEX-exposed children (including 48 with CAH) and 313	Cohort study	Kent Infant Development Scale (KIDS): 252 item questionnaires designed for the age group 0-15months and age-based normalized		✓

			unexposed children (including 195 with CAH)		standard score for five developmental subscales and a composite. Revised Prescreening Developmental Questionnaire (RPDQ or Revised Denver): four age specific form with 105 items that cover the age group 0 months to 6 year. Age-Based delay score (classified no delay, one delay, more than two delays). The child Development Inventory (CDI) 270 Yes or no items for age group 15month -6yr (sum up the eight domain scales and overall scale and general development) from the age 0-4year.			
	Harolyn et al., 1999	USA	157 newborn infants (follow up at 3 months (n=118), 6months (n=124) and 12 months (n=77)	Randomized home-based nursing-intervention trial	Gross motor milestone attainment at a certain age. Percentage of age (months) at achievement		✓	✓
	Fetter et al., 1998	USA, Israel	exposed (n=28) and unexposed (n=22)	A longitudinal study	The motor milestone was measured by the Alberta Infant Motor Scale (AIMS), the Movement Assessment of Infants (MAI) and the Peabody Development Motor Score (PDMS).		✓	
	Crowther et al.,1997 [29]	Australia	Hormone infants (531), control infants (511).	Double-blinded randomized controlled trial	7 gross motor milestones (sit to walk) were measured by mean of the gross motor milestones		✓	
	Richardson et al., 1995	USA	829	A longitudinal study	Mental and motor development was by Bayley Scales Development (BSID).		✓	✓
	Reid et al., 1991	USA	90	A longitudinal study	The Bayley Scales of Infants Development and Infant Mullen Scale	✓		

Children's exposed to environmental factors	Osnat et al., 2013[8]	USA	27 infants (17 males, 10 females)	Longitudinal observation study	Four motor milestones (e.g., sitting, pulling to stand, crawling and cruising) and infant's overall motor development were measured by using the Alberta Infant Motor Scale (AIMS).	✓		
	Yalçın et al., 2012	Turkey	1,553	Cross sectional study	Age of walking (mean age of month)	✓		✓
	Miquelote et al., 2012	Brazil	32	Longitudinal study	Gross Motor Skill (72 items)by the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III)	✓		
	Doralp et al., 2010	Canada	189(102boys, 87girls)	Cross sectional study	Early motor development (prone, supine, sitting and standing) was measured using the Alberta Infant Motor Scale (AIMS)	✓		✓
	Karasilk et al., 2008	USA	28	Cross sectional and observation	Crawling and walking by mean of month age achievement	✓		
	Pridham et al., 2002	USA	Full term (n=52) and preterm (n=47) infants.	Cross sectional study	Motor development scale at 12 month by Bayley Psychomotor Scale of Infant Development (BSID-I)	✓	✓	
	Garrett et al., 2002	Northern Ireland	190 (83 boys and 107girls)	Cross sectional study	Sitting , rolling over, crawling , standing and walking alone by mean age of month achievement		✓	✓
	Siegel et al., 1999	USA	109	Retrospective cohort and longitudinal study at 6,9 and 12 months	Crawl and walk alone Bayley Mental Development Index and PDI (Psychomotor Development Index)		✓	
	Mulligan et al., 1998	USA	48	Longitudinal observational study	Motor development was measured at 6, 9 and 12 months of age the Bayley Scale of Infant Development score	✓		✓
	Iwata et al., 1991	Japan	395	Cross sectional study	Age of first month walking alone (% of achievement)	✓	✓	
	Porter et al., 1972	Philippines	94	Longitudinal case	Motor development quotient	✓		

				control study	score in pretest, midtest and posttest. The mean of motor development quotient			
Children's sleeping and playing position	Lewycky et al., 2009	Canada	102(female =47, males=53)	Longitudinal observation study	Age of first rolling (e.g., supine to prone, prone to supine) by mean age of achievement			✓
	Ohman et al., 2009	Sweden	Eighty-two infants with CMT (35 females and 47 males) were compared with 40 healthy infants (18 females and 22 males)	Longitudinal study	Motor development was assessed with the Alberta Infant Motor scale (AIMS)	✓		
	Davis et al., 2008	USA	276	Prospective, practice base study (longitudinal)	Rolling prone to supine, tripod sitting, creeping, crawling, and pulling to stand by the mean age of month achievement	✓		✓
	Fetters et al., 2007	USA, Isarel	68 (30 preterm infants born very-low birth weight (VLBW) and white matter disease (PTWMD); 21 preterm infants born VLBW without WMD (PT); and 17 term infants (Term).	Longitudinal study at 1, 5, 9 months	Gross motor performance was measured by the AIMS (Alberta Infant Motor Scale) with a pass or fail score of 58 items	✓	✓	
	Salls, et al., 2002	USA	66 infants at 2.0 (n = 23), 4.1 (n = 26), and 6.0 (n = 17) months	Pilot study, Longitudinal study	Head up 45 degree, head up 90 degree, sit head steadyby the Denver II Gross Motor Sector (pass and fail distribution scores	✓		✓
	Jantz et al., 1997	USA	343	Longitudinal study	Rolling over, pulling to sit without head lag (at 4 months), and sitting upright at 6 months. The gross motor milestones were measured by the Denver Developmental Screening Revised Test (% of pass or fail score).	✓		✓
	Iwata et al., 1991	Japan	395	Cross sectional study	Age of first month walking alone (% of achievement)			✓
Other motor	Kimura-Ohba et al.,	Japan	290	Longitudinal	Rolling over, crawling and	✓	✓	

milestone's achievement	2011			study	sitting by mean age of walking related to % of those three gross motor milestone attainments was measured			
	Jaffe et al., 1996	Israel	360	Prospective cohort and longitudinal study	Mean age of sitting and walking alone was measured by the Denver Developmental Screening Test (DDST) and assessed the mean age of achievement.	✓		
	Bottos, et al., 1989	Italy	index group(n=270) control group(n=154)	Longitudinal case control study	The mean age of walking, Crawler on hands and knees: early crawlers, late crawlers, stomach creepers and shufflers by proportion of achievement	✓		
	Touwen et al., 1971	Netherland	50(27 boys and 23 girls)	A longitudinal study	Creeping, crawling and sitting) and walking without support. The gross motor milestone was measured by mean age of achievement.	✓		
Children's health status	Garcia et al., 2011	USA	52	Longitudinal study	Rolling front to back, rollingback to front, sitting alone for 10 seconds, crawling, pulling to stand, and walking alone was measured by the Alberta Infant Motor Scale (AIMS) and the mean age of month		✓	✓
	Olney et al, 2007	Tanzania	771	Cross sectional baseline analysis of the Child Development Sub study (CDS) Partly Randomized double blind trial (by observation)	From sit to walk (including creep, crawl, stand and walk (% of the highest motor milestone Achieved)		✓	
	Haley et al., 1986	USA	40 full term (>37weeks) non-handicapped infants aged 2-10months (males 33, females	Longitudinal study	Two gross motor milestones achievement (e.g., sitting and prone position). The gross motor milestone was		✓	

			17). Ten infants comprised each 2 months by age group. (2-4, 4-6, 6-8, 8-10 months). 20 infants with Down Syndrome aged 2-24months (males 7, females 13)		measured by the Bayley Scale of Infant Development (BSID)			
	Tenbrinck et al 1974	USA	200	Retrospective Cohort study	The gross motor milestones (e.g., sit, stand alone, and walk measured by the mean of age month achieved and distribution.		✓	✓
Other factors	Restiffe et al.,2012	Brazil	preterm infants (PT; n=101) without cerebral palsy to healthy full-term (FT; n=52	Prospective longitudinal study	Age of walking alone by the Alberta Infant Motor Scale (AIMS)and the mean age of achievement			✓
	Yalcin et al., 2012	Turkey	1,553	Cross sectional study	Age of walking (mean age of month)	✓		✓
	Kimura-Ohba et al., 2011	Japan	290	Longitudinal study	Rolling over, crawling and sitting by the mean age of walking related to % of those three gross motor milestone attainments was measured			✓
	Ohman et al., 2009	Sweden	Eighty-two infants with CMT (35 females and 47 males) were compared with 40 healthy infants (18 females and 22 males)	Longitudinal study	Motor development was assessed with the Alberta Infant Motor scale (AIMS)			✓
	Kirkesy et al., 1994	Egypt	50	Longitudinal observation study	BSID-I at 6 mo			✓
	Kuklina et al, 2004	Guatemala	263	Longitudinal study (at 9 and 12 months)	17-milestone Gross Motor Development Scale: (median and mean of age of walking)			✓
	Stanitski et al.,	USA	986 children (575	Cohort study	Walking (the mean age month	✓	✓	

	2000		male, 471 female		of walking attainment)			
	Iwata et al., 1991	Japan	395	Cross sectional study	Age of first month walking alone (% of achievement)		✓	✓
	Bottos, et al., 1989	Italy	index group(n=270) control group(n=154)	Longitudinal case control study	Crawler on hands and knees: early crawlers, late crawlers, stomach creepers and shufflers by proportion of achievement			✓
	Capute et al., 1985	USA	381	Longitudinal study	The gross motor milestones (e.g., roll prone to supine, roll supine to prone, sit with or without aid, creep get to sit, crawl, pull to stand, cruise, walk, walk backward and run)by the mean age and percentage of attainment base on the parental reports.	✓		
	Palisano et al., 1985	USA	Premature infant(n=23) and fullterm infants (n=20) at 12 months.	Cross sectional study	The gross motor milestone achievement was measured by the Peabody Developmental Motor Scale (PDMS).	✓		✓
	Grantham-McGregor et al 1971	Jamaica	300	Longitudinal study	Gross motor milestone: lift head to walk alone (% of achievement)			✓