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The Interaction of Social, Physical and Nutritive Factors in Triggering Early Developmental Language Delay in a Sample of Egyptian Children

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Abstract

BACKGROUND: Language acquisition and child development during the early years of life depend on multiple interacting factors.

AIM: To explore potential factors that can impact language development in 2 groups of Egyptian children, one with normal language development and the second with delayed development. Also, to explore to what extent can the involvement of impaired motor development potentiate the risk of developmental language delay.

METHODS: This cross-sectional case-control study involved Egyptian children belonging to the middle socioeconomic class between 18 and 36 months of age. Children were classified according to their performance on language domain of Bayley Scales of Infant and Toddler Development (Bayley-III) into two groups, infants with the average or above score (control group) and those having below-average scores (cases). Motor development was assessed on the same scale. Factors affecting language development were tested, including socio-demographic, obstetric, and maternal medical factors in addition to Infant Feeding Practices.

RESULTS: The independent factors lowering the language scores were early introduction of complementary food, low family income, history of delivery problems, pregnancy-related diseases of the mother, and maternal education. Impaired motor development appears as a further highly significant risk factor to the previously mentioned factors

CONCLUSION: In Egyptian children, delayed language development is severely affected by the interaction of medical, social and nutritional factors. Providing adequate maternal health care during pregnancy and childbirth, regular developmental monitoring at each child visit, and screening for such risk factors, can reduce size of the problem and promote child’s social and psychological development.

Introduction

Language development is an essential part of a child’s overall development. It builds the child’s ability to communicate, express and perceive feelings. It also promotes thinking, problem-solving, and enhancing and maintaining relationships [1]. A child's early years of language development are crucial for the basis of school readiness, such as literacy skills, social and psychological growth [2].

Children develop receptive and expressive language skills at varying rates. The term Developmental language delay (DLD) or late talker is used to identify children aged 18-36 months who fail to attain the least expressive vocabulary milestones expected for their age and sex [3].

The prevalence of communication disorders in the international literature varies according to the age of affected children and methods of assessment. It was found that 61% of 24-months old children display expressive speech disorders [4], [5]. Developmental language disorder (DLD) comprising the largest disability group in pre-school-aged children. Approximately 7% of the population is expected to have DLD [6]. Egyptian studies concerned with the prevalence of communication disorders are infrequent [7], [8]. Gharib et al. recorded that prevalence of confirmed delayed language development (DLD) in the Egyptian sample was 6.4% [8]. Unnoticed and unmanaged impaired language development can have a significant serious effect on a child's development, affecting educational, social, and psychological progress [9]. Academic difficulties, learning disabilities [10], shyness and social difficulties, anxiety disorder, behavioural problems [11], [12], [13] and ADHD [14] are common detrimental consequences.

Acquisition of early motor skills is known to enhance the child's cognitive, language and social development. However, the positive association between motor and language development has been considerably investigated [6], [15], [16]. Libertus and Violi et al., have found that the onset of independent sitting may initiate a developmental cascade that results in increased language learning opportunities [17]. On the other hand, a link between motor impairment and language impairment has been proved [18], [19]. The presence of subtle motor impairment may explain the unresponsiveness of children with language impairment to speech therapy.

Language development is also influenced by other factors. Environmental factors as perinatal problems, poor socioeconomic conditions, lack of parental interaction and improper nutrition may precipitate delay in all developmental domains, including language domain [8]. Speech and language delay may be symptoms of a global developmental disorder such as autistic spectrum disorder, or a genetic disorder as Down syndrome or may be an indicator of hearing impairment. The tendency to speech and language disorders is mostly believed to be multifactorial, involving complex interactions between some common genetic variants and environmental factors [20].

Screening procedures and regular surveillance to recognise factors affecting infant development are crucial for early detection of potential developmental delays and hence, choosing proper management approaches. Therefore, the purposes of the present study were:

- To investigate a group of Egyptian infants for potential risk factors that can influence language development as socioeconomic factors, nutritional factors and perinatal maternal and infant medical conditions.

- To estimate the proportion of infants with subtle motor impairment among a group of infants presented with language impairment and among another matched group with normal language development

- To explore to what extent can the involvement of impaired motor development potentiate the risk of developmental language impairment.

Subjects and Methods

Study design and setting

This cross-sectional case-control study involved male and female Egyptian children aged from 18 to 36 months. They were recruited from Developmental and Behavioral Paediatrics Clinic at the National Research Centre (NRC) and the Pediatrics Outpatient Clinic of Ain Shams University (ASU) in the period from September 2016 to September 2018. A child was enrolled if he belonged to the middle socioeconomic class, the parents' main complaint was the child's delayed speech, and if they consented to participate in the study. Children were excluded if they demonstrated any obvious congenital anomalies, features of genetic diseases, or had a history of any metabolic or physical problems.

Sample Size

Previous research had found that delayed motor milestones were documented in about 70% of children with developmental language impairment (LI) and only in 22% of the control children [21].

In this study, it was planned to use two-sided confidence intervals for the difference in proportions to calculate sample size. The used confidence interval method was the Yates chi-square simple asymptotic method with continuity correction (Newcombe, 1998) [22]. The proportion estimates to be used 0.70 for Group 1, and 0.22 for Group 2.

Calculated group sample sizes of 353 (to be rounded to 360) for group 1 and of 293 (To be rounded to 295) for group 2 produce a two-sided 85% confidence interval for the difference in population proportions with a width that is equal to 0.100

Subjects

Enrolled children were classified according to their performance on language domain of Bayley Scales of Infant and Toddler Development (Bayley-III) into two groups: infants having a below-average composite score (impaired development) and those having average or above-average scores (normal development). Three hundred and sixty children with below-average language composite score were recruited as cases, and 295 children of the same age and sex with average and above-average languages composite score served as a control group.

Methods

Socio-demographic assessment: For this special assessment questionnaire was used including questions about maternal age, maternal and paternal education and occupation, marital status, family income, and child order of birth [23]. Family income was classified according to father's occupation into two categories; lower-middle-income, if the father is unemployed, day-by-day worker, farmer, or manual labourer; upper-middle-income, if the father is employee, professional and employer, or a dealer. Mother education was classified into 3 categories; illiterate to preparatory school, secondary school, and higher education.

Assessment of maternal and prenatal history: This included parity, history of maternal chronic diseases as hypertension, diabetes or hypothyroidism, and diseases acquired during pregnancy as gestational diabetes or preeclampsia. The infant's data about gestational age, mode of delivery, history of complicated labour such as premature rupture of membranes, fetal asphyxia or umbilical cord prolapse were recorded. History of postnatal problems as cyanosis, jaundice or convulsions and admission to NICU was enquired.

Infant Feeding Practices in the first six months of life: was assessed to identify infants who were predominately breastfed, artificially-fed (who were consuming other milk including fresh, tinned, and powdered milk from cows or other animals) or mixed fed (artificial plus breast milk). The time of introduction of complementary feeding was recorded whether before or after the sixth month of age.

Thorough physical examination and anthropometric measurements: All measurements were made according to techniques described in the Anthropometric Standardization Reference Manual [24]. Physical examination and assessment of growth were performed for cases and control subjects.

Assessment of language and motor development: using the Bayley Scales of Infant and Toddler Development (Bayley-III): These scales were developed by Nancy Bayley [25] to assess the development of infants and toddlers between the age of 1 month to 42 months. Bayley-III consists of 5 subscales, i.e. Cognitive Scale, Language Scale (Receptive Communication and Expressive Communication), Motor Scale (Fine Motor and Gross Motor), Social-Emotional Scale, and Adaptive Behavior Scale. In this study, only the language and motor domains were being measured. The test was administered according to the infant's age-specific start point. Each correct response is given a score of 1, and the total raw score is then converted into its composite score.

Ethical Considerations: The study complies with the International Ethical Guidelines for Biomedical Research Involving Human Subjects [26]. The Research and Ethical Committee of NRC cleared the study protocol. The ethical approval number was 11020. Informed consent was obtained from the parents of enrolled children.

Confidentiality: Mothers and children were identified by a serial number, and the information at the individual level was kept strictly confidential.

Results

The included children were divided according to the language composite score on Bayley scale into two groups; below-average group (n = 360) who were considered the cases, and average and above-average group (n = 295) who were the controls. Tables 1, 2 and 3 show the results of the univariate analysis of factors affecting language composite score.

Table 1: The risk of impaired language development according to different feeding practices

	N	Children with impaired language development (Cases) (n = 360)	Children with normal language development (Control) (n = 295)	P	OR (95%CI)
Type of feeding					
Breast fed	321	160 (49.8)	161 (50.2)		1
Bottle fed	241	146 (60.6)	95 (39.4)	0.012	1.6 (1.1-2.2)
Mixed fed	93	54 (58.1)	39 (41.9)	0.16	1.4 (0.9-2.2)
Time to add complementary food					
Before six months	201	128 (63.7)	73 (36.3)	0.003	1.7 (1.2-2.4)
After six months	454	232 (51.0)	222 (49.0)		

OR: Odds ratio; CI: Confidence interval.

Comparison of cases and control groups revealed the independent factors lowering the language composite score and present children who are at more risk of impaired language development. Early introduction of complementary food before the age of six months carries a highly significant risk of impaired language development (OR = 1.7, P = 0.03) Table 1, the lower family income and low maternal education (illiteracy up to preparatory schools vs high education) represent highly significant social risk factors (OR = 1.7, p = 0.001 and OR = 1.9, p = 0.001 respectively) Table 2.

Table 2: The risk of impaired language development according to socioeconomic factors

	N	Impaired language development (n = 360)	Normal language development (n = 295)	P	OR (95%CI)
Childbirth order					
> 3	213	120 (56.3)	93 (43.7)	0.623	1.1 (0.8-1.5)
≤ 3	442	240 (54.3)	202 (45.7)		
Maternal age					
≤ 25 years	241	136 (56.4)	105 (43.6)	0.564	1.1 (0.8-1.5)
> 25 years	414	224 (54.1)	190 (45.9)		
Family Income					
Lower Middle	314	194 (61.8)	120 (38.2)	0.001	1.7 (1.3-2.3)
Upper Middle	341	166 (48.7)	175 (51.3)		
Mother education					
Illiterate to prep	194	124 (63.9)	70 (36.0)	0.001	1.9 (1.3-2.9)
Secondary	254	137 (53.9)	117 (46.1)	0.192	1.3 (0.9-1.9)
High education	207	99 (47.8)	108 (52.2)		1
Occupation					
House wife	513	278 (54.2)	235 (45.8)	0.451	0.9 (0.6-1.3)
Working	142	82 (57.7)	60 (42.3)		

Children subjected to delivery problems are at most risk for impaired language development (OR = 7.6, p < 0.001) and pregnancy-related diseases of the mother increases the risk of impaired language development significantly (OR = 2.5, p < 0.001), weight and height for age expressed without statistically significant difference (Table 3).

Table 3: The risk of impaired language development according to maternal and child medical history

	N	Children with impaired language development (n = 360)	Children with normal language development (n = 295)	P	OR (95%CI)
Maternal related Factors					
Chronic diseases					
Yes	124	74 (59.7)	50 (40.3)	0.24	1.3 (0.8-1.9)
No	531	286 (53.8)	245 (46.2)		
Pregnancy-related diseases					
Yes	89	65 (73.0)	24 (27.0)	< 0.001	2.5 (1.5-4.1)
No	566	295 (52.1)	271 (47.9)		
Iron deficiency anaemia					
Yes	312	163 (52.2)	149 (47.8)	0.18	0.8 (0.6-1.1)
No	343	197 (57.4)	146 (42.6)		
Nutritional status					
Malnourished	529	295 (55.8)	234 (44.2)	0.39	1.2 (0.8-1.8)
Normal	126	65 (51.6)	61 (48.4)		
Infant related Factors					
Gestational age					
Preterm	49	32 (65.3)	17 (34.7)	0.13	1.6 (0.8-2.9)
Full term	606	328 (54.1)	278 (45.9)		
Type of labour					
Cesarean	372	198 (53.2)	174 (46.8)	0.31	0.9 (0.6-1.2)
Normal	283	162 (57.2)	121 (42.8)		
Delivery problems					
Yes	86	76 (88.4)	10 (11.6)	<0.001	7.6 (3.9-15.1)
No	569	284 (49.9)	285 (50.1)		
Weight for age					
Underweight	49	28(57.1)	21(42.9)	0.865	1.1(0.6 -1.9)
Normal weight	606	332(54.8)	274(45.2)		
Height for age					
Stunted	82	47(57.3)	35(42.7)	0.734	1.1(0.7 -1.8)
Normal height	573	313(54.6)	260(45.4)		

OR: Odds ratio; CI: Confidence interval.

The proportion of infants with impaired motor development among cases with language impairment is high (69%) if compared with that (38%) among the control group, as shown in Figure 1.

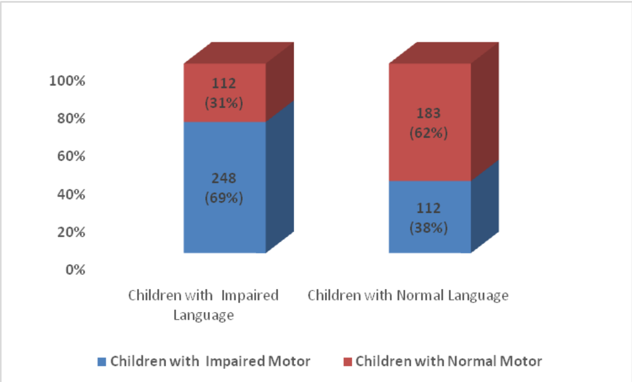

Figure 1: The proportion of children with impaired motor development among cases with impaired language development and controls with normal language development

Table 4 shows the most important predictors of impaired language development in the studied sample. Impaired motor development appears as a further highly significant risk factor to the previously mentioned factors, as shown in logistic regression analysis in Table 4.

Table 4: Logistic regression of factors affecting language composite score

	B	p	OR	95%CI of OR Lower	Upper
Early introduction of complementary food	0.771	< 0.001	2.162	1.457	3.207
Lower middle family income	1.176	0.002	3.242	1.719	6.115
Delivery problems	2.484	< 0.001	11.986	4.906	29.284
Pregnancy related diseases	2.837	< 0.001	17.070	3.869	75.312
Mother education (illiteracy vs. high education)	0.511	0.013	1.667	1.113	7.497
Impaired motor development	1.613	< 0.001	5.016	3.068	8.199

B: Regression co-efficient; OR: Odds ratio; CI: Confidence interval.

Discussion

Child development is influenced by genetic and environmental factors. Environmental issues appear to largely influence young children's attainment of language skills [27], [28]. In Egypt as a developing country, investigation and consequently, prevention of potential environmental risks is crucial.

This study demonstrated that factors that are independently associated with delayed language development in Egyptian children were early introduction of complementary food before the age of six months, low maternal education, low family income, delivery problems, pregnancy-related diseases of the mother and subtle delayed motor development.

The beneficial effect of breastfeeding on general growth and development of children has long been well recognised [29]. In the current study, history of feeding practices in the first six months of life revealed that bottle feeding and early weaning before the age of six months were associated with a significant risk of DLD. Many studies linked improved cognitive development rather than language development in infancy to breastfeeding. Exclusive breastfeeding was reported to positively affect cognitive development of children in early infancy [30], even after adjustment for other key cofactors [31]. In previous Egyptian studies, exclusive breastfeeding versus bottle-feeding during the first six months of life was correlated with above-average cognitive [32] and socio-emotional development of infants [33].

Few studies tested the link between breastfeeding and the language development of children. Leventakou et al. reported that a longer period of breastfeeding was independently associated with higher scores of language and motor development at 18 months of age [34]. A more recent study confirmed these findings and recommended the promotion of breastfeeding for more than 12 months to attain the maximum benefit in the cognitive and language development of children [35].

Many theories are proposed to explain the effect of feeding on language development. It was proposed that human milk contains a group of nutrients including the characteristic essential fatty acids such as docosahexaenoic acid (DHA) and choline, hormones, and growth factors that stimulate optimal development of brain structure and function [36].

Another theory is, the effect of breastfeeding on immune system function was supposed to influence learning and memory [37]. Also, the act of breastfeeding that enhances mother-infant relationship is thought to be important for cognitive, socio-emotional and language development [38].

Another independent factor that negatively affects language scores in the current study was a low socio-economic status (SES). The socioeconomic standard is usually ruled on the level of parental education, parental occupation and monthly family income [23]. This study showed that lower language composite scores were associated with lower family income and lower mother education. As language is a social act that progresses under social stimuli, it has been shown that children from lower-SES background show slower growth of vocabulary compared to higher-SES children from infancy up to school years [39], [40]. One pathway for explanation of this difference is the availability of learning resources in high-income families whether inside home (as books and toys) or outside home (as high-quality daycare centres or outdoor activities) [41]. Another pathway for this difference is the variation of parents' speech to their children. Hart and Risley estimated that children from professional families hear an average of 45 million words by age four compared to 13 million words in children from low-income families [42]. Other investigators found that the quality of speech and not the total amount of speech plays a more critical role in language development. In a large sample of low-income families, language development was positively affected by maternal vocabulary input and maternal language and literacy skills [43]. It was found that variation in the quality of nonverbal and verbal interactions were more powerful predictors of language development rather than the number of mothers' words during the communication with the infant [44], [45]. Mothers' level of education appeared to have a major effect on early language development not only in normal children but also in children with autism spectrum disorder (ASD) [28]. We thought that maternal education not only can affect language development directly through maternal vocabulary input but also indirectly through choosing appropriate feeding practices [46] and providing a health care and a safe environment for their children [47].

Another important factor affecting language development is the perinatal risk factors. In the current study, pregnancy-related complications (most commonly gestational hypertension, preeclampsia, eclampsia and gestational diabetes) and delivery problems (mostly birth trauma and asphyxia) were the main perinatal risk factors recorded in children with DLD. This could be explained based on placental insufficiency, oxygen deprivation in-utero, birth asphyxia, and neonatal hypoglycaemia which could affect neurocognitive functions and increase the risk of developmental disability [48], [49], [50].

In contrast to our findings, variables as first-minute Apgar scores < 7, mother's age, emergency caesarean section, maternal haemorrhage, and threatened abortion were significant factors for delayed cognitive and communication skills, while factors such as preeclampsia and premature rupture of the membrane had no significant relationship [51]. Other studies linked developmental disorders to prematurity, low birth weight, maternal difficulties during pregnancy, and congenital malformations [52]. In the current study, variables as maternal malnutrition, maternal chronic diseases, prematurity and caesarean delivery seemed irrelevant to developmental delay. Thus, the relationship between specific perinatal risk factors and subsequent developmental delay has not reached a consensus.

Nutritional deficiencies during infancy are likely to affect cognition, communication, behaviour, and productivity throughout childhood and adulthood [53].

In the current study, though the prevalence of underweight children and that of stunted children were higher in cases than in controls, the differences didn't reach a significant level (7.8% of cases were underweight vs 7.1% in controls; 13% of cases were stunted vs 11.9% in controls). Thus, malnutrition was not a significant risk factor for DLD in this study. This finding is in agreement with that of Mendes et al., 2012 [54]. However, other studies found that both malnutrition and anaemia early in life might lead to problems in cognitive development and language acquisition [55], [56]. We think that the severity of malnutrition and the association of anaemia are important variables controlling the impact on language development.

Language development depends on other developmental domains. The influence of cognitive and social-emotional domains on language development is completely supported [57]. Some studies support language and motor skills as separate domains, while others suggest that motor skills are a prerequisite for language development [58]. Some research recognised the relationship between motor and cognitive development, and consequently between motor and language development as a sub-domain of cognition. This relationship is a logical consequence in the context of bodily interaction with the physical and social environment [59]. Neuroimaging techniques have shown that areas of the brain implicated in language functions are activated during motor tasks [60], and the activation of motor areas was detected during language tasks [61]. Behavioural studies revealed associations between infant motor maturity and language development [42]. Also, other studies have shown a link between motor performance and between motor performance and language [62], [63].

In the current study, the interrelationship between language and motor development was evident. The percentage of children have got below-average score on Bayley-motor scale, was significantly higher among children with DLD than in normal children (69% vs 38%). Also, delayed motor development appeared as a highly significant predictor of language development in logistic regression analysis. The application of these findings is very important. It denotes the significance of careful evaluation of all developmental domains even the child is presented with DLD only. Non-responding children to intensive speech therapy may benefit if they attend physiotherapy sessions in parallel.

Logistic regression analysis in this study approved the independent predictors of DLD according to their contribution and their level of significance as follows: maternal health problems during pregnancy and child-birth difficulties, followed by impaired motor development, low family income, early introduction of complementary food and the least significant predictor was maternal education.

Limitations: Details of parental-child interaction and whether the child attended childcare centre were not included in the questionnaire. Neither language impairment was not classified into receptive communication disorders and expressive communication disorders, nor was motor impairment not classified into fine motor and gross motor disorders. This is because estimation of composite score of Bayley-scales depends on sum of both functions.

In conclusion, a group of social, medical and nutritional factors are interacting to affect language development in Egyptian children. The most significant risk factors were pregnancy-related diseases and labour-associated problems. This denotes inadequate access of Egyptian mothers to maternal health care during pregnancy and childbirth. Low family income and the level of maternal education were the predominant social risk factors. Child developmental screening should include all developmental domains. Subtle motor impairments common among children with DLD and can potentiate its risk.

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