Child developmental assessment at two-years of age: Data from the Pacific Islands Families Study

Janis Paterson[1§], Leon Iusitini[1], Wanzhen Gao[2]

[1] AUT University, School of Public Health and Psychosocial Studies, Auckland, New Zealand
[2] Temple University, Center for Asian Health, Department of Public Health, Philadelphia, USA

§ **Corresponding author:** Professor Janis Paterson, School of Public Health and Environmental Sciences, AUT University, Private Bag 92006, Auckland, New Zealand. Phone: +64-9-921 9999 ext: 7324. E-mail: janis.paterson@aut.ac.nz

Type of article: Original article

Abstract

Aims: *To describe the developmental profile of Pacific children living in New Zealand at two years of age in personal/social, language, cognitive, fine motor, and gross motor domains, and to examine how sociodemographic, maternal, and cultural factors influence children's development.*

Methods: *A cohort of Pacific infants born during 2000 in Auckland, New Zealand, was followed up at two-years postpartum. Maternal interviews were administered and the developmental status of the child was measured using the Australian Developmental Screening Test.*

Results: *Maternal child development reports are presented for 1,018 two-year-old children. The majority of children were identified as having no developmental delay. The prevalence of no delay in any of these five domains was 64.8%. For those children (35%) who were identified with possible overall delay the significant risk factors were child ethnicity, low birth weight, being breastfed for less than six weeks, and single parenthood.*

Discussion: *The powerful associations of these factors and developmental outcome suggest that interventions need to have the flexibility to address such issues within individual Pacific families and communities.*

Introduction

The developing child is viewed as embedded in a number of organised, interrelated systems with a hierarchy of sociodemographic, maternal and cultural factors that can facilitate or hinder early child development.[1,2] Although there are numerous child development studies there is a paucity of research that investigates the powerful role that social stratification variables, such as ethnicity, play in shaping the unique environments in which development occurs.[3,4]

Pacific peoples are one of New Zealand's fastest growing population subgroups.[5] The 2006 census recorded the total population at 4,143,279 people, and the total Pacific population living in New Zealand at 265,974. It is a relatively young population with Pacific children and youth under 19 years of age comprising 48% of the Pacific population, compared to 29% of the total population.[6] Pacific peoples are among the lowest socio-economic groupings in New Zealand and have consistently been linked with poorer health and developmental outcomes.[7-9]

Parental socio-economic status, as measured by variables such as maternal education,[10,11] occupation, and income[12] has been linked with childhood intelligence scores from the age of two years.[13] Research suggests that the sustained experience of poverty over the critical periods of infancy and early childhood is associated with delayed cognitive development, diminished social competence, and problem behaviour.[14,15]

A number of maternal, lifestyle and child factors have been associated with poorer developmental outcomes. These include poor maternal mental health,[16] post-natal depression,[17,18] maternal smoking habits,[19] maternal problem gambling,[20,21] excessive maternal alcohol consumption,[22] low birth weight,[23,24] and limited breastfeeding.[25-27] Harsh parenting has also been associated with poor developmental outcomes.[28,29] Pacific researchers have described the harsh parenting practices of Pacific parents and the focus on obedience without question.[30,31] Overall, these findings highlight the complexity of early child development and the multiple factors that are likely to affect optimal child outcome.

The aim of this study is to (1) describe the developmental status of the Pacific children at two years of age in personal/social, language, cognitive, fine motor, and gross motor development, and (2) examine how sociodemographic, maternal and cultural factors influence children's development.

Methods

Mothers of Pacific infants born at Middlemore Hospital, Auckland, New Zealand, between March and December of the year 2000, were invited to join the Pacific Islands Families Study (PIFS). All births where at least one parent self-identified as being of Pacific Island ethnicity and a New Zealand permanent resident were eligible for inclusion in the study. Participants were identified through the Birthing Unit, in conjunction with the Pacific Islands Cultural Resource Unit. Mothers were approached by a Pacific researcher before leaving the hospital and were provided with information about the study. Consent was sought to make a home visit at six weeks postpartum. At the hospital 1,647 mothers were invited to participate in the study, of which 1,590 (96%) consented to a home visit; and of these 1,477 (93%) were found to be eligible for the PIFS. Of those eligible, 1,376 (93%) participated at six-weeks, 1,224 (83%) participated at 12 months, and 1,144 (77%) participated at 24 months. Female interviewers of Pacific ethnicity visited mothers in their homes when the child was 24 months of age. Once informed consent was obtained, mothers participated in a one-hour interview concerning aspects of family functioning, maternal lifestyle and the health and development of the child. All interviews were conducted in English but the interviewer was capable of clarifying concepts in the specific Pacific language of the mother if required. Following this interview a child assessor visited the family and carried out a child assessment that included the Australian Developmental Screening Test.[32] Two trained researchers administered the child assessment. They were observed for the first two administrations and their work was double coded throughout data collection to ensure inter-rater reliability.

Measures

Child Development: The Australian Developmental Screening Test (ADST) is a standardised, individually administered developmental screening test for children aged from six months to five years of age (32) that was designed for use by medical practitioners where developmental delay is suspected. It consists of 150 items arranged in five domains of development: personal/social (e.g. waves goodbye), language (e.g. names familiar objects), cognitive (e.g. identifies one body part), fine motor (e.g. holds out toy), and gross motor (e.g. stands on tip toes). Mean and standard deviation scores are reported across the five domains of development. Based on the examiners' manual, performances on the ADST are classified as "No Delay" or "Possible Delay".

No Delay is where the developmental profile is either: very close to the age line (within one month) or above the age line; above or matches the age line in four domains, and is no more than two months below the age line in one domain; or is below the age line by no more than one month in up to three domains. Possible Delay in any single domain is where the developmental profile is below the age line by at least four months. For the screening of possible overall delay, the developmental profile is below the age line in one domain by four months or more and/or is below the age line in three or more domains by at least two months.[32] In addition, to differentiate psycho-social and physical development and identify some specific risk factors that might be related to physical development but not to psychosocial or vice versa, we also defined subtotal screening criteria: if a child's developmental profile is below the age line in one of three domains of personal/social, language, and cognitive by four months or more and/or is below the age line in all three domains by two months or more then he/she is considered as having possible delay in psycho-social development. If a child's developmental profile is below the age line in one of two domains of fine motor and gross motor by four months or more and/or is below the age line in both domains by two months or more, he/she is considered as having possible delay in physical development.

The ADST showed reasonable reliability through standard error of measurement, test-retest reliability, and inter-rater reliability. The consideration of validity was based on construct validity, content validity, and criterion-related validity. The ADST has been compared against the Australian Developmental Record for Infants and Young Children[33] and a correlation coefficient of 0.875 indicated a high degree of agreement between the two measures.[34] Based on data from the PIFS cohort, Cronbach's α scores were 0.66, 0.78, 0.77, 0.78, and 0.85, respectively for personal/social, language, cognitive, fine motor, and gross development. Apart from the personal/social scale, all other scales exceeded the widely accepted reliability coefficient of 0.7.

Parenting practices: The Parent Behaviour Checklist (PBC) is an objective measure of how parents are raising their children.[35] The original scale consists of 100 items and three empirically derived subscales: Expectations, Discipline and Nurturing. In order to form a shorter scale we used selected items from the Discipline and Nurturing scales. The former assesses parental responses to children's challenging behaviours with verbal and corporal punishment; the latter measures specific behaviour that promotes a child's psychological growth. In order to reduce the burden on participants, these two subscales were shortened. Fifteen items were chosen on the basis of high item factor loadings, resulting in five discipline items (e.g. I smack my child) and 10 nurturing items (e.g. I praise my child for learning new things). Minor language modifications were made, where appropriate. This resulted in a modified harsh discipline subscale incorporating those original items which correlated more strongly with the 'discipline' factor and were, as might be expected, 'harsher' in nature. Thus, the modified discipline subscale used in this study can be said to measure harsh disciplinary practices, as opposed to the PBC's broader measure of discipline. Prior to administration to the full cohort, the revised scale was piloted on 47 maternal participants (a pilot group) and the alpha coefficients of both subscales (Discipline 0.675; Nurturing 0.683) were sufficient to support the inclusion of the scale. Validity for the PBC has been established and the alpha coefficients and test-retest reliability scores were high on the original scales (Discipline 0.91, 0.87, and Nurturing 0.82, 0.81 respectively). For the modified PIFS scales, the Cronbach's α was 0.77 for Discipline and 0.71 for Nurturing. The two scale scores were categorised into four levels using quartiles. Higher scores in each subscale were indicative of greater nurturance and greater use of harsh discipline behaviours.

Maternal psychological disorder: At 24 months postpartum, maternal mental health was assessed using the General Health Questionnaire (GHQ12).[36] This self-report screening tool consists of 12 items and is widely used to identify minor psychiatric disorder in adults. High validity coefficients for the GHQ12 of between 0.83 and 0.93 have been reported in a number of settings.[37] The GHQ12 was scored to give a total of 12 using the binary method of scoring. Each item was scored 1 if the answer was "rather more than usual" or "much more than usual"; otherwise it was scored 0. A threshold of three is recommended for screening psychological disorder. Mothers who scored at or above the threshold were referred to in this study as symptomatic and mothers who scored below as non-symptomatic. The reliability coefficient of the GHQ in the PIFS was 0.87.[38]

Acculturation: The General Ethnicity Questionnaire (GEQ)[39] is based on the widely used concept of acculturation, the process of change that groups and individuals undergo when they come into contact with another culture. Four different varieties of acculturation were identified: these are termed assimilation (reference group), integration, separation, and marginalization.[40] Participants agreed or disagreed with a list of 11 statements related to the dominant New Zealand culture and Pacific culture (e.g. I was brought up in the New Zealand/Pacific way). The acculturation measure was an adaption of the original 38-item GEQ to an 11-item measure that focused on reducing the number of questions but relating the key dimensions of language, social affiliations , activities of daily life, and food.[41] In the present analyses, mothers were categorized based on their acculturation scores for affinity toward New Zealand mainstream culture or identification with Pacific Island tradition and lifestyle. In assimilation, cultural identity is relinquished and the individual moves into the larger society. Hence assimilated mothers had high New Zealand identification and low Pacific identification. Integration involves maintenance of cultural integrity but also the movement to become an integral part of the larger society (high New Zealand/high Pacific). Separation refers to self-imposed withdrawal from the larger society (low New Zealand/high Pacific), and marginalization refers to losing the essential features of one's culture, but not replacing them by entering the larger society (low New Zealand/ low Pacific). Good reliability and validity is reported for the GEQ,[39] and in this cohort, Cronbach's α score of 0.81 was obtained for the New Zealand acculturation scale and 0.83 for the Pacific acculturation scale.[41]

Demographics and other variables: At each measurement wave a suite of questions are included that are appropriate to the age of the child and the family context. Maternal lifestyle was assessed using specific questions about smoking, alcohol and gambling. Mothers were asked if they had smoked yesterday; if they drank alcohol monthly, or less than monthly with 6 drinks or more on one occasion, and if they had bet or spent money on gambling activities or games in the last 12 months. A composite lifestyle risk factor was defined as 0 (none of these behaviours: reference group), 1 (any one of these behaviours), and 2 (any two or all of these behaviours). The duration of breastfeeding was assessed by classifying three groups from maternal reports of breastfeeding: less than six weeks (reference group), (6 – 52) weeks, and 52 weeks or more. Low birth weight was identified from birth records and was set at <2,500g. Details of the socio-demographic characteristics of the cohort appear in Table 1.

Table 1. Frequencies (percentages) of socio-demographic characteristics for participating mothers and children (N=1,018)

Socio-demographic characteristics	N[a]	(%)
Maternal characteristics		
Age (years)		
<20	76	7.5
20–29	513	50.4
30–39	390	38.4
>40	38	3.7
Highest educational qualification		
No formal qualifications	367	36.1
Secondary	328	32.3
Post-secondary	321	31.6
Ethnicity		
Samoan	494	48.5
Cook Island	174	17.1
Tongan	213	20.9
Other Pacific/Multi[b]	70	6.9
Non-Pacific[c]	67	6.6
Years lived in New Zealand		
0–5	191	18.8
6–10	114	11.2
>10	710	70.0
Marital status		
Partnered	827	81.2
Non partnered	191	18.8
Parity: live born children		
1	272	27.2
2–4	559	55.8
>5	170	17.0
Household income (NZD) at 6 weeks interview		
>$20,000	334	32.8
$20,000–$40,000	524	51.5
>$40,000	126	12.4
Unknown	34	3.3
NZ born		
No	688	67.6
Yes	330	32.4
Maternal Acculturation		
Assimilationist	324	32.1
Separationist	336	33.3
Integrationist	181	18.0
Marginalisationist	167	16.6
Infant characteristics		
Age in months (mean ± SD)	26.4	± 1.5
Multiplicity of birth		
Singleton	1,000	98.2
Twin	18	1.8
Gender		
Female	489	48.0
Male	529	52.0
Ethnicity		
Samoan	494	48.5
Cook Island	174	17.1
Niuean	45	4.4
Tongan	213	20.9
Other Pacific/Multi[d]	92	9.0

[a]   The numbers do not always sum to 1,018 due to missing values.

[b]   Includes mothers identifying equally with two or more Pacific Island groups, equally with Pacific Island and Other/Multi groups, or with Pacific Island groups other than Tongan, Samoan, or Cook Island Māori.

[c]   Includes non-Pacific mothers who were eligible through the Pacific ethnicity of the father.

[d]   Includes children identifying equally with two or more Pacific Island groups, equally with Pacific Island and Other/Multi groups, or with Pacific Island groups other than Tongan, Samoan, Cook Island Māori, or Niuean.

Results

At 24 months, 1,144 mothers were interviewed in relation to 1162 children (including 38 twins). Maternal child development reports were gathered on about 1048 children. Twin births were excluded from the present study. Twenty-six reports were also excluded from further ADST analysis because the child's age was greater than 30 months. Another four reports were excluded as they had more than 10 missing values on the ADST. This left 1,018 children and their primary caregivers for the present analysis, of whom 489 (48%) were girls and 529 (52%) were boys. Children's ethnicity was classified as Samoan (48.5%), Cook Island (17.1%), Niuean (4.4%), Tongan (20.9%), and Other-Pacific (9.0%). Detailed information about the PIFS cohort and procedures is described elsewhere.[42]

Prevalence of possible child developmental delay

As presented in Table 2, the prevalence rate of possible delay among the PIFS children was 5.1% in personal/social, 14.4% in language, 29.4% in cognitive, 9.3% in fine motor, and 6.2% in gross motor. The rate of overall Possible Delay was 35.2%, psychosocial delay was 32.7%, and physical delay was 13.4%. McNemar's test was used to compare the differences between any two of the five ADST dichotomous variables to determine whether the row and column marginal frequencies are equal (i.e. symmetry of the discordant observations that were identified as Possible Delay in one domain but not in the other).[43] If the difference between the row and column marginal frequencies is statistically significant one can conclude the prevalence rates of Possible Delay are different between the two compared domains. McNemar's tests indicated that there was no significant difference between the prevalence of Possible Delay in personal/social and in gross motor (P-value=0.159); whereas all the other comparisons were significant, which implied a descending order of prevalence of Possible Delay: cognitive, language, fine motor, gross motor, and personal/social.

Table 2. Prevalence rate of Possible Delay, number and row percentage of ADST measures (N=1,018)

Domain	No Delay		Possible Delay [a]	
	N	(%)	N	(%)
Personal/Social	966	(94.9)	52	(5.1)
Language	871	(85.6)	147	(14.4)
Cognitive	719	(70.6)	299	(29.4)
Subtotal: Psycho-social	685	(67.3)	333	(32.7)
Fine Motor	923	(90.7)	95	(9.3)
Gross Motor	955	(93.8)	63	(6.2)
Subtotal: Physical	882	(86.4)	136	(13.4)
Overall	660	(64.8)	358	(35.2)

[a] For the delay in each domain, the developmental profile is below the age line by at least 4 months; for the delay in each subtotal, the developmental profile is below the age line by 4 months or more in one domain and/or is below the age line by at least 2 months in all the three domains of personal/social, language, and cognitive (for psycho-social) or in all the two domains of fine motor and gross motor (for physical); for the delay in overall measure, the developmental profile is below the age line by 4 months or more in one domain of the seven and/or is below the age line by at least 2 months in 3 or more domains of the seven.

Socio-demographic, maternal and lifestyle factors

Bivariable logistic regression procedures were employed to explore the associations between maternal and socio-demographic risk factors and possible overall child developmental delay. The variables with P-values <0.25 were then included in the multivariable hierarchical logistic regression models as potential risk factors.[44] The variables with P-values <0.25 were child ethnicity, household income, maternal marital status, parity, maternal acculturation, parenting, duration of breast feeding, maternal lifestyle risk scores, and low birth weight. These variables were then included in the multivariable hierarchical logistic regression analyses

in the order of socio-economic factors, mother's parenting, maternal lifestyle risk factors, maternal health, and finally child health. The odds ratio (OR) and 95% confidence interval (CI) are presented to indicate the likelihood of being identified as Possible Delay in the presence of a risk factor compared with the absence of that factor. An odds ratio greater than 1 implies the factor was a risk factor and less than 1 a protective factor. Nagelkerke's R^2 was used to estimate the variability in the dependent variable explained by the model and Hosmer–Lemeshow's goodness-of-fit test was conducted to determine whether the model fit was adequate. All analyses were performed using SAS version 9.1 and a significance level of $a=0.05$ was used to determine statistical significance for all comparisons.

The multivariable hierarchical logistic regression models are presented in Table 2. The first model included socio-demographic factors; the second model included the model one variables plus parenting variables; the third model included the model two variables plus lifestyle variables; the final model included the model three variables plus child health variables. The significant variables were child ethnicity, maternal marital status, duration of breastfeeding, and low birth weight in the final model. Compared with Samoan children, the odds of being identified as Possible Delay were 6.30 in Cook Island, 4.96 in Niuean, 8.80 in Tongan, and 4.87 in other Pacific children. Samoan was used as the reference category because it is the largest group and generally fares better in terms of socio-economic and general health status compared with other Pacific groups (45). Children of mothers who did not have a husband or partner were more likely to have Possible Overall Delay (OR=1.65). Prolonged duration of breastfeeding was associated with a decreased likelihood of experiencing Possible Overall Delay. The chance of experiencing Possible Overall Delay was less than one half (OR=0.41) among those being breastfed for six to 52 weeks and one-third (OR=0.29) among those breastfed for more than one year, compared to those breastfed for less than six weeks. Children with low birth weight were more than twice as likely to be identified as having Possible Overall Delay than those with normal birth weight (OR= 2.21).

Table 3. Multivariable hierarchical logistic analysis of overall Possible Delay: adjusted odds ratios and P-values

Variable	Category	Model 1		Model 2		Model 3		Model 4	
		OR	P-value	OR	P-value	OR	P-value	OR	P-value
Socio-demographic factors									
Child's ethnicity	Samoan	-	***	-	***	-	***	-	***
	Cook Island	5.89		6.54		6.29		6.30	
	Niuean	4.47		5.05		4.91		4.96	
	Tongan	8.29		8.60		8.76		8.80	
	Other Pacific/Multi	4.78		5.17		4.91		4.87	
Household income	$0 – $20,000	-	#	-	#	-	#	-	#
	$20,001 – $40,000	1.39		1.39		1.39		1.39	
	>$40,000	1.37		1.33		1.33		1.36	
	Unknown	1.74		1.84		1.80		1.68	
Maternal social marital status	Partnered	-	*	-	*	-	*	-	*
	Non partnered	1.62		1.68		1.63		1.65	
Parity: live born children	1	-	#	-	#	-	#	-	#
	2–4	0.93		0.89		0.87		0.88	
	>5.	1.12		1.01		0.98		0.99	
Maternal acculturation	Assimilationist	-	#	-	#	-	#	-	#
	Separationist	1.11		1.17		1.15		1.18	
	Integrationist	1.19		1.15		1.13		1.16	
	Marginalisationist	1.42		1.41		1.34		1.39	
Mother's parenting									
Harsh discipline	Lower quartile			-	#	-	#	-	#
	Second quartile			1.17		1.18		1.16	
	Third quartile			1.20		1.22		1.22	
	Upper quartile			0.78		0.78		0.79	
Breastfeeding	<6 weeks			-	**	-	**	-	**
	6–52 weeks			0.42		0.42		0.41	
	>52 weeks			0.29		0.30		0.29	
Lifestyle risk factors									
Overall risk scores	No risk -behaviour					-	#	-	#
	One risk -behaviour					0.95		0.94	
	Two or three - risk behaviours					1.21		0.21	
Child health									
Low birth weight (<2,500g)	No							-	*
	Yes							2.21	
Nagelkerke's R²		0.23		0.26		0.25		0.26	
Hosmer-Lemeshow goodness-of-fit P-value		0.476		0.227		0.480		0.180	

P-value ≥0.05; * P-value<0.05; ** P-value<0.01; *** P-value<0.001.

In addition, we analysed the risk and protective factors related to possible psycho-social delay and possible physical delay separately. The independent factors related to possible psycho-social delay were child ethnicity, duration of breastfeeding, and low birth weight. Child ethnicity and the duration of breastfeeding were also independently associated with possible physical delay.

Discussion

These findings revealed Pacific children who were screened with the ADST at the two-year measurement point showed a prevalence rate of no delay of 94.9% in personal/social, 85.6% in language, 70.6% in cognitive, 90.7% in fine motor, 93,8% in gross motor development, and 64.8% in overall. The most powerful risk factors for overall possible developmental delay (35% of cohort children) were child ethnicity, low birth weight, limited duration of breastfeeding, and singe maternal marital status. We found that children from all other Pacific ethnic groups consistently presented higher prevalence and odds of possible overall developmental delay compared to Samoan children. Tongan children were significantly more likely to be identified as having overall possible developmental delay than Samoan children. This finding may be partly explained by immigration patterns. In general, the Samoan population is well established in New Zealand and is substantially larger than all other Pacific ethnic groups. It is possible that having strong and numerous bonds to identify with may have a protective influence in terms of health and developmental outcomes for children and families.[45]

The other variable significantly associated with higher possible overall developmental delay was found in children who had been breastfed for less than six weeks. Numerous studies that have shown that children who are breastfed score higher on tests of cognitive development than children who are formula fed,[46] and that this effect becomes more pronounced with increasing duration of breastfeeding.[47,48] Several large studies have found that motor milestones were reached earlier in children who were breastfed than children who were formula fed.[27] It is suggested that the psycho-social aspect of nurturing may play a role, as well as the biological impetus of breastmilk.[49,50] Maternal hormones and other biologically active peptides being transferred to the infant via breast milk may exert an influence on brain and muscle development.[51-53]

Consistent with a growing body of research,[23,24] we found that low birth weight was significantly associated with overall possible developmental delay. A recent systematic review reported a small, consistent positive association between normal birth weight and childhood cognitive ability, even when corrected for confounders. However, the authors found that parental socio-economic status accounted for a larger proportion of the variance than birth weight.[54] The broader literature on low birth weight suggests that children's home environment and the socioeconomic and demographic backgrounds of their parents may have a more powerful influence on cognitive development than the weight at which they were born.[55,56]

And terms of the home environment, children of single mothers were more likely to be identified as having possible overall developmental delay. Single parenthood has been associated with greater behavioural problems and lower academic achievement among children and youth,[57] and the benefits of paternal involvement for children's wellbeing and development have been documented.[58] Although not significant in the final model, high levels of harsh discipline were associated with possible overall developmental delay in the bivariable analysis indicating that such parenting behaviour could be implicated in developmental delay. However it is likely that this effect may not be fully revealed at this early age.[3] We found no associations between socio-demographic variables and overall developmental delay at two years of age. This may be partly explained by the minimal variation in socioeconomic circumstances within the cohort, meaning the children's experience of economic disadvantage does not differ substantially. Any effects are likely to be masked by this homogeneity. The age of the children is likely to have some bearing on these results given that it is long term experience of socioeconomic disadvantage that appears to account for negative consequences for child development.[59]

The official language in New Zealand is English but anecdotal evidence suggests that home island languages may be used in some Pacific homes. It is likely that early cognitive and English language development in Pacific children is affected by the language spoken in the home. Research has shown that bilingualism has a positive effect on specific intellectual and linguistic abilities.[60,61] However, research in New Zealand schools demonstrated that Pacific children, whose home language is not the language of instruction (English), were more likely to have markedly lower literacy levels than other children in New Zealand.[62] It is postulated that there are many unmeasured cultural factors that influence cognitive and language development with many children not only switching between languages but also switching between cultural contexts, such as very different home and school environments, rules, traditions, and expectations.[63]

Caution is required when interpreting these findings due to several limitations. Although the ADST is an internally robust scale used in clinical settings we found no other published work using this scale thus we were unable to compare outcomes from other studies with our data. This measure was selected because it is a brief screening test, and it is based on other well known tests that have been used in New Zealand and internationally. The PIFS has contributed to establishing the reliability and validity of this standardised instrument when applied to a minority population.

The young age of the child participants is a limitation due to the difficulties associated with the measurement of developmental abilities at two years of age and thus must be considered when interpreting the reliability of scores. The maternal interviews and child assessments were administered by a team of Pacific health professionals thus mothers and children are usually interviewed by women of their own specific ethnicity. The cultural sensitivity of our methods and procedures and the size of the cohort demonstrate the robustness of the PIFS findings.

Based on the strong beneficial effect of prolonged breastfeeding on developmental status found in this study, we recommend that child health efforts continue to highlight the importance of breastfeeding for optimal child development. The detrimental effect of single parenthood and low birth weight on developmental status also needs to be considered in the planning of services to Pacific families. Of particular importance is the powerful association between child ethnicity and developmental outcome. This finding suggests that interventions need to have the flexibility to allow relevant issues to be effectively addressed within individual Pacific communities. This initial analysis of child development in the context of this large scale longitudinal study provides an opportunity to explore these complex issues over time and to improve our understanding of the early life influences on developmental outcomes.

Acknowledgements

References

1. Sameroff AJ. Developmental systems: Contexts and evolution. In: Kessen W, ed. *Histories, Theories, and Methods.* New York: John Wiley; 1983.

2. Brofenbrenner U, Crouter A. The evolution of environmental models in developmental research. In Mussen PH, ed. *Handbook of Child Psychology.* New York: John Wiley; 1983.

3. Roberts JE, Burchinal M, Durham M. Parents' report of Vocabulary and Grammatical Development of African American Preschoolers: Child and Environmental Associations. *Child Development.* 1999; 70: 92-106.

4. Garcia Coll C, Lamberty G, Jenkins R, McAdoo HP, Crnic K, Wasik, BH. An integrative model for the study of developmental competencies in minority children. *Child Development.* 1996; 67:1891-1914.

5. Cook L, Didham R, Khawaja M. *On the demography of Pacific people in New Zealand.* Wellington: Statistics New Zealand; 1999.

6. Statistics New Zealand – Te Tari Tatau. *2001 Census, snapshot 6, Pacific peoples.* Wellington: Statistics New Zealand; 2002.

7. Statistics New Zealand – *Te Tari Tatau.Employment and income of Pacific peoples in New Zealand.* Wellington: Statistics New Zealand; 2002.

8. Chen, E. Why socioeconomic status affects the health of children: A psychosocial perspective. Current directions in Psychological Science: *A Journal of the American Psychosocial Society* .2004; 13: 112-115.

9. Power C. Childhood adversity still matters for adult health outcomes. *The Lancet.* 2002; 360: 1619-1620.

10. Cohen SE, Parmelee AH. Prediction of 5-year Stanford-Binet scores in preterm infants. *Child Development.* 1983; 54:1242-1253.

11. Roberts E, Bornstein MH, Slater AM, Barrett J. Early cognitive development and parental education. *Infant and Child Development.* 1999; 8:49-62.

12. Hernandez DJ. Child development and the social demography of childhood. *Child Development.* 1997; 68:149-169.

13. Rubin RA, Balow B. Measures of infant development and socioeconomic status as predictors of later intelligence and school achievement. *Developmental Psychology.* 1979; 15: 225-227.

14. Wacharasin C, Barnard KE, Speiker SJ. Factors affecting toddler cognitive development in low-income families. *Infants and Young Children.* 2003; 16: 175-181.

15. Duncan GJ. Brooks-Gunn J, Klebanov P.K. Economic deprivation and early childhood development. *Child Development.* 1994; 65: 296-318.

16. Kurstjens S, Wolke D. Effects of maternal depression on cognitive development over the first 7 years of life. *Journal of Child Psychology and Psychiatry.*2001; 42:623-636.

17. Poobalan AS, Aucott LS, Ross L, Smith WCS, Helms J, Williams JHG. Effects of treating postnatal depression on mother-infant interaction and child development. *British Journal of Psychiatry* .2007; 191: 378-386.

18. Beck C. The effects of postpartum depression on child development: a meta-analysis. *Archives of Psychiatric Nursing Research.* 1998; 12: 12-20.

19. Julvez J, Ribas-Fito N, Torrent M, Forns M, Garcia-Estaban R, Sunyar J. Maternal smoking habits and cognitive development of children at age 4 years in a population-based birth cohort. *International Journal of Epidemiology.* 2007; 36, 825-832.

20. Darbyshire P, Oster C, Carrig H. Children of parent(s) who have a gambling problem: a review of the literature and commentary on research approaches. *Health & Social Care in the Community.* 2001; 9: 185-193.

21. Shaw MC, Forbush KT, Schlinder J, Rosenman E, Black, D.W. The effect of pathological gambling on families, marriages, and children. *The International Journal of Neuropsychiatric Medicine.* 2007; 12: 615-622.

22. Sher KJ. *Children of Alcoholics: A critical appraisal of theory and research.* Chicago: University of Chicago Press; 1991.

23. Wilcox AJ. Of the importance–and the unimportance-of –birth weight. *International Journal of Epidemiology.* 2001; 30: 1233-1241.

24. Wood NS, Marlow N, Costeloe K, Gibson AT, Wilkinson AR. Neurologic and developmental disability after extremely preterm birth. *The New England Journal of Medicine.* 2000; 343: 378-84.

25. American Academy of Pediatrics. Policy statement: breastfeeding and the use of human milk. *Pediatrics.*2005: 115, 496-506.

26. Innes SM, Gilley J, Werker J. Are human milk long-chain polyunsaturated fatty acids related to visual and neural development in breast-fed infants? *Journal of Pediatrics.*2001; 139: 532-538.

27. Vestergaard M, Obel C, Henriksen, T, Sorensen H, Skajaa E, Ostergaard J. Duration of breastfeeding and developmental milestones during the latter half of infancy. Acta *Paediatrica.* 1999; 88: 1327-1332.

28. Erath SA, El-Sheik M, Cummings EM. Harsh parenting and child externalizing behaviour: Skin conductance level reactivity as a moderator. *Child Development.* 2009; 80: 578-592.

29. Gershoff ET. Corporal punishment by parents and associated child behaviours and experiences: A meta-analysis and theoretical review. *Psychological Bulletin.* 2002; 128: 539-579.

30. Anae M. The New Viking of the Sunrise: New Zealand borns in the Information Age. In: Mcpherson C Spoonley P, eds. *Tangata o te Moana Nui: The Evolving Identities of Pacific Peoples in Aotearoa/New Zealand* Palmerston North: New Zealand: Dunmore Press; 2001:102-122.

31. Fairbairn-Dunlop P. Tetee atu le sasa ma le upu malosi: Hold back your hands and your harsh words. *Pacific Health Dialog.* 2002; 8: 220-221.

32. Burdon B. *ADST: Australian Developmental Screening Test.* Sydney, Australia: Harcourt Brace & Co: 1993.

33. Atkinson J. *Too Late at Eight: Prevention and Intervention. Young Children's Learning Difficulties.* Brisbane: Queensland University; 1980.

34. Nunnally J C. *Psychometric theory.* New York: McGraw-Hill; 1978

35. Fox RA. *Parent Behaviour Checklist.* Brandon, Vermont: Clinical Psychology Publishing Co;1994

36. Goldberg DP, Williams P A. *User's Guide to the General Health Questionnaire.* Windsor, U.K: NFER-Nelson; 1998.

37. Goldberg DP, Gater R M, Sartorius N, Ustun TB, Riccinell, M, Gureje O, Rutter C. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychological Medicine,* 1999; 27: 191-197..

38. Gao W, Paterson J, Abbott M, Carter S, Iusitini L. Maternal Mental Health and Child Behaviour Problems at 2 years – findings from the Pacific Islands Families (PIF) Study. *Australian & New Zealand Journal of Psychiatry.* 2007; 41:885-895.

39. Tsai J, Ying Y, Lee P. The meaning of being Chinese and being American: variation among Chinese and American young adults. *Journal of Cross-Cultural Psychology.*2000; 31: 302-332.

40. Berry JW. Conceptual approaches to acculturation. In Chun KM, Organista PB, Marin G, eds. *Acculturation: Advances in Theory, Measurement & Applied Research* Washington, DC: *American Psychological Association;* 2003:17-38.

41. Borrows J, Williams M, Schluter P, Paterson J, Helu S. Pacific Islands Families Study: The association of infant health risk indicators and acculturation of Pacific Island mothers living in New Zealand. *Journal*

of Cross-Cultural Psychology. 2010.

42. Paterson J, Percival T, Schluter P, Sundborn G, Abbott M, Carter S. Cohort profile: The Pacific Islands Families (PIF) Study. *International Journal of Epidemiology.*2008; 37: 273-279.

43. McNemar Q. Note on the sampling error of the difference between correlated proportions or percentages. *Psychometrika.* 1947; 12: 153-157.

44. Hosmer DW, Lemeshow S. *Applied Logistic Regression.* New York: Wiley; 1989.

45. Statistics New Zealand – *Te Tari Tatau. Pacific Profiles 2006.* Wellington: Statistics New Zealand; 2006.

46. Anderson JW, Johnstone BM, Remley DT. Breastfeeding and cognitive development; A Meta Analysis. *American Journal of Clinical Nutrition.* 1999; 70: 525-35.

47. Angelsen NK, Vik T, Jacobsen G, Bakketeig L.S. Breastfeeding and cognitive development at age 1 and 5 years. *Archives of Diseases in Childhood.* 2001; 85: 183-188.

48. Oddy WH, Kendall GE., Blair E, de Klerk HH, Stanley FJ, Landau LI, Zubrick S. Breastfeeding and cognitive development in childhood: a prospective birth cohort study. *Pediatric and Perinatal Epidemiology.*2003, 17: 81-90.

49. Jacobsen SW, Chioddo LM, Jacobsen JL. Breast feeding effects on intelligent quotient in 4- and 11 year old children. *Pediatrics.* 1999; 103, 171.

50. Lanting CI, Patandin S, Weisglas-Kuperus N, Touwen BCL, Boersma ER. Breastfeeding and neurological outcome at 42 months. *Acta Paeditric.* 1998; 87: 1224-1229.

51. Britton JR, Koldovsky O. Development of luminal protein digestion: implications for biologically active dietary peptides. *Journal of Pediatric Gastroenterology.* 1989; 9: 144-162.

52. Lucus A, Morely R, Fewtrell MS. Low triiodothyronine concentration in preterm infants and subsequent intelligence quotient (IQ) at 8 year follow up. *British Medical Journal.* 1996; 312: 1132-1133.

53. Sacker A, Quigley MA, Kelly YJ. Breastfeeding and Developmental Delay: Findings from the Millennium Cohort Study. *Pediatrics.* 2006; 118: 682-689.

54. Shenkin SD, Starr JM, Deary IJ. Birth weight and cognitive ability in childhood. *Psychological Bulletin,* 2004; 130: 989-1013.

55. Boardman, JD, Powers DA, Padilla YC, Hummer, RA. Low birth weight, social factors, and developmental outcomes among children in the United States. *Demography.* 2002; *39:* 353-368.

56. Brooks-Gunn J,Duncan GJ. (1997). The effects of poverty on children. *The Future of Children.* 1997;*7:* 55-71.

57. cLanahan S, Sandefur G. *Growing up with a single parent: What hurts, what helps?* Cambridge, MA: Harvard University Press; 1994.

58. Lamb ME, Tamis LeMonda CS. The role of the father: An Introduction. In Lamb ME, ed. *The Role of the Father in Child development.* 4th ed. Hoboken, N.J: Wiley; 2004:1-31.

59. Smith JR, Brooks-Gunn J, Klebanov PK. Consequences of living in poverty for young children's cognitive and verbal ability and early school achievement. In Duncan GJ, Brooks-Gunn J, eds. *Consequences of Growing Up Poor.* New York: Russell Sage Foundation; 1997: 132-89.

60. Siegal M, Iozzi L, Surian L. Bilingualism and conversational understanding in young children. *Cognition.* 2009; 110: 115-122.

61. Bialystok E. *Bilingualism in development: Language, literacy, and cognition.* New York: Cambridge University Press; 2001.

62. Wagemaker H. Preliminary findings of the IEA: New Zealand achievement in the national and international context. *Educational Psychology.* 1992; 12: 195-214.

63. Carlson SM, Meltzoff AN. . Bilingual experience and executive functioning in young children. *Developmental Science.* 2008; 11: 282-298.