Impact of home environment on motor development of infants in South India: A cross-sectional study

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Abstract

Introduction: Early childhood development is a fundamentally important phase and is influenced by stimulus and nurturing. Environment influences, particularly the home environment, is considered the critical factor for optimal growth and development.

Objectives: To determine the impact of home environment on motor development in South Indian infants.

Method: 164 infants aged 1-11 months residing in Belagavi City, India, were recruited in a community-based cross-sectional study based on the inclusion and exclusion criteria. Structured questionnaire was used to assess the home environment followed by motor development assessment using Peabody developmental Motor Scale-2 (PDMS-2).

Results: Gestational age was positively associated, while duration of breast feeding, hospitalization and weight of the infant (-1.17, p= 0.03) had negative association with the fine and total motor quotient of PDMS-2. Father's education, occupation and income had significant positive effect on total and fine motor quotients. Outside space to play had positive association with fine motor quotient (2.28, p= 0.0154). Non availability of play material like pop up toys and child never exposed to play with floating toys, cups and socks also showed lower total quotient scores.

Conclusions: Gestational age, father's education, occupation and income had a positive effect on the motor development of South Indian infants participating in the study.

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Introduction

The interactive role of heredity and the environment in the development process of human beings has been recognized for many years[1]. For the past 40 years, efforts have been devoted to mapping the relationship between the home environment and selected aspects of the child's development[2]. Recently, considerable efforts have been devoted to investigate the relationship between motor development and the home environment[3]. Although specific home environment and motor development characteristics have been examined, minimal information is available in relation to the multidimensional effects of the home on motor development[4]. Motor development may be defined as the process of change in motor behaviour across the life span[5]. In a recent review, it was concluded that, although the home environment is within the host of subsystems contributing to infant motor development, little research exists to examine this relationship[6].

Objectives

To identify the determinants of motor development in South Indian infants.

Method

A community-based cross-sectional study was conducted among 164 infants in the age group 1-11 months from February 2019 to January 2020 in Belagavi, South India.

Inclusion criteria: Children between 1 and 11 months, with more than 37 weeks of gestation and having more than 2.5kg birth weight and paediatrician declaring that child is normal and typically developing as per the records were included in the study.

Exclusion criteria: Children already diagnosed with genetic disorders, congenital or acquired musculoskeletal, neurological, cardiovascular, cardiorespiratory, systemic illness and with non-cooperative parents were excluded from the study.

Sample size: We used the probability proportion to population size[7] method for sample size estimation,

in which a multistage random sampling technique was used to recruit the children from the urban area. Belagavi has 54 blocks and using simple random sampling method (lottery method) 18 blocks were selected. Using random number table, the first sampling interval number that is 5 was selected so, the 5th house was the first selected. The second selected house was 5+5=10, next 15, 20 and so on till we recruited 9 participants from each block, so that the estimated sample size was 162, but to compensate for the possible loss in the sample (5% attrition) we increased the sample to 170.

Peabody developmental Motor Scale-2 (PDMS-2): An interview was conducted with the mother using the structured questionnaire which took around 15 minutes. Questionnaire on determinants comprised information on child and family characteristics, home environment and play material. The child characteristics included gestational age, birth weight, present weight and height, duration of breast feeding, birth order and number of siblings. The family characteristics and home environment incorporated parents' name, age, education, occupation and income per month, outside and inside house space, and play material in terms of number of age-appropriate toys available and duration of play time with those toys by both child and parent[9,10]. Each child was then administered the PDMS-2 individually in the presence of the parent or caregiver. This process took around 45 minutes to 1 hour per child. The PDMS-2 assesses fine (grasping and visual-motor integration) and gross (reflexes, stationary, locomotion and object manipulation) motor skills of children from birth to 5 years (72 months). The obtained raw scores are converted to standard score and gross motor quotients (GMQ), fine motor quotients (FMQ) and total motor quotient (TMQ). Every item is rated on a 3-point rating scale. Internal consistency of the scale is very high (alpha = 0.97)[8].

Ethical issues: The study was approved by the Ethics Committee of KLE University, Belagavi, India (Ref. No. KLEU/EC/17-18/D-100). Written informed consent was obtained from the parents of the infants recruited in the study.

Statistical analysis: Multiple linear regression model was used to identify determinants of motor development. Variables for the statistical analyses were selected in a manual, stepwise forward procedure as suggested by Hosmer and Lemeshow (Applied logistic regression, Second Edition). The association between each independent variable with the selected outcomes were initially assessed in unadjusted models. Variables that were significant at a $p < 0.05$ level were kept in multiple models while variables non-significant in the initial crude assessment were re-introduced one at a time into these multiple models. This manual stepwise procedure was repeated for GMQ, FMQ and TMQ. The statistical analyses were performed in R. Studio.1.2.5001 (R Studio, PBC, Vienna, Austria).

Results

In the given study total 164 infants (80 boys, 84 girls) in the age group of 1-11 months were included. Child and family characteristics are presented as numbers (n) and percentages (%), and by means and standard deviations (SD) in Tables 1 and 2.

Determinants of gross motor quotient (GMQ)

At 5% level of significance, the availability of 1-2 rattles and parents spending some time with the infants playing with the rattle had positive association, whereas parents never spending time with infant had negative association with GMQ (Table 3).

Determinants of fine motor quotient (FMQ)

Gestational age in weeks, father's occupation as professionals, family income Rs 20715-42429 per month, presence of adequate space outside house for child to play or move around and child playing with pillows had statistically significant effect on FMQ. Duration of breast feeding, history of hospitalization, mother's education at post-graduate level, presence of suspended toys and child playing with it sometimes, availability of 1-2 stuffed toy and parents never indulging with infants playing with toys (cups) had statistically significant negative effect on FMQ (Table 4).

Determinants of total motor quotient (TMQ)

Infants weight, non-availability of play material like pop up toys and child never exposed to play with toys (floating, cups and socks) also showed lower total quotient scores as compared to those children who were exposed to play with variety of toys. Fathers educated to postgraduate level and parents involved in playing with infants for some time in a day showed higher total motor quotients (Table 5).

Table 1: ***Frequency distribution of characteristics under study (n=164)***

Variable	Subcategory	Number (%)
Gender	Female	84 (51.2)
	Male	80 (48.8)
Hospitalization during first year	No	76 (46.3)
	Yes	88 (53.7)
Number of siblings	Brother / Sister	43 (26.2)
	None	121 (73.8)
Main caregiver	Mother	115 (70.1)
	Mother and grandmother	49 (29.9)
Father's education	Primary 0-7th	31 (18.9)
	Secondary 8-10th	36 (22.0)
	Pre-university 10-12th / Diploma	33 (20.1)
	Graduate	29 (17.7)
	Post-Graduate	35 (21.3)
Father's occupation	Clerk, shop owner	28 (17.1)
	Profession	26 (15.9)
	Semi Profession	29 (17.7)
	Semi-Skilled Worker	19 (11.6)
	Skilled Worker	35 (21.3)
	Unskilled Worker	27 (16.5)
Family income (per month)	< 2091	26 (15.9)
	2092 – 6213	15 (09.2)
	6214 – 10.356	32 (19.5)
	10,357 – 15,535	18 (11.0)
	15,536 – 20,714	24 (14.6)
	20,715 – 42,430	32 (19.5)
	>42,430	17 (10.4)
Mother's education	Primary 0-7th	43 (26.2)
	Secondary 8-10th	25 (15.2)
	Pre-university 10-12th / Diploma	31 (18.9)
	Graduate	30 (18.3)
	Post-Graduate	35 (21.3)
Mother's occupation	Clerk, shop owner	0 (0)
	Profession	40 (24.4)
	Semi Profession	35 (21.3)
	Semi-Skilled Worker	57 (34.8)
	Skilled Worker	10 (06.1)
	Unskilled Worker	22 (13.4)
Housing type	Apartment	90 (54.9)
	Independent	74 (45.1)
Family type	Nuclear	76 (46.3)
	Joint	88 (53.7)
Is there an adequate space outside your house for your child to play and move around?	No	89 (54.3)
	Yes	75 (45.7)
Is the space outside your house safe for your child to play and move around?	Yes	36 (22.0)
	No	39 (23.8)
	Didn't give a response	89 (54.3)
Are there steps/stairs/ramp, where your child plays?	Yes	40 (24.4)
	No	35 (21.3)
	Didn't give a response	89 (54.3)
Is there any equipment to hold and stand or walk?	Yes	34 (20.7)
	No	41 (25.0)
	Didn't give a response	89 (54.3)
Is there any garden/park/playground near your house where your child can play?	No	75 (45.7)
	Yes	89 (54.3)
Is there enough space in the house for your child to play or move around?	No	76 (46.3)
	Yes	88 (53.7)
Is there any equipment in the house for your child to hold and stand/ walk/ jump?	No	80 (48.8)
	Yes	84 (51.2)
Does your child play on different ground texture?	No	79 (48.2)
	Yes	85 (51.8)
Are there thresholds in the home while entering any rooms?	No	79 (48.2)
	Yes	85 (51.8)

Table 2: ***Mean and standard deviation of characteristics under study (n=164)***

Variable	Mean	Standard deviation
Gestational age in weeks	38.50	1.08
Age in months	5.65	3.53
Birth weight (kg)	3.05	0.37
Present weight (kg)	5.79	1.48
Height (cm)	61.92	7.41
Duration of breast feeding in months	5.02	2.88
Number of children in the house	1.26	0.44
Father's age (years)	28.03	1.99
Father's age at conception (years)	26.78	2.02
Mother's age (years)	26.19	2.02
Mother's age at conception (years)	26.78	2.02
No. of years living in the house	3.08	1.40
Number of adults	3.04	1.34
How many rooms are there in the house?	1.96	0.79
Gross motor quotient (GMQ)	94.35	6.08
Fine motor quotient (FMQ)	96.80	6.05
Total motor quotient (TMQ)	94.74	4.81

Table 3: ***Linear regression analysis for finding significant effect on gross motor quotient***

Variable	Estimate	p-value
Rattle (1 - 2)	2.17	0.028
Parent time (never)	-3.5432	0.01
Parent time (sometimes)	2.9087	0.028
Suspended toys parent time (never)	- 3.2142	0.034

Table 4: ***Linear regression analysis for finding significant effect on fine motor quotient***

Variable		Estimate	p-value
Child characteristics	Gestational age in weeks	1.5389	0.0011
	Duration of breast feeding in months	-0.505	0.0032
	Hospitalisation during first year (Yes)	-2.184	0.0183
Family characteristics	Father's occupation (Profession)	5.1576	0.0016
	Family income per month (20,715-42,429)	3.709	0.0212
	Mother's education (Postgraduate)	-3.757	0.0124
Home environment	Is there adequate space outside house for child to play and move around? (Yes)	2.2874	0.0154
Play material	Suspended toys child time (sometimes)	-3.1	0.0205
	Stuffed toys (1 - 2)	-1.915	0.0389
	Cups parent time (Never)	-3.088	0.0264
	Pillows (1 - 2)	3.0798	0.0012

Table 5: ***Linear regression analysis for finding significant effect on total motor quotient***

Variable		Estimate	p-value
Child characteristics	Present weight in kg	-1.174	0.0368
Family characteristics	*Father's education (postgraduate)*	2.4864	0.0352
Play material	Rattle parent time (sometimes)	2.2831	0.0195
	Cups child time (never)	-2.385	0.0282
	Socks (1 - 2)	-2.158	0.0033
	Water floating toys (none)	-1.544	0.0472
	Pop up toys (none)	-1.499	0.0448

Discussion

The present study aimed to identify the determinants of motor development in South Indian infants. The assessed factors are commonly studied in western countries but to the best of our knowledge this study is first of its kind conducted in this part of India. In the present study it was found that availability of 1-2 rattles and parents spending some time with the infants playing with the rattle had positive association, whereas parents never spending time with infant had negative association with gross motor development. Gestational age in weeks, father's occupation as professionals, family income 20715-42429 Rs per month, presence of adequate

space outside house for child to play or move around and child playing with pillows had positive impact on fine motor development, while duration of breast feeding, history of hospitalization, mother's education at post-graduate level, presence of suspended toys and child playing with it sometimes, availability of 1-2 stuffed toy and parents never indulging with infants playing with cups had negative effect on fine motor development. Infant's present weight, non-availability of play materials like pop up toys and child never exposed to play with floating toys, cups and socks also showed lower motor development as compared to those children who were exposed to play with a variety of toys. Fathers educated to postgraduate level and parents involved in playing with infants for some time in a day showed better motor development.

Gross motor skills define the motor coordination, skills and the competency. The GMQ is derived from the three subtests i.e., reflex (automatic reaction to the environment), stationary (attain stable posture when not moving) and locomotion (ability to maintain stability while moving from one place to other). It measures the ability to use large muscle systems to react to environmental changes[8]. In the present study it was found that, availability of play material and parents spending time with the child playing with these toys was associated with the gross motor development of the infant. It was observed that child rearing activities like sitting with or without support, allowing the child to move around freely, facilitating them to crawl and walk and exposing the child to different play materials and participating with the child while he/she is playing were practised by the parents and this could be one of the reasons for this positive association. The findings of the study are in line with a systematic review which stated that interventional toys and sources which enable object control and motor coordination assist in improving motor competency[11].

Fine motor development is the refined use of small muscle groups with control to perform skills such as grasping, fingering hands, transferring the objects from one hand to the other[12]. Gestational age, father's occupation and family income, presence of adequate space outside the house for child to play or move around and child playing with toys were significant predictors of fine motor development. Authors assessed association between motor affordance in home and child motor and cognitive behaviour. Children were assessed at 9 months of age and later after 6 months. There was significant positive correlation between dimensions of home (daily activities and play materials) and global motor performances[13]. Similar findings were seen in a study, association of timing of milestone attainment with pre- and postnatal factors like gestational age, weight increase in the first year of life and parental social status. Variance in overall mean of milestone achievement was explained by 16.2% of predictors[14]. Occupation and income are positive predictors of socioeconomic status (SES) and its effect on child development can be detected during early infancy[15]. In the present study, better socioeconomic status has led to better knowledge of early child development, due to which the infant is exposed to variety of learning material. This could have been the possible causation explaining improved fine motor skills in the infants in the present study. Duration of breast feeding, history of hospitalization, mothers educated at post-graduate level, presence of suspended toys and child playing with it sometimes, availability of stuffed toy and parents never indulging with infants playing had significantly negative effect on FMQ. Previous studies point that motor skill development are not significantly related to environmental factors (e.g., infections, trauma and hospital stay)[16,17]. The results of the present study could be delineated through protective effects of high parent education and negative impact of high SES since parents have understanding but have no time to stay with children spending quality time. This allows us to understand the progressive relationship between motor development and environment.

Non-availability of play material and child never exposed to playing with floating toys, cups and socks showed lower motor development as compared to those children who were exposed to play with a variety of toys. The same link was found in the study done to assess the association between quality of stimulation in the family environment and child's development and found positive association[18]. Educated fathers and parental involvement in playing with infants showed higher motor development in the present study. In a systematic review done to assess the father's involvement in early childhood development, the authors found a positive correlation[19].

Conclusions

Gestational age, father's education, occupation and income had a positive effect on the motor development of South Indian infants participating in the study.

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