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Effect of Biological Risk Factors and Home Environment on Motor Development in Early Child-Hood

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ABSTRACT

Background: *The assessment of the motor domain of childhood development is of paramount importance as the motor milestones are often the earliest milestones to emerge in an infant's life and are easily noted by the parents and other caregivers.* ***Objectives:*** *To evaluate the association between biological risk factors, home affordances, and infant motor development.* ***Methodology:*** *A total of 460 infants in the age group of 3-18 months were enrolled in the study from the immunization setting of District Hospital, Faridkot, Punjab. Gross motor and fine motor assessment of infant development were done using Ages and Stages Questionnaire (ASQ) and Affordances in Home Environment for Motor Development-Infant Scale (AHEMD-IS) tool were used to evaluate the home affordances and socio-economic status was evaluated from family income, class, and education status of parents.* ***Results:*** *Most of the study subjects 426 (92.6%) were born at term gestation whereas 34 (7.3%) were born preterm. The majority of subjects had a mean birth weight (2.9kg ± 0.387). Also, out of a total of 460 subjects 259 (56.3%) were male and 201(43.7%) were female. Typical biological risk factors like gestation and birth weight are highly associated with motor development similarly some home environment factors like availability of space, parental interaction, and motor toys significantly affect infant motor development.* ***Conclusion:*** *Biological risk factors significantly influence an infant's motor development, similarly the home environment plays a key role to improve motor development that could be modified to meet the requirement of infants with high biological risk factors.*

Keywords: Motor development, Home environment, Socio-Economic Status (SES), Family, Infant

INTRODUCTION

Background of Study

Early childhood, commonly referred to as the first five years of life, is a critical period in the development of an individual when a variety of motor, language, cognitive, and social skills are acquired. As a human process, motor development relates to the changes that occur in our ability to move and our movement in general as we proceed through the lifespan. Specifically, it has been defined as the study of change in motor behavior of an individual as influenced by his or her biological and environmental factors. In the context of motor development of preschool children, the home environment is the most important setting for learning and development including the development of motor skills. Variations in the upbringing conditions are frequently cited as a major factor influencing a child's motor development during infancy and early childhood [1]. Differences in various practices related to child-upbringing highlight the role of parents and other caregivers in providing affordances for action. Starting from early infancy, these caregivers promote the child's action by facilitating or constraining the circumstances surrounding the child's developing skills [2]. For example, the caregivers decide whether infants are on a spacious floor or they are carried in the arms most of the time, whether they are given access to stairs or not, and whether they sleep on their backs or their stomach [3-5]. The quality of the family environment appears to be directly associated with the cognitive and motor development of the family members, with the boys being especially more susceptible than girls to the influences of the surrounding environment [6,7].

The early years of life of a child are the period of rapid growth and development. Various factors affect child growth and development such as biological factors, environmental factors especially the home environment. Children are like clay in the potter's hand and early development could be shaped and modified by many external influences. Contemporary research in child development had drawn attention towards the fact that an optimal level of child development occurs with a stimulating environment and strong contextual support [8]. There are several studies related to factors affecting child development. Biological risk factors are very well-known factors affecting child development as much work has been done in this field. Several studies have proved that biological risk factors are the typical factors that grossly affect child development in major areas of development like physical parameters, gross motor, fine motor, social, language, cognitive, etc. Monitoring the growth and development in the context of these factors is an important aspect of child health care. A long back, researchers around the world thrived their best to study the home environment and association with the social and cognitive development of a child. But a very few studies have focussed on finding an association between the home environment and motor development of the child. The most notable work in this direction is the Home Observation for Measurement of Environment (HOME) by Bradley and Caldwell [9]. Although HOME inventory was not designed to assess the association of home environment with motor development in children but the availability of toys for providing a stimulating environment for learning and its relation to child development, further drew the attention of researchers towards the role of home affordances in early motor development. HOME inventory was the most commonly used tool to assess the home environment that was helpful for a general home assessment. In the assessment of home environment in the context of affordances for motor development in children, a recently developed and validated tool Affordances in Home Environment for Motor Development-Infant Scale (AHEMD-IS) has been used in few studies [10-13]. Similar to these studies, AHEMD-IS tool has been used in the present study as there are very few international studies and none from the Indian subcontinent that have made use of this recent home assessment tool. In the study by Cacola et al, regarding the affordances in home and motor development in infants 3-18 months significant differences in AHEMD-IS total scores were found for the socioeconomic status [13]. It was postulated that the families with higher SES were able to provide their infants with more toys and space, the parameters which had a positive correlation with motor development [14]. A study by Guryan et al, noted that maternal education levels had a positive influence on quantity and quality for home affordances for motor development and also identified that mothers with higher education levels were those with higher SES [15]. The prime aim of our study was to assess the effect of the home environment on motor development in the age group of 3-18 months of age and to find an association between biological risk factors and motor development. Assessment of early motor development serves the purpose of screening the infant for developmental delay. Also helps to find out factors affecting motor development like a home environment.

METHODOLOGY

The present research study was conducted in Civil Hospital, Faridkot, Punjab, India which is a district-level public hospital. The immunization setting of the hospital was selected for data collection. An immunization setting allows for a very feasible and practical approach to meet parents and interact with them. Infants aged 3-18 months and their parents were enrolled in the research study using the purposive sampling technique. The calculated sample size was 400 using power analysis which was increased to 460 subjects. Written informed consent was taken from parents for participation in the study. With the parents' consent infants of age group, 3-18 months were assessed for gross and fine motor development using Ages and Stages Questionnaire (ASQ) tool. ASQ is a standard assessment tool and it includes five dimensions: Gross motor, fine motor, problem-solving, personal-social, and communication. For use in the current study reliability of all five dimensions was calculated separately which was at an acceptable level (>0.7) and home assessment for affordances in the home environment for motor development was done using AHEMD-IS tool. While assessing the home environment self-reporting by parents was done for home affordances. AHEMD-IS includes broadly four dimensions that include items physical space (1-7), variety of stimulation (8-15), gross motor toys (16-21), and fine motor toys (22-26). The tool describes the overall scoring and interpretation of all individual items.

Statistical Analysis

Data were compiled and analyzed using IBM SPSS (SPSS software, version 23, SPSS Inc., Chicago, IL, USA). The level of significance was kept at 5% for this study. The p-value of ≤ 0.05 was considered statistically significant. To find the association Chi-square test was applied and also regression analysis was done to find an association between home environment and motor development. Study results were presented in form of tables and figures.

RESULTS

Descriptive parameters of the study participants including gender and gestation age are presented in Table 1. Most of the study subjects 426 (92.6%) were born at term gestation whereas 34 (7.3%) were born preterm. The mean birth weight of the participants was (2.9 ± 0.387) Kg. Besides, out of total of 460 subjects, 259 (56.3%) were male and 201 (43.7%) were female.

Table 1 Distribution of study subjects as per baseline characteristic N=460

Variables	Frequency (N)	Percentage
Gestation		
Term infants	480	92.60%
Preterm infants	34	7.30%
Gender		
Male	259	56.30%
Female	201	43.70%
Birth weight		
Normal birth weight	429	93.30%
Low birth weight	31	6.70%

Based on the age of enrollment, three categories were constituted (Table 2). These categories were semester one (between 0-6 months of age), semester two (7-12 months of age), and semester three (13-18 months of age). The mean birth weight of infants was in the range of (1.25 to 4.5) kgs with an SD of 0.3874 gm and between comparing three semesters regarding birth weight, there was no statistically significant difference among the subjects. There was a uniform distribution of term and preterm infants among the semesters and the p-value were 0.434 which is statistically non-significant.

Table 2 Distribution of study subjects in semesters as per baseline characteristic N=460

Variable	Total	Semester 1	Semester 2	Semester 3	Chi^2, Df p-value
Total	460	178	136	146	
Gestation					
Term	426	162	129	135	1.669, Df 2
Preterm	34	16	7	11	0.434
Gender					
Male	259	96 (53.9%)	73 (53.7%)	90 (61.6%)	2.481, Df 2
Female	201	82 (46.1%)	63 (46.3%)	56 (38.4%)	0.289
Categories of weight					
Normal Birth weight	429	162 (91%)	128 (94.1%)	139 (95.2%)	2.471, Df 2
Low birth weight	31	16(9%)	16 (9%)	7 (4.8%)	0.291
Birth weight (mean ± SD in grams)	2.9304 ± 0.387	2.92 ± 0.399	2.95 ± 0.411	2.91 ± 0.347	F= 0.538, Df 2 0.584

The socioeconomic status of the family and home environment factors are represented in Table 3. Most of the families were categorized in the lower middle class (35.2%) followed by upper lower class (32.8%), the remainder of the sample was categorized upper middle class (14.3%), upper class (7.8%), and lower class (9.8%). Houses of most of the families (74.8%) had adequate physical space. Most of the children (82.6%) used to play with other children. Nearly two-thirds of the parents (69.1%) engaged themselves in practicing body movements with their children. Out of the total study subjects, 17% had attended child care centers. The majority of the study subjects (88.9%) were free to take toys by choice from a particular place inside the home.

Table 3 Socioeconomic status of the family and home environment factors N=460

Variables	Frequency	Percentage
Socioeconomic status		
Lower	45	9.80%
Upper lower	151	32.80%
Lower middle	162	35.20%
Upper middle	66	14.30%
Upper	36	7.80%
Home environment		
Space inside home	344	74.80%
Child plays with children	380	82.60%
Parents practice movements with child	318	69.10%
Child attended child care/crutch	78	17%
Child takes toys by choice	409	88.90%

Tables 4 and 5 depicts the association of biological factors with mean gross motor and fine motor scores. "t" test was applied to compare the means. Preterm infants had a significantly low mean gross and fine motor score as compared to term infants' score.

Table 4 Association between gross and fine motor score with gestation age

Development	Gestation		p-value
Scores mean	Term	Preterm	
Gross motor score	44.0 ± 8.4	37.5 ± 11.6	0.000*
Fine motor score	43.5 ± 8.0	34.5 ± 14.2	0.000*

Table 5 Association between gross and fine motor score with birth weight

Development	Birth weight		p-value
Scores mean	Normal	Low birth weight	
Gross motor score	44.1 ± 8.3	36.2 ± 12.5	0.000*
Fine motor score	43.4 ± 8.0	35.4 ± 15.0	0.000*

Similarly, to find the relationship between birth weight and mean gross motor and fine motor score "t" test was applied which showed a statistically significant difference between normal and low birth weight infants.

Further, the bivariate correlation was applied to find out the correlation semester wise and it was found that gestation age had a significant effect on both gross and fine motor development in all three semesters whereas birth weight had a significant effect in the first semester only. The correlation did not reach a statistically significant level in the second and third semesters in both gross motor and fine motor development.

To find out the association between biological risk factors and motor and fine motor delay, the Chi-square test was applied (Tables 6 and 7) and it was found there was a statistically significant difference. It shows preterm infants and infants with low birth weight were more prone to develop gross motor and fine motor delays. Further analysis has shown that biological factors have a marked impact in the first and second semester, whereas in third-semester environmental factors play a major role.

Table 6 Association between gross and fine motor delays with gestation age

Development delay	Gestation age		Chi-square and Df	p-value
	Term	Preterm		
Gross motor delay	33 (7.7%)	11 (32.7%)	22.039 Df=1	0.000*
Fine motor delay	24 (5.6%)	15 (44.1%)	60.098 Df= 1	0.000*

Table 7 Association between gross and fine motor delay with birth weight

Development delay	Birth weight		Chi-square and Df	p-value
	Normal	Low birth weight		
Gross motor delay	34 (7.9%)	10 (32.3%)	19.788 Df=1	0.000*
Fine motor delay	26 (6.1%)	13 (41.9%)	47.952 Df= 1	0.000*

Linear regression with backward extraction was applied and results have pointed out that variables that are positively associated with fine motor development are gestation age, variety of stimulation, education of mother, childcare clinic attendance, and the number of gross and fine motor toys. The model was significant (r=0.536 and p=0.000). Together these factors explained 53.6 % of the change in fine motor development.

On the other hand, variables positively associated with infant gross motor development outcome were mainly gestation age, education of mother, attended childcare, total space, varies of stimulation, and gross motor toys. The model was significant (r=0.893 and p=0.000) these home affordances factors together explained 89.3% of the variation in gross motor development.

Regarding differences among semesters: correlation between the biological risk factors and motor development.

Motor Development

Gestation: Correlation between motor development and gestation was found significant and negative, smaller the gestation less was motor development in the first semester, (r=-0.245, p=0.001). For the second semester non-significant correlation was found between gestation and motor development, (r=0.006, p=0.944). For the third semester, it was a significant and negative correlation between two variables, (r=-0.286, p=0.000).

Birth weight: Bivariant correlation between the birth weight and motor development for the first semester was significant and positive, (r=0.286, p=0.000). For second semester it was non-significant, (r=0.051, p=0.559). For the third semester, there was a non-significant correlation between birth weight and motor development, (r=0.197, p=0.017).

Fine Motor Development

Gestation: For the first-semester correlation between the gestation age and fine motor development was significant but negative. Smaller was the gestation less was fine motor development, (r=-0.309, p=0.000). For the second semester also it was significant and negative, (r=-0.070, p=0.416). For the third semester also there was a negative correlation between gestation and fine motor development, (r=-0.322, p=0.000).

Birth weight: In the first semester there was a significant and positive correlation between birth weight and fine motor development, (r=0.241, p=0.001) and in the second semester there was a non-significant correlation between two variables, (r=0.000, p=0.997). For the third semester also it was a non-significant correlation between two variables, (r=0.181, p=0.029).

DISCUSSION

The current study was conducted with the main objective of finding an association between biological risk factors, environmental factors; and motor development among children of 3-18 months of age group. In the present study, we found biological risk factors are typical risk factors during the early development stages, later on, the environment contributes more. We found there was a significant and positive correlation between motor development and birth weight. Similar findings were found by Datar et al, in a study involving the developmental assessment of twins [16]. In this study, it was found that very low birth weight (less than 1500 gm) and moderately low birth weight (1500 gm to

2499 gm) had pronounced negative effects on parameters of motor and mental development at 9 months and 2 years of age [16]. In a recent study published by Drozd-Dabrowsk et al, in 2108, the authors evaluated various risk factors in infancy that were associated with developmental delay in childhood [17]. The results of this study indicated that the most common risk factors in infancy which were more associated with future developmental delay in childhood were: Caesarean section, infections, and chronic diseases during pregnancy. In this study, it was found that infants with a birth weight of less than 2500 gm were three times more likely to develop developmental delay as compared to infants with normal birth weight [17]. Another recent study by Pirhadi et al, from Iran, studied the relation of birth weight to the occurrence of developmental delay in children aged 4 to 16 months [18]. In this study, it was found that the low birth weight of the child was associated with developmental delay in domains of fine motor movements, problem-solving and total scores as assessed by ASQ [18]. Inferential statistics analysis of our study has shown that delay was more significant at first semester whereas at second and third semester it was not significant that could be possibly due to catch up of weight gain at later stages of life. Gestation age is another typical risk factor for motor delay; it had a significant association with motor development in infants. Present study findings have shown that it was more evident in the first and second semesters of life. A study by Kerstjens et al, assessed the effect of gestational age on the occurrence of developmental delay in various domains by ASQ among children aged around 4 years [19]. The results of this study showed that the prevalence rate of abnormal scores on the ASQ total problem scale increased with decreasing gestational age: from 4.2% among the term-born children to 37.5% among children born at 24-25 weeks of gestation ($p<0.000$). The risk of abnormal ASQ total score increased exponentially with decreasing gestational age compared with children born at term [19]. A study by Schonhut et al, from Chile 2015 of 1667 infants evaluated the association between the gestation age at birth and risk of developmental delay using ASQ at 8 and 18 months of corrected postnatal age [20]. This study found that compared with full-term born infants the odds ratio for the developmental delay was 1.6 for those born early term, 2.58 for infants born late preterm, and 3.01 for those born moderately preterm. It was concluded that an inverse dose-response relationship between gestational age and the risk of developmental delay was found in the study population [20]. Several home environmental factors have been found related to motor development. Our study results have shown that the home affordances that contribute significantly to motor development are a variety of stimulations at home, a child playing regularly with the other children, parent's interaction with children and their practicing learning body parts and movements; and the number of gross and fine motor toys. A recently published study from Iran by Zoghi et al, studied 49 children of 24-42 months of age and evaluated the impact of home affordances on the motor, cognitive, and social development [21]. Although this study did not find any significant relationship between total AHEMD score and motor development there was a significant relationship between total AHEMD score and total cognitive development, verbal IQ, social development, and socio-economic status. A significant positive correlation was also found between the total AHEMD score and education status of parent's especially maternal education [21].

CONCLUSION

Present study results have shown that biological risk factors like gestation and birth weight are highly associated with the degree of motor development. Less gestation age influences the motor score negatively; infants with less gestation age are at high risk of motor delay compared to infants born at term. Similarly, low birth weight increases the risk of motor delay significantly. Home environment factors that are positively associated with fine motor development are the variety of stimulation, education of mother, childcare clinic attendance, and the number of gross and fine motor toys. On the other hand, variables positively associated with infant gross motor development outcome were mainly education of mother, attended childcare, total space, variety of stimulation, and gross motor toys. Both biological risk factors and socio-economic status put a vital impact on motor development, however, in contrast to biological risk factors, the home environment could be modified to foster motor development.

DECLARATIONS

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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