ORIGINAL ARTICLE

The Prevalence of Developmental Delay among Filipino Children at Ages 6, 12 and 24 Months Based on the Griffiths Mental Development Scales

Ma. Rochelle Buenavista-Pacifico,[1,2,3] Alexis L. Reyes,[1,2] Bernadette C. Benitez,[1,2]
Esterlita Villanueva-Uy,[1,2] Hilton Y. Lam[4] and Enrique M. Ostrea, Jr.[5]

[1]*Institute of Child Health and Human Development, National Institutes of Health, University of the Philippines Manila*
[2]*Department of Pediatrics, College of Medicine and Philippine General Hospital, University of the Philippines Manila*
[3]*Department of Pediatrics, De La Salle University Medical Center, Dasmarinas, Cavite, Philippines,*
[4]*Department of Clinical Epidemiology, College of Medicine, University of the Philippines Manila*
[5]*Department of Pediatrics, Hutzel Women's Hospital, the Carman and Ann Adams*
Department of Pediatrics, Children's Hospital of Michigan, Wayne State University, Detroit, Michigan

ABSTRACT

Background. To determine prevalence of delay in 5 developmental domains among Filipino children at 6, 12 and 24 months and investigate influence of socioeconomic status, maternal intelligence, gender and home stimulation. Variations and developmental domains as reliable indicators of potential delay were determined.

Methods. 754 maternal/ infant dyads were followed up until 2 years old. The Griffiths Mental Development Scales determined sub-quotient scores in locomotor, personal/social, hearing/language, eye-hand coordination and performance subscales before averaging for General Quotient(GQ) score. Score < 85 was considered delayed.

Results. Low GQ scores were noted in 5.4% at 6 months, 19.1% at 12 months and 11.0% at 24 months old. GQ scores were lowered by performance subscale at 6 months, hearing/language and performance at 12 months and hearing/language at 24 months. No single subscale consistently lowered GQ across time. Only 4.2% maintained low GQ scores in all three ages.

Conclusion. Prevalence of developmental delay varied across 24 months with highest rates noted at 12 months of age. No developmental domain consistently lowered test scores and no test age was predictive of future outcome but focused early intervention according to age is suggested. Home environment, higher socioeconomic status, maternal IQ and supervision were associated with improved potential.

Key Words: Griffiths test, Filipino children, neurobehavioral development

Corresponding author: Ma. Rochelle Buenavista-Pacifico, MD, FPPS, FPSDBP
College of Medicine
De La Salle Medical Health Sciences Institute
Department of Pediatrics,
De La Salle University Medical Center
Congressional Ave., Dasmarinas, Cavite, Philippines
Telephone: +632 988-3100
Email: ochiebp@yahoo.com

INTRODUCTION

Concerns regarding development and behavior have been issues continuously relevant to our times. With evidence of increasing prevalence of developmental disorders, the practice of surveillance for early detection and intervention has undoubtedly been key for improving prognosis.[1,2] In the Philippines, referral for developmental delays from 2004 to 2008 showed an increasing trend.[3] However, in an unpublished observation study done in 1997 which looked at surveillance practices of Filipino pediatricians, more than half of them have 5 % of their patients presenting with at least one developmental or behavioral concern, 84% would routinely monitor development up to 5 years old, with 53% relying on parental recall of developmental milestones and only 7% performing formal screening. However, studies across cultures show the need to review developmental patterns, as possible differences may occur due to genetic and environmental influence. In a study that compared Filipino and British infants, results showed that the sub-quotients of Filipino children as they grew older were significantly lower than their British counterparts, possibly as a result of genetic, cultural and environmental influences like non-familiarity with test materials used and the modest scores in the modified WAIS test of their Filipino mothers.[4] Palfrey demonstrated that expectations in terms of skills acquisition differ from one stage of childhood to another and so would transpire an evolutionary pattern for developmental delays.[5] Levy and Hyman showed that problems in sucking, muscle tone and response to environmental stimuli are common among newborn infants while motor delay become apparent during the first year.[6] Language and behavioral problems are common at 2 to 3 years of age, while learning difficulties emerge during the school age years. Because of the evolutionary nature of delays and unique influences generated by cultural and genetic predispositions, it is imperative that patterns of delay are investigated in a variety of populations to establish consistency in expectations. This is also necessary because standardized tests of developmental assessment are often used in culturally diverse populations to identify developmental patterns and to diagnose delays, often without regard for validation which results in controversial and conflicting findings. Moreover, in the Philippines, there is a high rate of pesticide exposure among pregnant women and their infants which can adversely affect the neurobehavioral outcome of children.[7] Preliminary knowledge of the prevalence and nature of developmental delays among children in a culturally diverse population and the effect of confounders in modifying their neurobehavioral development are important information to study the adverse effects of exposure to toxicants on their development.

The objectives of this study were to determine the prevalence of developmental delays in 5 areas of development among Filipino children using the Griffiths Mental Development Scales at 6, 12 and 24 months of age. The influence of socioeconomic status, maternal intelligence, gender and home stimulation were also investigated. Since this prospective study allowed for the evaluation of the children over a time period of 24 months, the study determined the stability of initial trajectories and domains of development that may be consistent and reliable indicators of potential delays thereafter.

MATERIALS AND METHODS

Study population

The subjects were part of a study in the Philippines, entitled, "Fetal exposure to environ- mental toxins and infant outcomes" and funded by the United States National Institute of Child and Human Development. The research was conducted in Bulacan, an agro-industrial and fishing province, north of Manila and the study design involved enrollment of pregnant women at mid-gestation, their follow up until delivery and then the follow up of their children's development up to 24 months of age. The children will also be recalled at 4 and 6 years of age for further follow-up and psychometric assessment. For enrollment into the study, pregnant women in the prenatal clinic of the Bulacan Provincial Hospital (BPH) from June 2002 to April 2004 were approached for their participation in the study. However, for inclusion in the study, the pregnant women were required to deliver at the BPH to allow the collection of meconium in the infants to test for their prenatal exposure to pesticide. Mother and their infants who delivered elsewhere were excluded from the study. This study was approved by the Human Investigation Committee at Wayne State University, Detroit, Michigan, the University of the Philippines Manila and the Bulacan Provincial Hospital. Informed consent was obtained from the mothers for themselves and their infants. Exclusion criteria for infants included lethal malformations, severe asphyxia (defined as Apgar < 3 at 5 min) and those where meconium collection was not feasible (imperforate anus, gastroschisis or in need of immediate abdominal surgical intervention). A total of 793 mother/infant dyads were enrolled at birth and followed at 6 months (n = 784), 12 months (n = 761) and 24 months (n = 754). Follow-up rate remained high at 95.1% by the end of the 2nd year visit. This report is based on the 754 infants who were successfully followed up until 24 months of age. There were no significant differences in demographic characteristics between the 754 dyads remaining at 2 years compared with those who dropped out, except for a lower rate of married women (43.6% vs. 73.6%, $P < 0.03$) and lower parity (0.3 vs. 0.7, $P < 0.03$) in the latter. There were 102 (12%) premature infants (<37 weeks of gestation) out of the initial 793 children enrolled in the study. By the 24th month, only 754 infants remained in the study for testing; and of these, only seventy-seven (10%) of the premature infants were left to complete all 3 test ages and were part of the subjects for over-all analysis. Seventy-seven percent (n=60) of these pre-term infants were 36 to 37 weeks premature. Only 17 (22%) of the infants had a gestational age $\leq$ 35 weeks. The premature infants were assigned for evaluation at 6, 12 and 24 months based on their corrected age. The same corrected age was used in place of their chronologic age to compute for their sub-quotient scores. Infants and children who were identified with significant delays at any time were referred for habilitative intervention which basically comprised of one on one physical and/or occupational therapy, as necessary, twice a week. Identified Developmental Disorders in the infants were also recorded.

Instruments

The Griffiths Mental Development Scales (GMDS) from birth to 2 years and for older children,[8] was used to test the children's neurodevelopmental status by two Griffiths certified developmental pediatricians at 6 and 12months and by three Griffiths certified developmental pediatricians at 24 months. The inter-rater agreements for the two and three Griffiths testers were 0.9855 (p<0.0001) and 0.8525 (p<0.0001), respectively. The Griffiths Mental Development Scales for 0 to 2 year old consist of five subscales: locomotor, personal and social, hearing and language/speech, eye and hand coordination and performance, the latter dealing more with non-verbal problem solving tasks.[8,9] Aside from the aforementioned five scales, the scales for older children included a practical reasoning scale that evaluated number concept and realization of simplest practical problems. Scoring in the Griffiths scale for 0–2 years old was done by reference standards that indicate a functional age based on the accumulated score for a particular subscale and a general quotient that is obtained by averaging scores in the five subscales. In the scales for older children, functional age in each subscale was obtained through ascribed computations. Developmental sub-quotients (DQ) were determined for each subscale by dividing the functional age of the child with his chronologic age at the time of testing and the quotient multiplied by 100. Corrected age of 6, 12 and 24 months were applied for the sub-quotient calculations among premature infants instead of their actual chronologic age. The general quotient (GQ) was obtained through averaging. Based on standard deviations for the GMDS, a developmental quotient score lower than 85 was assigned as the cut-off score for significant developmental delay in the different areas of development tested, as well as in their general quotient scores. Several potential confounders to the child's neurodevelopmental performance were evaluated which included infant gender, maternal intelligence (modified Weschler Adult Intelligence Scale III **or** WAIS-III performance subscale[10]), evaluation of home environment[11] and level of parental education and socioeconomic status by the Roberto Scale.[12] The Roberto Scale was chosen over the conventional Hollingshead measure[13] since the latter was not applicable to the Philippine population due to cultural differences. The Roberto Scale is widely used in the Philippines to assess socioeconomic status and is based on home structure and appearance. The scale ranges from A (highest) to E (lowest). The WAIS III is an internationally accepted reliable test of intelligence often used amongst Filipinos and used to assess maternal intelligence in the study. However, non-familiarity with several language-based items prevented the mothers to perform well in the Verbal IQ (VIQ) scales of the WAIS potentially underestimating overall IQ. For example, mothers could not identify a "fireplace" because obviously, this is not commonplace in the Philippine home. Therefore, we preferred to test only the Performance IQ (PIQ) as index of maternal IQ as this is less affected by acculturation and language proficiency. Moreover, the PIQ may still reflect valid cognitive potential or intelligence level because individuals with cognitive impairment or low intellectual potential will not be able to do well in any non-verbal test of intelligence such as the PIQ component of the WAIS. Validation of the WAIS was applied to the study population in the Philippines. A pretest was made of the Performance test of WAIS to determine the subtests that were suitable for the study population. A group of 30 females from the study site were tested. Based on their performance scores, the following subtests were selected to comprise the short form for computing the performance IQ: Picture completion, matrix reasoning, picture arrangement and object assembly. Demographic and anthropometric measurements were also recorded.

Statistical analysis

Descriptive statistics were calculated and comparisons of sample means and frequencies were analyzed by paired t-test and multiple ANOVA. Because of multiple t-tests performed, a Bonferroni correction was used for the comparison between development quotients in different areas of development. Multiple regression analysis was performed to identify relationships between independent and dependent variables. With binomial correlations of GQ at 24 months, only correlations with a p value < 0.15 were accepted for the regression analysis. Level of significance was set at p < 0.001.

THEORY

The study will provide the neurodevelopmental characteristics of Filipino children using the Griffiths Mental Development Scales (GMDS), which includes, 1) the prevalence of developmental delay based on developmental quotients at 6, 12 and 24 months of age, 2) the developmental subscale/s which contributed most to the decrease in general quotient score at each test age, 3) the number of children who presented with persistently delayed general quotients as opposed to those who subsequently improved over time, and 4) the influence of gender, socioeconomic status, maternal intelligence, parental education and home stimulation of the child on developmental trajectories and performance on the GMDS.

RESULTS

The characteristics of the 754 mother/infant dyads at birth were as follows:

Maternal

The mean ± SD values were: maternal age (25.7 ±5.9 years), gravidity (2.4 ± 1.6), parity (1.2 ± 1.5), married (72.1%), maternal intelligence by WAIS-III performance subscale (75.4 ± 11.0). Use of cocaine, opiates, marijuana and alcohol (<1%), methamphetamine (4.5%), active smoking (2.5%) and passive smoking (77.4%).

Infant

Mean gestation (38.6 ± 1.3 weeks), male (54.2%), weight (2.88 ± 0.44 kg), length (48.6 ± 2.6 cm) and head circumference (33.1 ± 1.5 cm). Apgar was 7.7 ± 1.0 and 8.9

± 0.7 at 1 and 5 min, respectively. The mean weight of the infants at 6 months was 7.39 ± 0.94 kg, at 12 months, 9.01 ± 1.25 kg and at 24 months, 11.31 ± 1.76 kg.

Home and environment

A survey of the family, home and child's environment was conducted for each subject. Results showed that 69.4% of mothers and 69.2% of fathers obtained at least a high school diploma. The father's mean age was 28.4 years and 74.1% were non-skilled laborers, and 76.9% of mothers were homemakers. The average number of people and families per household was 5.3 and 1.6, respectively. The mean number of children under the family's support was 1.1 (range of 0–11). Families reported other dependents (children or other relatives) receiving family support (mean number 0.3, range of 0–10) and an age range of 0.3–78 years. The predominant religion was Catholic (89.3%). About 57.2% of mothers lived in their own homes, although 7.3% were living in makeshift homes. The socioeconomic status was assessed using the Roberto scale (Roberto 2002) that is based on the appearance, materials used and structure of the home because of the difficulty in obtaining accurate information on income per household in the Philippines. The scale ranges from A (highest) to E (lowest). Few households were classified as A or B in the study and were combined into AB. About 4.5% were in class AB, 34% in class C, 50.1% in class D and 11.4% in class E. A lead recycling plant was located near 7% of the homes. The cleanliness of the home and surroundings were rated as fair (71%). The toilet was predominantly water-sealed (81%), water source was either piped in (51%) or from a well (42%), waste disposal was predominantly via sewer (26%) or canal (62%) and 60% had organized garbage collection. A modified version of the HOME (Home Observation for Measurement of the Environment, Caldwell & Bradley, 1984) was administered by trained interviewers. HOME scores are based on behaviors, materials in the home and parent report. Mean HOME score in this cohort was 32.1 ± 5.08 with a median of 32, which is comparable to those obtained in the normative samples (12-month mean total = 30.9 ± 7.6) (Caldwell & Bradley, 1984).

The percentage of children who achieved a score of < 85 in general quotients at 6, 12 and 24 months are shown in Table 1. At 6 months of age, 5.4% of the children achieved a score of <85 which increased to 19.1% at 12 months and decreased to 11.0% at 24 months.

Table 1. Percentage of children who scored < 85% in general quotient

Age	Children who scored <85 *		
	Number (%)	Nominal change	% change
6 months	41 (5.4%)		
12 months	144 (19.1%)	103	251.2%
24 months	83 (11.0%)	-61	-41.7%

** imputed and winsorized scores*

Among the 5 different subscales in the GMDS, the performance subscale showed highest percentage of children who scored <85 at 6 months (19.9%), at 12 months, it was on the hearing/language and performance subscales (31.7% and 29.8%, respectively) and at 24 months, it was on the hearing and language scale (41.6%) (Table 2). The children's overall performance in the different subscales was worse at 12 months of age but improved at 24 months with the exception of hearing and language.

The subscale which contributed the most towards lowering the general quotient score at 6, 12 and 24 months are shown in Table 3. There was no single subscale that consistently contributed towards lowering the GQ scores across the different time periods. This suggests that specialized focus of intervention will depend on the age of the child. Thus, children at 6 months who are not doing well in their general quotient should probably be given more help in the performance subscale; at 12 months, they should be given support on social skills and at 24 months, it should be on hearing and language skills.

Table 2. Percentage of children who scored < 85 in each of the 5 subscales at ages 6, 12 and 24 months

Subscale	Age at testing	Number (%) of children who scored <85*		
		Number (%)	Nominal change	Percent change
Locomotor	6 months	35 (4.6%)		
	12 months	160 (21.2%)	125	357.1%
	24 months	17 (2.3%)	-143	-89.4%
Hearing/Language	6 months	18 (2.4%)		
	12 months	239 (31.7%)	221	1227.8%
	24 months	324 (41.6%)	85	35.6%
Eye/Hand Coordination	6 months	83 (11.0%)		
	12 months	111 (14.7%)	28	33.7%
	24 months	97 (12.9%)	-14	-12.6%
Performance	6 months	150 (19.9%)		
	12 months	225 (29.8%)	75	50.0%
	24 months	150 (19.9%)	-75	-33.3%
Personal/Social	6 months	42 (5.6%)		
	12 months	209 (27.7%)	167	388.1%
	24 months	63 (8.4%)	-146	-69.9%

** imputed and winsorized scores*

Table 3. Mean Scores and Griffiths subscale that contributed most towards the lowering of the General quotient score*

Scales at 6 months	Mean	Median	Std. Dev.	Min	Max	p value**
General quotient	103.7	106.0	9.4	47.8	123.6	
Sub-quotients						
Locomotor	108.2	111.0	10.6	35.0	133.0	< 0.001
Hearing/Language	106.1	105.0	11.3	42.0	137.0	< 0.001
Eye-Hand Coordination	105.4	109.0	15.3	50.0	133.0	<0.05
Performance	92.2	96	13.2	45.0	117.0	<0.001
Personal/Social	106.4	108.0	12.3	22.0	136.0	<0.001
Scales at 12 months	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**p value****
General quotient	**92.5**	**92.0**	**9.0**	**48.9**	**115.6**	
Sub-quotients						
Locomotor	94.2	95.0	12.9	13.0	125.0	<0.01
Hearing/Language	90.0	89.0	12.1	23.5	128.0	<0.001
Eye-Hand Coordination	97.7	100.0	13.5	45.0	129.0	<0.001
Performance	91.0	92.0	12.5	10.0	123.0	NS
Personal/Social	89.4	90.0	13.3	11.8	127.0	<0.001
Scales at 24 months	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**p value****
General quotient	92.8	93.0	6.9	56.2	110.8	
Sub-quotients						
Locomotor	94.5	95.0	5.5	41.0	112.0	<0.001
Hearing/Language	85.2	87.0	11.6	37.0	115.0	<0.001
Eye-Hand Coordination	93.9	94.0	9.6	44.0	119.0	<0.05
Performance	91.5	90.0	10.4	49.0	140.0	NS
Personal/Social	98.9	99.0	11.7	45.0	142.0	<0.001

* *imputed scores for 754 children*
** *Bonferonni adjusted p value of paired t-test of imputed scores with respect to the general quotient*

Over the age periods of 6, 12 and 24 months, there were 216 children who scored <85 in their General Quotient scores. At 6 months, there were 41 children who scored <85. At 12 months, there were 144 children who scored <85, while at 24 months, there were 83 children who scored <85. Of the 161 children between 6 and 12 months, only 20 children (12.4% of 161) scored <85 in both ages. Of the 198 children between 12 and 24 months, only 29 children (14.7% of 169) scored <85 in both ages. Of the 112 children between 6 and 24 months, only 12 children (10.7%) scored <85 in both ages. While of the 216 children in all three ages, only 9 children (4.2% of 216) scored <85 in all three ages.

Repeated analysis of variance was done on the test scores of children who presented with general quotient scores <85 at any time during the test periods (Table 4). This was done in order to determine whether scoring deficiently in any of the test ages is correlated with future performance at 24 months of age. Results showed that GQ scores of the children were significantly different over time (p value < 0.001). There does not seem to be any indicator that scoring <85 in either 6 or 12 month testing is associated with scoring <85 at 24 months old. Therefore, there seems to be no test age that is predictive of future developmental outcome in children at least until 24 months of age. Moreover, less children remained to have GQ scores < 85 by the 24th month old testing (n=83) and on close observation, only 9 children (4%) were noted to have persistently low GQ scores throughout the 24 month test period (Figure 1).

By multiple logistic regression, several factors significantly affected a child's score of <85 in general quotient at 24 months. These factors included father as head of the household, maternal age, infant's gender, maternal IQ index and the presence of dog in the house (Table 5). If the father

Table 4. Repeated ANOVA between general quotient scores in the different ages of testing for predicting later performance at 24 months of age among those who scored <85 in the GMDS

	Of the 218 children who have scored < 85 in GQ at 6, 12, or 24 months		
Time period	6 months	12 months	24 months
n with <85% score	41	144	83
Mean score	77.3	78.9	79.8
Standard Deviation	7.6	6.0	6.0
Min	47.8	48.9	56.2
Max	84.8	84.8	84.8
Repeated ANOVA p value*	<0.001		

* *for Huynh-Feldt, Greenhouse-Geisser and Box p-values*

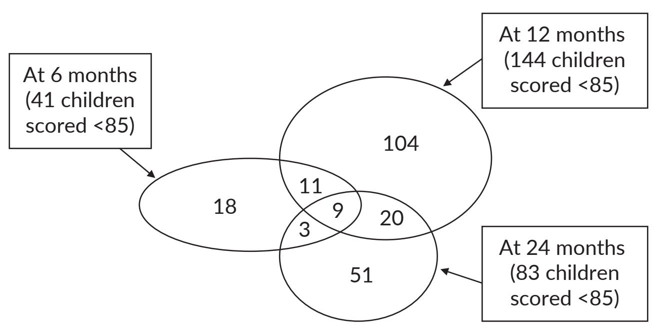

Figure 1. Venn Diagram of the 216 children who scored <85 in their GQ scores at 6, 12 and 24 months.

Table 5. Factors which significantly affected a child's score of <85 in general quotient at 24 months

Logistic regression		**Number of observations =**	561
		LR chi2 (7) =	34.53
Log likelihood :	-189.92971	**Prob > chi2 =**	0.0000
Predictive value:	71.3%	**Pseudo R2 =**	0.0833

General Quotient at 24 months <85%	Odds Ratio	Std. Err.	Z	P>z	95% Conf.	Interval
Father as head of household	0.647	0.149	-2.47	0.013	0.846	0.195
Age of mother	0.057	0.021	-2.64	0.008	0.098	0.015
Gender of baby	1.518	0.736	3.16	0.002	0.420	3.466
IQ index	-0.034	0.012	2.83	0.005	-0.010	-0.060
Presence of dog in the house	0.489	0.141	-2.43	0.015	0.703	0.121

was the head of the household, the child was is 64.7 times more likely to score <85 in general quotient. For every year of increase in maternal age, the child was 5.7 times more likely to score <85. If the child was male, the child was 151.8 times more likely to score <85. For every point increase in maternal IQ Index, the child was 3 times less likely to score <85 and if there was a dog in the house, the child was 48.9 times likely to score <85.

DISCUSSION

Child development is constantly dynamic. While genetic predisposition offers a template for potential development, the influence of environment is far more than convincing, especially with awareness of brain plasticity which appears to be a very reliable factor during the first 3 years of life.[14,15] Because certain studies show that cultural influences can affect developmental potential,[4,16,17] it is essential that developmental patterns of delay be ascertained in a variety of populations to determine constancy across cultures especially at intervals spanning the first 24 months of age when identifying delays is at its greatest importance.[1,18,19,20] This is because identifying patterns of delay can help diagnose eventual neurodevelopmental disorders[21] and early identification of children at risk is key in improving their prognosis and outcome.[5,20,22] Results of our study show the variability in presentation and progression of delays during the first 2 years of life among Filipino children. While development seems to be generally normal for the first 6 months of life, where only 5.4% scored <85% in general quotients of the GMDS (Table 1), delays increased in almost all areas of development at 12 months. However, at 24 months, there was an improvement in the prevalence of developmental delays which could be attributed to catch up in skills (Table 2). For improved developmental trajectories between 12 to 24 months of age, gross motor and performance subscales basically testing problem solving skills were mostly contributory and consistent with developmental expectations during this transition period. At this time, an infant is becoming increasingly mobile which offers a sense of power and control that will allow him to be more explorative and inadvertently learn during the process. Furthermore, only after 12 months old would inhibitory control of attention and perception of causation be manifest to improve problem solving.[23] By 24 months old, only 11% of children remained to have low scores in general quotients of <85%. Estimates of delays in this study is comparable with other countries wherein about 10-13% of children followed up between 9 to 24 months old were noted to have developmental delay which needed early intervention.[24] In our study, average mean scores were also lowest at 24 months old, with hearing and speech showing the lowest average score among the subquotients (Table 3). No particular domain during the first 6 or 12 months of life proved to be predictive of general delay or adverse developmental outcomes at 24 months old (Table 4). To presume that early estimates will remain to reflect true prevalence in the general population may be inaccurate because of the propensity for developmental trajectories to change, especially in infants and toddlers.[18]

It is understandable that performance scales offered the lowest scores during the 6th month old testing. The performance subscale contains items that deal mostly with non-verbal problem solving abilities. Problem solving skills are heralded by object permanence, a skill that usually evolves by the 7th to 9th month of life when the infant starts to look for objects that have been hidden away from his sight. Before this, an infant learns from his environment through focused attention, by simply familiarizing himself and manipulating objects or experiences that are novel to him.[23,25] Moreover, most of the materials in the GMDS that have been used to test performance are objects that Filipino infants are not familiar with. Most of the children tested belong to families within low socioeconomic class where blocks and form boards are not common infant toys. At this age, highest scores were contributed by locomotor skills (Table 3) which is regarded as the principal milestone achieved at this period of development.

During the 12 month testing, infants performed least in the personal and social areas of development (Table 3). In the GMDS, this domain required infants of this age to engage interactively with others and show interest in what others do. It also looked into how infants assimilated and accommodated skills learned through earlier experiences very much through imitation in manipulating objects like playing with a cup and spoon. Improvement in this domain would rely heavily on how much environmental exposure and opportunity for stimulation are provided for an infant to generalize a skill. Unless caregivers are cognizant in helping develop and encourage this skill, infants may fare modestly in their ability to master skills in this area. Filipino parents are typically over-indulgent toward their children, especially during infancy and having extended family in their household may offer more help than necessary. It is a cultural norm among Asians to co-sleep especially with the very young to immediately respond to their needs and establish a more secure relationship.[26,27] But it is this same practice that may promote over dependence in hindering opportunities for acquisition and mastery of self–help milestones.[17] Skills in fine manipulation (eye-hand coordination) obtained the highest scores at this age group in comparison to the other domains (Table 3). As an infant learns to handle objects and items more voluntarily and purposefully at this age, he gains increasing ability to explore and learn more from his surroundings.

By 24 months of age, speech becomes a very important milestone. It is the highlight of developmental expectations for this age[1,18] and is therefore a skill that elicits the greatest concern in its absence. In our study, failure in hearing and language tests contributed most towards lowering the general quotient scores during 24 months of age testing. This observation is consistent with studies in children of this age group where speech delay is the most prevalent. In local and international studies that have looked at developmental concerns, speech delay is the most common parental concern that toddlers will present.[3,21] Highest scores were seen in personal /social domains (Table 3) which suggest much improved capacity for assimilation and accommodation of skills and experiences during this age. As toddlers assert their autonomy, they improve on their ability to forge relationships with familiar and new personalities and become more confident in trying out novel skills, especially in repeated activities of daily living like feeding, dressing, etc, which are mostly highlighted in this domain of the GMDS.

There was an intent to determine whether earlier test results could be predictive of later developmental delay during the first 2 years of life and it is reassuring that none of the earlier performances at 6 or 12 months could reliably predict future developmental outcomes. Based on results from our study, the alarming concern over discovery of early delays and the increasing probability of poor outcomes is allayed by the encouraging result that earlier concerns need not be permanent once these are identified and managed through early habilitative intervention such as occupational therapy, which was started in the children, once significant delays were noted. The discovery of improved developmental trajectories and decreasing prevalence of delays suggest that much can be done in further promoting development, despite perceived risks on potential based on earlier test results. As infants and toddlers are advantageously positioned within the window of opportunity for brain plasticity, developmental trajectories can significantly change that would improve or lessen the impact of any impending impairment or adverse outcome. In our study it was imperative that children who were identified as having low scores at any point of testing be given early intervention and this could have improved or minimized the negative impact of an impending pervasive problem in development, had early habilitative intervention been delayed.

Of major interest is that almost 4.6% of children were noted to be consistently performing poorly from 6 to 24 month old (Figure 1). This could represent the children who will remain to have significant delays and eventually be diagnosed definitively with more serious developmental disorders. A global and persistent delay in developmental patterns can be suggestive of a more permanent disability or a static condition such as mental retardation or any other condition that has this in association like cerebral palsy and autism spectrum disorder.[28,29] It is therefore crucial to continuously monitor their rates of development as they are given early intervention and to formally assess them for a definitive diagnosis. By the end of the 24th month testing, a total of 24 children were identified as already having or to be at risk for a developmental disorder like autism, cerebral palsy, communication disorder, attention deficit / hyperactivity disorder or global developmental delay (Table 6).

Table 6. List of children identified with or at risk for a developmental disorder:

Developmental Disorder	Frequency
Autism	2
Cerebral Palsy	3 (1 death)
Communication Disorder	5
Communication Disorder suspect	2
Communication Disorder, at risk for AD/HD	3
Global Developmental Delay (GDD)	2
GDD to consider Communication Disorder	1
At risk for Attention Deficit/ Hyperactivity Disorder	6
Total	24

The influence of the environment and culture in which the child is being reared can also significantly affect cognitive and emotional development, as well as behavior.[30] There is overwhelming evidence on improvement in a child's potential through better home environment often associated with higher socioeconomic status, maternal IQ, maternal presence or supervision and fertility and child rearing issues with increasing maternal age.[18,31,32,33] Several of these findings were demonstrated in this study (Table 5). Two interesting observations were noted in the results of logistic regression analyses on the inverse relationship between general quotient scores and the father being head of the household as well as the presence of a dog in the house. It cannot be inferred with certainty that the father being head of the household would lower children's GQ since the father is generally considered head of household, Filipinos being largely a patriarchal society. Regarding pet ownership, Purewall[34] did an evidence review for the potential associations between pet ownership and emotional; behavioral; cognitive; educational and social developmental outcomes, many showing positive association but mostly among older children and adolescents. Potential for immunity related risk of infection can be inferred especially in the very young.[35,36] Bacterial zoonoses can be transmitted by a variety of household pets potentially causing human disease either through direct contact or indirectly through food and domestic environmental exposures especially to those who are immunocompromised. Infants and young children are especially susceptible due to lower hygiene standards and closer physical contact to the animals and the dirt that the animals may bring into the household environment like the floor, etc.[37,38] With immunity only rapidly maturing during the first 3 years of life, infants would usually experience illnesses during the first year of life in the presence of animal pets at home due to direct contact with the animals, and the microorganisms and dirt that the animals may bring into the home. These repeated bouts of infection during the first 1 to 2 years can pose a burden on the health and inadvertently, the development of the infant and young child, thus a potential for pets in the household lowering IQ scores early in life.

CONCLUSION

In conclusion, mean general and subscale quotients of Filipino children tested at 6, 12 and 24 months are all within average for age. Prevalence of delays in Filipino infants and toddlers on the other hand are assessed to be slightly higher than universal estimates on general populations but the evolution of delays in the different streams of development across infancy and toddlerhood seems to be comparable. It is presumptive to conclude that these rates will stabilize over time due to the vast potential for improvement in developmental trajectories during these stages of development. The possibility of delayed maturation and unexpected improvement must be considered, especially with the important influence of environmental factors and for this reason, pattern of development should continuously be monitored through developmental surveillance to effectively identify those who are potentially at risk and to provide timely intervention to maximize their potential for development.

Statement of Authorship

All authors have approved the final version submitted.

Author Disclosure

All the authors declared no conflicts of interest.

Funding Source

This paper was funded by the Grants from National Institute of Health / National Institute of Child Health and Human Development (R01HD039429), US Environmental protection Agency (RFA 2001-STAR-H1. No. R829395), Environmental Health Services center Grant P30 ES06639 from National Institute of Health / National Institute of Environmental Health Services, Enrique M. Ostrea, Jr., MD, Principal Investigator, Wayne State University, Detroit, Michigan.

Acknowledgments

We would like to acknowledge the invaluable help and participation in this research of Essie Ann M. Ramos, MD, Abner M. Hornedo, MD, Patrocinio C. Mateo, MD, Philip Cruz, MD, Lilibeth R. Avendano, Rubilyn S. Obando, Maribel V. Santiago, Roberta S. Briones, Rizza D.C. Villavicencio, Cecilia C. Santiago and Melody Dizon.

REFERENCES

1. Glascoe F, Dworkin P. Surveillance and screening for development and behavior. In: Wolraich M, Drotar D, Dworkin P,Perrin E, eds. Developmental–Behavioral Pediatrics: Evidence and Practice, 1 st ed. Philadelphia: Mosby, Inc; 2008. pp. 130-43.
2. Lipkin P. Developmental and behavioral surveillance and Screening within the Medical Home. In: Voight R, Macias M, Myers S,eds. Developmental and Behavioral Pediatrics. USA: American Academy of Pediatrics; 2011. pp. 69-92.
3. Reyes A, Herrin J. A five year review of referrals to the Developmental Pediatric Section of a Major Tertiary Hospital. Acta Med Philipp. 2009;43:12-7.
4. Reyes A, Pacifico R, Benitez B, Villanueva-Uy E, Lam H, Ostrea Jr EM. Use of the Griffiths Mental Developmental Scales in an agro-industrial province in the Philippines. Child Care Health Dev. 2010;36:354-60.
5. First L, Palfrey J. The infant and young child with developmental delay. New Engl J Med. 1994;330:478-83.
6. Levy S, Hyman S. Pediatric assessment of a child with developmental delay. Pedtr Clin N Amer. 1993;40:465-77.
7. Ostrea Jr EM, Reyes A, Pacifico R, Benitez B, Lam H, Villanueva-Uy E. Fetal exposure to propoxur and abnormal child neurodevelopment at 2 years of age. Neurotoxicology. 2012;33:669-75.
8. Griffiths R. A comprehensive system of measurement for the first eight years of life. In: Griffiths R,ed. The Abilities of Young Children, rev. ed. Bucks (UK): The Test Agency for ARICD; 1984. pp. 101-72.
9. Huntley M. The Griffiths Mental Developmental Scales Manual for Birth to Two Years. Bucks (UK): The Test Agency for ARICD; 1996. pp. 5-39.
10. Weschler D. Manual for the Wechsler Adult Intelligence Scale–Revised. rev. ed. San Antonio, Texas: The Psychological Corporation; 1981.
11. Caldwell BM and Bradley RH. Administration manual, revised edition: HOME observation for measurement of the environment. rev.ed. Little Rock: University of Arkansas at Little Rock; 1984.
12. Roberto N. The marketer's guide to socio-economic classification of consumers: Insights and challenges of target marketing in the Philippines using SEC indicators. Thousand Oaks, CA: Sage Publications; 2002.
13. Hollingshead A. Four factor index of social status. New Haven, CT: Department of Sociology, Yale University; 1975.
14. Shonkoff J, Phillips D. The Science of Early Childhood Development. In: Shonkoff J and Phillips D, eds. From Neurons to Neighborhoods. Washington, DC, USA: National Academy Press; 2000. pp. 19-56.
15. Coon H, Carey G, Fulker D. Community influences on cognitive development. Intelligence. 1992;16:169-88.

16. Yoshinaga–Itamo C, Moushey J. Audiologic Consideration for South Pacific Islander and Filipinos [Online]. 2008. [cited 2008 Jan]. Available from http://www.mariondowns.com/multicultural=issues-deafness-memory.
17. Carlson V, Harwood R. Understanding and negotiating cultural differences concerning early developmental competence: The six raisin solution. Zero To Three.2000;20(3):19-24.
18. Illingworth R. Variations in general patterns of development. In: Illingworth R. The Development of the Infant and Young Child. 9 th ed reprint. Singapore: Longman Singapore Publishers Ltd; 1993. pp. 129-44
19. Shapiro B. Neurodevelopmental assessment of infant and young children. In: Capute A, Accardo P (eds). Developmental Disabilities in Infancy and Childhood, 2nd ed. Baltimore, Maryland: Paul H. Brookes Publishing Co; 1996; vol1: pp. 311-322.
20. Glascoe F. Can clinical judgement detect children with speech-language problems?. Pediatrics. 1991;87(3):317-22.
21. Tervo RC. Identifying patterns of developmental delays can help diagnose neurodevelopmental disorders. Clin Pedtr. 2006; 45(6):509-17
22. Dworkin PH. British and American recommendations for developmental monitoring: The role of surveillance. Pediatrics. 1989;84(6):1000-10.
23. Willats P. Development of means–end behavior in young infant: Pulling a support to retrieve a distant object. Dev Psych. 1999;35(3):651-62.
24. Rosenberg S, Zhang D, Robinson C. Prevalence of developmental delays and participation in early intervention services for young children. Pediatrics. 2008;121:e1503-9
25. Cohen L, Amsel G, Redford M, Casasola M. The development of infant causal perception. In: Slater A. (ed). Perceptual Development: Visual Auditory and Speaking Perception in Infancy. London: University College of London Press; 1997 pp. 4-44
26. Young J. Babies and bedsharing (Co-sleeping) – The Natural Child Project. Midwifery Dig. 1998;8:364-9.
27. Faroogi S. Ethnic differences in infant care practices and the incidence of sudden infant death syndrome. Early Human Dev. 1994;38(3):215-20.
28. Gupta V. Differential diagnosis of a child with developmental delay or failure. In: Gupta V. Manual of Development and Behavioral Problems in Children. New York: Marcel Dekker Inc; 1999. pp. 46-50.
29. Batshaw M. Mental Retardation. Pedtr Clin N Amer. 1993;40(3):510.
30. Markus H, Kitayama S. Culture and self-implication for cognition, emotion and motivation. Psych Rev. 1991;98:224-53.
31. Bradley R, Corwyn R. SES and child development. Ann Rev Psych. 2002;536:379-88.
32. Pan B, Rowe M, Singer J, Snow C. Maternal correlates in toddlers vocabulary production in low income families. Child Dev. 2005;76(4):763-82.
33. Barclay K, Myrskyla M. Advanced Maternal Age and Offspring Outcome: Reproductive Aging and Counterbalancing Period Trends. Population and Developmental Rev. 2016;42(1):69-94.
34. Purewall R, Christley R, Kordan K, et al. Companion Animals and Child / Adolescent Development: A Systematic review of Evidence. Int J Environ Res Public Health. 2017;14:234.
35. Simpson A. Effect of household pet ownership on infant immune response and subsequent sensitization. J Asthma Allergy. 2010 30(3):131-7. doi: 10.2147/JAA.S6958.
36. Gern JE, Reardon CL, Hoffzan S, et al. Effects of Dog Ownership and Genotype on Immune Development and Atopy in Infancy. J Allergy Clin Immunol. 2004;113(2):307-314.
37. Damborg P, Broen EM, Chonal B, etal. Bacterial Zoonoses Transmitted by Huosehold Pets: State-of-the-Art and Future Perspectives for Targeted Research and Policy Actions. J Comp Path. 2016;155(1 Suppl 1):S27-S40.
38. Bergroth E, Remes S, Pekkanen J, Kauppila T, Büchele G, Keski-Nisula L. Respiratory tract illnesses during the first year of life: effect of dog and cat contacts. Pediatrics. 2012;130(2):211-20. doi: 10.1542/peds.2011-2825.