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Influence of Enhanced Handling and Positioning on Motor Development in Full Term Versus Preterm Infants

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ABSTRACT

The purpose of this study was to determine the influence of enhanced handling and positioning program on motor development in full term and low risk preterm infants. One hundred and twenty four infants from both sexes participated in this study, 95 full term infants and 29 low risk preterm infants. Assigned into three groups, group (A) control, group (B) study and group (C) 2nd study group (preterm infants). Full term infants were randomly assigned according to order of admission into either group A or B. A baseline examination of motor development was performed at two months of age for all groups, an examination after four weeks of (enhanced handling and positioning program for group (B) and (C) versus social experience for group (A) and a follow up examination at six months of age using Alberta infant motor scale, in addition to kinematic analysis of emergent reaching pattern from supported sitting position using kinovea motion analysis software at six months of age. The pre- intervention results revealed no significant difference between group A and B and significant difference between group C and groups (A and B) in motor development. While significant difference was found post intervention in all measured variables in favor of the study groups. These results high light the importance of early intervention and family centered care in full term as well as preterm infants.

Key words: Motor development, infancy, handling and positioning, motion analysis and reaching

INTRODUCTION

Infants born preterm or Low Birth Weight (LBW) are at increased risk of developing motor, cognitive and behavioral impairments compared with infants born at term (Doyle, 2004). The risks associated with preterm birth increase as Gestational Age (GA) decreases and vulnerability remains in moderate (GA 32-34 weeks) and late (GA 34-36 weeks) preterm infants (De Jong *et al*., 2012). It is important to point out that low-risk preterm infants are an understudied population, especially because they are considered clinically similar to full-term infants. In fact, neuropathology is less frequent in low-risk preterm infants than in infants born at considerably younger gestational ages. However, low-risk preterm infants are not only less physiologically and metabolically mature than full-term infants, but also their central nervous system is more immature. Thus, the neurodevelopmental outcomes between these groups are often distinct (De Toledo *et al*., 2011). Early developmental interventions have been used in the clinical setting with the aim of improving the overall functional outcome for preterm infants. However, the long-term benefit of these

programs remains unclear (Spittle *et al*., 2012). Enhanced handling and positioning namely are "enhanced" because they involved behaviors that are not typical of daily life for young infants. These behaviors included supported sitting and standing, encouragement of independent head and trunk control and emphasis on prone positioning (Kuo *et al*., 2008). Enhanced handling and positioning is presumed to have longer lasting effects on motor development for two reasons. First, the altered handling and positioning activities are expected to advance infants' foundational abilities that are developmentally linked to future skills. Second, care givers are expected to adapt to their infants' emerging abilities and continue advancing their interactions even outside of and after the home experience period. A cycle would occur in which changes in care givers or infants would in turn create change in the other (Lobo and Galloway, 2012). For pediatric rehabilitation, studies that quantify the effect of caregiver-infant interactions provide an important foundation for new assessment and intervention strategies and highlight the potential benefits of family-centered interventions (Bamm and Rosenbaum, 2008). Thus, the aim of the current study was to determine the influence of enhanced handling and positioning program on motor development in full term versus low risk preterm infants.

MATERIALS AND METHODS

One hundred and twenty four infants from both sexes participated in this study, 95 full term infants and 29 low risk preterm infants. Infants were collected from public health offices, public hospitals (well baby room) and incubators. Agreement of the ethical committee of the faculty of physical therapy, Cairo University and parent consent were obtained before the beginning of the study. Evaluations were performed 3 times for each infant as scheduled. Only 69 infants (24, 24 and 21) in group A, B and C, respectively completed the 3 assessments owing to health and commitment issues.

Design: Infants were assigned into three groups, group (A) control, group (B) study and group (C) 2nd study group (low risk preterm infants). Full term infants were randomly assigned according to order of admission to either the social experience control group (20 boys, 28 girls) or the handling and positioning experience study group (24 boys, 23 girls). Low risk preterm term infants (13 boys and 16 girls) served as the 2nd study group i.e., received the same handling and positioning program.

Inclusion criteria

- **Age depended on the group:** Age range for preterm was less than 36 weeks and more than 32 weeks Gestational Age (GA) (M = 34.68 w±1.07) and for full term infants 37-40 weeks GA (M = 38.53 w±1.16, 38.17 w±0.93) for group A and B, respectively
- Infants without neurological disturbance and medically stable

Exclusion criteria

- History of any problems during pregnancy or labor
- Major birth complication e.g., Hypoxia, ischemia or any congenital anomalies
- Apparent visual or auditory defects for both groups
- Past History of admission to Neonatal Intensive Care Unit (NICU) more than 72 h

Materials and tools for assessment

- **Alberta infant motor scale (AIMS):** The AIMS is an infant developmental test, used to identify developmental level. It evaluates motor performance from birth to independent walking. A total number of 58 items in four positions (supine, prone, sitting and standing) were scored. Each item contains three components of movement: weight-bearing, postural alignment and antigravity movement. The AIMS raw score was used to compare between influence of enhanced handling and positioning program versus social experience on both full term and low risk preterm infants
- Matt, wooden bench or chair and toys
- **Kinovea (motion analysis software):** Video recording and kinovea software was used to assess reaching from supported sitting position
- **Materials used for video recording:** Sony HD digital video camera (Digital zoom 16X-16 mega pixels)
- Standing frame to support the child in sitting position
- **Materials used for analysis:** Open-license Kinovea 0.8.15 motion tracking software and Personal computer.

Procedures for evaluation

Schedule of assessments: A baseline examination of motor development was performed at two months of age for all groups, an examination after four weeks of (enhanced handling and positioning program for group (B) and (C) versus social experience for group (A), in addition to follow up at six months of age using (AIMS). Only the third assessment included kinematic analysis of emergent reaching pattern from sitting position using kinovea motion analysis software. Preterms were assessed at corrected ages as scheduled.

Alberta Infant Motor Scale (AIMS): Infant's general motor ability was assessed using the AIMS when infants were in an awake and alert state. Infants were evaluated through putting them in a serious of positions as instructed by Alberta scale. Infants received a score of 1 for behaviors they were observed performing, 0 for more advanced items they weren't observed performing and 1 for items previous to least mature behavior observed. Infant were evaluated in supine, prone, sitting and standing. The values of each position were added to each other to reach a value that states the infant's developmental level. During evaluation, the examiner didn't facilities the infant, instead mother or care giver was left to play with the infant while the examiner observe. The whole evaluation was video recorded for later review.

Kinovea analysis

Reaching: Infant preparation: The infants were seated on a standing frame and a strap was fastened on the infants' trunk to provide trunk stability as shown in Fig. 1. Video recording was done when the infant is expected to be alert with the camera positioned to the side of the infant so as to capture a lateral view of the body. The camera was positioned on a carrier 75 cm from the floor and 1 m away from the standing frame to capture a whole-body view. An attractive object was presented in the midline and at shoulder length of the infant to stimulate reaching movements and video recording was continued until the child performed 3 to 5 successful reaching movements, the same procedure was repeated for the other side. Targets were selected depending on the infant's interest and motivation.

Fig. 1: Tracking motion path using kinovea

Data analysis: The operator calibrated recorded videos using a measured line from reality (frame length) so that kinovea software could measure time and distance accurately. Using the program, the operator added across marker at the infant's wrists (dorsal carpal region) to track the motion path.

Adjustment index: Calculated by the ratio between the time spent in the movement following the higher peak of velocity until the touch on the object and the total duration of the reach, it indicates the proportion of the time that was necessary to decelerate the arm movement so that the hand touched the object. A greater adjustment index indicates a longer time spent in decelerating the arm movement.

Procedures for experience groups

Social experience (group A): Care givers in the control group were asked to place their infants in supine and engage them in face-to-face interaction for 15 min daily. The aim of these experiences is to control for the social interaction and associated general movements that infants in the experimental group would receive.

Handling and positioning experience (group B and C): Care givers in these groups were asked to perform enhanced handling and positioning activities with their infants 15 min daily. The specific activities involve care givers encouraging and assisting infants: (a) by placing them in prone on the floor or care giver while encouraging them to push up to lift their head (b) By pulling them up and lowering them down slowly between sitting and supine while assisting them to keep their head in line with their body (c) by supporting them in sitting and standing while swaying them slowly in different directions while encouraging them to weight bear and to reorient their body upright with respect to gravity and (d) by moving their hands to midline for play to encourage a shift from lateral to more midline arm placement.

These activities provided enhanced perceptual-motor experience across positions in order to promote abilities including strength, postural control and midline hand behavior. These activities also involve a fair amount of social interaction between care givers and infants.

Care givers were informed that they could perform the experiences in shorter segments of time throughout the day if necessary to ensure infants remained in a positive behavioral state during the activities and received an illustrated manual and training from the experimenter at the first study visit. They were given a diary to record the frequency, duration and content of their sessions. There was a minimum experience performance criterion of 60% of the days for inclusion in the study.

Data analysis: The collected raw data of the current study were statistically treated using SPSS software for medical statistics.

- **Descriptive statistics:** This included Mean and standard deviation
- **Inferential statistics:** Between subjects multivariate analysis of variance (MANOVA) was performed for all dependent variables. Multiple pairwise comparison tests (Post hoc tests) were performed for all dependent variables

RESULTS AND DISCUSSION

Motor development: As shown in Table 1 and 3 Comparing mean values of raw scores of the AIMS at 2 months of age revealed no significant difference between group (A) and group (B) ($p>0.05$) and significant difference between group (C) and groups (A) and (B) ($p<0.05$).

The results of the current study revealed that infants who received enhanced handling and positioning experiences at 2 months of age showed significant improvement in their motor development: as shown in Table 1 and 3 the mean values of the raw scores of AIMS at 3 months of age showed significant difference ($p<0.05$) between full terms who received enhanced handling as compared with the social experience group whereas preterm infants showed no significant difference ($p<0.05$) with their full term controls.

Finally, as shown in Table 2 and 3 comparing the mean values of the raw scores of AIMS at six month of age showed significant difference ($p<0.05$) in motor development in favor of the study groups as compared with their full term controls.

Table 1: Mean and standard deviation of raw scores of the AIMS

Groups	Mean±SD
Assessment 1	
A	8.2±1.09
B	8.1±1.08
C	6.3±0.82
Assessment 2	
A	10.29±0.85
B	11.45±1.64
C	10.28±1.82
Assessment 3	
A	23.50±1.79
B	27.79±1.65
C	25.57±3.34

SD: Standard deviation

Adjustment index: As shown in Table 2 and 3 comparing the mean values between groups showed significant difference in both arms ($p<0.05$) in favor of the study groups.

This study focused on studying the influence of enhanced handling and positioning on motor development in full term and low risk preterm infants. As there is a growing body of evidence suggesting that care giver handling and positioning influence infant development (Adolph *et al*., 2010). Together with the fact that late preterm infants have received little attention as they were not typically admitted to the Neonatal Intensive Care Unit (NICU) and have been considered to be at low risk for developmental delays (Ishiguro *et al*., 2009). However, previous research suggests that infants born late preterm are at higher risk of developmental delays and poor school performance compared to infants born full term (Morse *et al*., 2009).

Table 2: Mean and standard deviation of Rt and Lt arms adjustment index

Groups	Mean±SD
RAI	
A	0.43±0.072
B	0.33±0.099
C	0.36±0.12
LAI	
A	0.47±0.18
B	0.32±0.09
C	0.35±0.11

RAI: Right adjustment index, LAI: Left adjustment index

Table 3: Multiple pairwise comparison tests (*post hoc* tests) for all dependent variables

Variables	Versus	Groups	Values	Significance
A1				
Group B	Versus	Group A	1.000	NS
		Group C	0.000	S
Group A	Versus	Group B	1.000	NS
		Group C	0.000	S
A2				
Group B	Versus	Group A	0.025	S
		Group C	0.031	S
Group A	Versus	Group B	0.025	S
		Group C	1.000	NS
A3				
Group B	Versus	Group A	0.000	S
		Group C	0.007	S
Group A	Versus	Group B	0.000	S
		Group C	0.013	S
RAI				
Group B	Versus	Group A	0.002	S
		Group C	0.847	NS
Group A	Versus	Group B	0.002	S
		Group C	0.065	S
LAI				
Group B	Versus	Group A	0.001	S
		Group C	1.000	NS
Group A	Versus	Group B	0.001	S
		Group C	0.012	S

S: Significant, NS: Non-significant, A 1,2,3: Assessment 1,2,3, RAI, LAI: Right and left adjustment index

The pre-intervention results of the AIMS at 2 months of age revealed non-significant difference between group (A) and group (B) ($p>0.05$) and significant difference between group (C) and groups (A) and (B) ($p<0.05$), ensuring the homogeneity of the full term groups and coming in agreement with the literature reporting that Preterm newborns have been shown to differ from the full term ones as regards such motor skills as postural control (Van Der Heide *et al*., 2004) and kicking movements (Fetters *et al*., 2004) and that infants born preterm are at increased risk of developing motor impairments compared with infants born at term (Spittle *et al*., 2012).

Post intervention results showed 1st influence on gross motor development as measured by AIMS: The results of the current study revealed that full term infants who received enhanced handling and positioning experiences at 2 months of age showed significant improvement in motor development ($p<0.05$) at 3 months of age as compared with the social experience group whereas preterm infants showed no significant difference ($p<0.05$) with their full term controls.

Kinney (2006), stated that the weight of the brain at GA 34 weeks is only 65% of the term infant's and the undeveloped brain of preterm infants continues to develop under non-optimal conditions in the Neonatal Intensive Care Unit (NICU). Early Intervention (EI) can affect the rapidly growing brain and may change and improve the developing neural pathways (Vanderveen *et al*., 2009). This could justify how preterm infants showed advancement in their motor behavior in response to the handling and positioning program.

The results of the current study come in agreement with Vaivre-Douret *et al*. (2004) who documented the importance of frequent position changes and functional postural support enabling spontaneous motor activity for normal neuromuscular and osteoarticular function in low-risk preterm infants aged 31-36 weeks' gestation.

These results also comes in agreement with Lee and Galloway (2012) who found that young infants are able to take advantage of postural and movement experiences to rapidly advance their head control as early as 4 to 6 weeks of postnatal life and that infant positioning, care giver handling and care giver-infant interactions were likely contributing factors.

In addition, between groups comparison at six month of age showed significant difference ($p<0.05$) in motor development in favor of the study groups as compared with their full term controls, here it was highlighted that low risk preterm infants didn't only catch up but they exceeded their full term controls which raises the question for future research what the results would be if the comparison was made at chronological age rather than corrected age?

The results of the current study support the results of Lobo and Galloway (2012) who studied the effects of 3 weeks of enhanced handling and positioning experiences provided to 14 infants versus control experiences provided to 14 infants at 2 months of age were assessed with follow-up through 15 months of age. Behaviors in prone were immediately advanced. Short-term advancements occurred in multiple behaviors, including prone, head control, reaching and sitting behaviors. Longer term advancements, up to 12 months after the experience period, occurred in object transfer, crawling and walking behaviors. This suggests broad and long-lasting changes can arise via brief periods of change in caregiver-infant interactions. Also, such result support the findings of Spittle *et al*. (2012) who concluded that early intervention programs for preterm infants have a positive influence on cognitive and motor outcomes during infancy with the cognitive benefits persisting into pre-school age.

The results of the current study come in contradiction with Kyno *et al*. (2012) who examined the long-term effect of an early intervention program for preterm infants on cognitive, gross motor

and behavioral outcomes at 36 months corrected age and concluded that the intervention had no effect on the aforementioned domains of development.

To better understand these results, it shouldn't be ignored that the developmental outcome of infants born prematurely is heterogeneous and can be partly associated with biological risk factors, such as gestational age, birth weight, brain damage acquired in the pre or perinatal period or subsequent illnesses. However, these factors account only for a portion of the variance associated with long-term outcomes. In part, the outcome is also mediated by environmental experience (Blauw-Hospers *et al*., 2007). Together with the fact that human motor behavior is far more varied and malleable than is generally appreciated and it always occurs in a social and cultural context (Adolph *et al*., 2010).

We now understand, better than ever before, how experience-based brain and biological development in the early years (i.e., conception to age 6 years), influences development of the neural pathways from the sensory nerves to other parts of the brain involved in emotions, response to stress, physical movement, language, cognition and biological pathways that affect health and well-being. There are critical and sensitive periods in early life when the differentiation of nerve function and establishment of neural pathways occur. This explains why the early years of experience can set trajectories in health (physical and mental), behavior and learning that last throughout the life cycle (Young and Richardson, 2007).

Finally, the further advancement of motor behavior from the second to the third assessment could be justified: First, with the interplay between caregivers' perceptions and actions and infants' abilities these interactions underlies the developmental process, even in the first months of life, typical development involves a cooperative process of communication and interaction between care givers and infants as infants facilitate and regulate their own learning in conjunction with guidance from more experienced care givers, care givers who are more sensitive at reading infant's cues and adapting their interactions to match infant's abilities and needs have infants with better social-emotional and cognitive development at 1-2 years of age (Lobo and Galloway, 2012).

Second, infants' motor skills improve as their bodies and environments are changing. Infants learn in the context of continual development (Berthier *et al*., 2005).

This explains how a short period of intervention early in life results in advancement in gross motor behaviors immediately after intervention and up to six months. In the current study, parents who performed enhanced handling and positioning experiences continued to observe changes in their infant's motor behavior after the home play period ended, Moreover, some of them facilitated their infants through the acquisition of motor milestone through guided play. On the other hand, social experience group parents also reported changes and advancements in their infant's attention and motor behavior.

2nd influence on reaching kinematics as measured by kinovea adjustment index: The selection of adjustment index to measure was based on the findings of Toledo and Tudella (2008) who investigated the development of reaching behavior in low-risk preterm infants in seated position over age 5-7 months by analyzing certain kinematic variables and characteristics of grasping. Their results showed that all the kinematic variables analyzed remained unchanged throughout the months for the full term infants while for the preterm ones the only variable altered was the adjustment index at 6 months of age. They also reported that slower movements and greater adjustments may be functional strategies of preterms to achieve successful grasps. In addition, Rocha *et al*. (2006a,b) demonstrated that the development of reaching in 4-6-month-old full term infants may occur through periods of both stability and instability. According to these

authors, the phase transition is more evident between the fourth and the fifth month while the period between the fifth and the sixth month is the more stable one.

In light of these observations, the current study aimed to examine the influence of enhanced handling and positioning experience on infants reaching behavior after the infants have explored the movement possibilities and adapted a stable pattern of reaching. In the present study between groups comparison at six months revealed significant difference ($p<0.05$) in favor of both study groups (full term and low risk preterm infants) as compared with their full term controls who showed higher adjustment index which mean they showed higher deceleration time to successfully touch the object.

These findings come in line with the results of Lee (2010) who investigated the effects of early postural and movement experiences on young infants' head control, pre-reaching movements and early reaching behaviors through multi-level measurements beginning when infants were 1 month old through when they were 4 months old. Results revealed that infants with training demonstrated more advanced head control and displayed different control in pre-reaching movements which led to earlier successful reaching.

As for preterm infants (Salt and Redshaw, 2006) stated that these infants commonly show problems with visual perception, visual motor control, eye-hand coordination, visuomotor integration, fine motor skills and goal directed behavior Carvalho *et al.* (2007) argued that with an increased deceleration time, the preterm infants have more time to process and use visual information to touch the object. This strategy may have been necessary due to the intrinsic constraints typical of preterm infants.

However, the literature reported the role of movement experiences in overcoming internal constraints related to prematurity. Heathcock *et al.* (2008) evaluated the effectiveness of a movement training program on the emergence of reaching in infants born at less than 33 weeks of gestational age and concluded that there are early gross motor skill differences in these infants that a caregiver-based daily training program, is effective at lessening some but not all, of these differences over the short term.

So, improvement in preterm infants' reaching quality could be attributed to two reasons.

First, early experiences in the current study resulted in a better head control which in turn created less mechanical perturbations to arm movements as infants are learned to control their arms (Lee, 2010). Similarly, the acquisition of some level of postural control is thought to provide the same mechanical and perceptual foundation for the future development of functional skills including early skills such as head control and reaching (Shumway-Cook and Woollacott, 2007).

Second, in infancy, reaching movements are performed in supine and sitting positions. However, the sitting position challenges postural control more than the supine position. This may imply that in atypically developing infants, whose postural control is impaired, reaching is particularly difficult in sitting (Hadders-Algra, 2013). Thus, the use of a strap fastened on the infants' trunk provided trunk support, which may led to a decrease in the amount of postural activity and to a consequent improvement in postural control, thus allowing infants to produce only the amount of arm force required to defy gravity and perform the movement.

In summary, the overall improvement in motor behavior of enhanced experience groups could be justified by the neuronal group selection theory which suggests that the structure and function of the nervous system depend on repeated behavioral experience, motor actions and their sensory consequences. Practice is necessary to develop motor function. It needs first to be consistent and

then within a variety of situations. A variety of movement experiences helps to stimulate as well as reinforce motor learning (Levitt, 2010).

CONCLUSION

Based on the findings of the current study and relevant literature it could be concluded that early intervention family based programs have a positive effect on infants motor development especially those at risk of developmental delay.

REFERENCES

Adolph, K.E., L.B. Karasik and C.S. Tamis-LeMonda, 2010. Moving between Cultures: Cross-Cultural Research on Motor Development. In: Handbook of Cross-Cultural Developmental Science, Volume 1: Domains of Development across Cultures, Bornstein, M. (Ed.). Lawrence Erlbaum Associates Publishers, Mahwah, NJ., pp: 61-88.

Bamm, E.L. and P. Rosenbaum, 2008. Family-centered theory: Origins, development, barriers and supports to implementation in rehabilitation medicine. Arch. Phys. Med. Rehabi., 89: 1618-1624.

Berthier, N.E., M.T. Rosenstein and A.G. Barto, 2005. Approximate optimal control as a model for motor learning. Psychol. Rev., 122: 329-346.

Blauw-Hospers, C.H., V.B. de Graaf-Peters, T. Dirks, A.F. Bos and M. Hadders-Algra, 2007. Does early intervention in infants at high risk for a developmental motor disorder improve motor and cognitive development? Neurosci. Biobehav. Rev., 31: 1201-1212.

Carvalho, R.P., E. Tudella and G.J.P. Savelsbergh, 2007. Spatio-temporal parameters in infant's reaching movements are influenced by body orientation. Infant Behav. Dev., 30: 23-35.

De Jong, M., M. Verhoeven and A.L. van Baar, 2012. School outcome, cognitive functioning and behaviour problems in moderate and late preterm children and adults: A review. Semin. Fetal Neonatal Med., 17: 163-169.

De Toledo, A.M., D.A. Soares and E. Tudella, 2011. Proximal and distal adjustments of reaching behavior in preterm infants. J. Motor Behav., 43: 137-145.

Doyle, L.W., 2004. Evaluation of neonatal intensive care for extremely low birth weight infants in Victoria over two decades: I. Effectiveness. Pediatrics, 113: 505-509.

Fetters, L., Y.P. Chen, J. Jonsdottir and E.Z. Tronick, 2004. Kicking coordination captures differences between full-term and premature infants with white matter disorder. Hum. Mov. Sci., 22: 729-748.

Hadders-Algra, M., 2013. Typical and atypical development of reaching and postural control in infancy. Dev. Med. Child Neurol., 55: 5-8.

Heathcock, J.C., M. Lobo and J.C.C. Galloway, 2008. Movement training advances the emergence of reaching in infants born at less than 33 weeks of gestational age: A randomized clinical trial. Phys. Ther., 88: 310-322.

Ishiguro, A., Y. Namai and Y.M. Ito, 2009. Managing healthy late preterm infants. Pediatr. Int., 51: 720-725.

Kinney, H.C., 2006. The near-term (late preterm) human brain and risk for periventricular leukomalacia: A review. Semin. Perinatol., 30: 81-88.

Kuo, Y.L., H.F. Liao, P.C. Chen, W.S. Hsieh and A.W. Hwang, 2008. The influence of wakeful prone positioning on motor development during the early life. J. Dev. Behav. Pediatr., 29: 367-376.

Kyno, N.M., I.H. Ravn, R. Lindemann, M.W. Fagerland, N.A. Smeby and A.M. Torgersen, 2012. Effect of an early intervention programme on development of moderate and late preterm infants at 36 months: A randomized controlled study. Infant Behav. Dev., 35: 916-926.

Lee, H.M., 2010. The effect of early intensive postural and movement training on head control, pre-reaching movements and early reaching behaviors. Ph.D. Thesis, University of Delaware, Delaware.

Lee, H.M. and J.C. Galloway, 2012. Early intensive postural and movement training advances head control in very young infants. Phys. Ther., 92: 935-947.

Levitt, S., 2010. Treatment of Cerebral Palsy and Motor Delay. 5th Edn., Blackwell Scientific Publication, Oxford, pp: 62-196.

Lobo, M.A. and J.C. Galloway, 2012. Enhanced handling and positioning in early infancy advances development throughout the first year. Child Dev., 83: 1290-1302.

Morse, S.B., H. Zheng, Y. Tang and J. Roth, 2009. Early School-age outcomes of late preterm infants. Pediatrics, 123: e622-e629.

Rocha, N.A.C.F., F.P.S. Silva and E. Tudella, 2006a. Impact of object proprieties on infant's reaching behavior. Infant Behav. Dev., 29: 251-261.

Rocha, N.A.C.F., F.P.S. Silva and E. Tudella, 2006b. [Influence of object size and rigidity on proximal and distal adjustments to infant reaching]. Braz. J. Phys. Ther., 10: 262-268, (In Portuguese).

Salt, A. and M. Redshaw, 2006. Neurodevelopmental follow-up after preterm birth: Follow up after two years. Early Hum. Dev., 82: 185-197.

Shumway-Cook, A. and M.H. Woollacott, 2007. Motor Control: Translating Research into Clinical Practice. 3rd Edn., Lippincott Williams and Wilkins, Philadelphia, PA.

Spittle, A., J. Orton, P. Anderson, R. Boyd and L.W. Doyle, 2012. Early developmental intervention programmes post-hospital discharge to prevent motor and cognitive impairments in preterm infants. Cochrane Lib. 10.1002/14651858.CD005495.pub3

Toledo, A.M. and E. Tudella, 2008. The development of reaching behavior in low-risk preterm infants. Infant Behav. Dev., 31: 398-407.

Vaivre-Douret, L., K. Ennouri, I. Jrad, C. Garrec and E. Papiernik, 2004. Effect of positioning on the incidence of abnormalities of muscle tone in low-risk, preterm infants. Eur. J. Paediatr. Neurol., 8: 21-34.

Van der Heide, J.C., J.M. Fock, B. Otten, E. Stremmelaar, L.A. van Eykern and M. Hadders-Algra, 2004. Postural control during reaching in preterm children with cerebral palsy. Dev. Med. Child Neurol., 46: 253-266.

Vanderveen, J.A., D. Bassler, C.M. Robertson and H. Kirpalani, 2009. Early interventions involving parents to improve neurodevelopmental outcomes of premature infants: A meta-analysis. J. Perinatol., 29: 343-351.

Young, M.E. and L.M. Richardson, 2007. Early Child Development from Measurement to Action: A Priority for Growth and Equity. World Bank Publications, Rome, Italy, ISBN-13: 9780821370872, pp: 43-86.