SCIENTIFIC ARTICLES & BRIEF COMMUNICATIONS

Maternal Self-Report of Oral Health in 4-Year-Old Pacific Children from South Auckland, New Zealand: Findings from the Pacific Islands Families Study

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Abstract

Objectives: *To report on the oral health risk in a disadvantaged group of 4-year-old Pacific children and their mothers living in South Auckland, New Zealand.* ***Methods:*** *The Pacific Islands Families study follows a cohort of Pacific infants born in 2000. Maternal self-report of mother and child's oral health practices and child's filling and extraction experience was undertaken at interview approximately 4 years postpartum.* ***Results:*** *Overall, 1,048 mothers of children were interviewed. Children's reported oral health practices were generally poor, with 47 percent brushing ≤1/day, 47 percent having no adult assistance with brushing, 57 percent routinely snacking or drinking immediately prior to bed, and 26 percent yet to receive their first dental checkup. Maternal practices were also poor, with 34 percent brushing ≤1/day and 50 percent having never seen or last visiting a dentist over 5 years ago. Significant differences were seen in many practices between the major ethnic subgroups. Of children attending the school dental service, 22 percent were reported having at least one filling and/or extraction. In multivariable analyses, variables corresponding to mother's toothbrushing frequency, child snacking or drinking prior to bed, and duration of breastfeeding were significantly associated with reported filling and/or extraction experience; but no difference was seen between the three major maternal ethnic subgroups.* ***Conclusions:*** *Many mothers and their Pacific children have poor basic oral hygiene and dietary practices that increase the oral health risk in these children. Culturally appropriate and targeted strategies aimed at these modifiable practices need to be widely promoted so that the oral health burden carried by Pacific children can be reduced.*

Key Words: epidemiology, early childhood caries, disparities, oral health, public health

Introduction

Despite substantial improvements in the oral health of many of the world's populations over the last 30 years, problems still persist. In 2000, the 53rd World Health Assembly (WHA) endorsed a global strategy for the prevention and control of noncommunicable diseases (resolution WHA 53.17) (1,2). Priority was given to addressing common, preventable, or modifiable behavioral and environmental risk factors, which impact health, including oral health (2). One of the World Health Organization's target groups for oral health promotion is children, as the burden of oral disease in this group is significant and has a lifetime impact on quality of life and general health (3).

A recent systematic review of 73 published studies identified 106 factors significantly related to the prevalence or incidence of caries in children aged ≤6 years (4). The review also found that children of ethnic minorities, indigenous peoples, and immigrant groups in developed countries have excess oral health risk. The burden of oral disease for these disadvantaged groups in both developing and developed countries is now recognized to be high, and that worldwide strengthening of public health programs for the prevention of oral disease and promotion of oral health is urgently needed (5,6).

Within the New Zealand context, improving oral health is one of the government's 13 health priorities (7). The importance of oral health in the young and the current ethnic disparities are also recognized (8,9). Pacific peoples are one of the fastest growing immigrant ethnic minorities, comprising 6.8 percent of the population, and Auckland is their preferred region of domicile (10). Pacific peoples are generally less advantaged in education, housing, and health compared to their non-Pacific counterparts (10). As such, Pacific people are frequently overrepresented in many adverse health and

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DOI: 10.1111/j.0022-4006.2007.00014.x

social risk factors (10,11) leading to Pacific infants' higher rates of hospitalization (11,12) and death (10). However, there is scant epidemiological information published on Pacific children's dental health status and the prevalence of their risk factors associated with oral diseases. This makes evaluation of policy implementation difficult to assess. Furthermore, there is no published information on the dental health status and associated risk factors for the Pacific subgroups [Samoans constitute the largest ethnic subgroup (50 percent), followed by Cook Island Maori (23 percent), and Tongans (18 percent)]. Yet each Pacific population has differing cultures, languages, strength of acculturation, and corresponding access to health and social services (13).

In 1993, Thomson reported on dental caries data for 3,283 5-year-old children from the Manawatu–Wanganui area of New Zealand, and found that 61.5 percent of European, 33.5 percent of Maori children, and 47.3 percent of Pacific children had never experienced dental caries (14). More recently, Lee and Dennison investigated dental records from 8,030 5-year-old children enrolled with the Canterbury and Wellington area School Dental Service (SDS) and found that oral health disparities were greater for Maori and Pacific children and those of low socioeconomic status. They reported that for children in nonfluoridated areas, 56.7 percent of non-Maori/non-Pacific children, as compared to 22.6 percent of Pacific children, were caries-free; while in fluoridated areas, 69.8 percent of non-Maori/non-Pacific children, as compared to 38.6 percent of Pacific children, were caries-free (15). When examining data from 5-year-old children living in Wellington over 1995 to 2000, Thomson and colleagues statistically demonstrated a widening of ethnic inequalities in caries severity but not prevalence among the children (16). Apart from children's sex, socioeconomic status, and fluoridation water status, a few other of the 106 factors previously demonstrated to be associated with the prevalence or incidence of caries in children aged under 6 years have been related to the oral health status of Pacific children in New Zealand (4,15,16).

Responding to Petelo and colleagues' request urging researchers to investigate Pacific people's oral health in New Zealand (17), and heeding the call of Hobdell and colleagues in their setting of global goals for oral health by the years 2020 (18), this study aims to report on the oral health risk in a disadvantaged group of 4-year-old Pacific children and their mothers within South Auckland, New Zealand. Another aim of this study is to report on differences between the major ethnic subgroups in order that the ethnic disparities may be better understood and this information used to inform targeted heath promotion strategies.

Methods

Data were collected as part of the Pacific Islands Families (PIF) study. This study follows a cohort of Pacific infants born at the Middlemore Hospital in South Auckland between March 15 and December 17, 2000. All potential participants were selected from births where the child had at least one parent who identified as being of Pacific Islands ethnicity and was also a New Zealand permanent resident. Recruitment occurred through the Birthing Unit in conjunction with the Pacific Islands Cultural Resource Unit and consent was sought from potential participants to make a home visit.

Approximately 6 weeks postpartum, trained female bilingual or multilingual interviewers of Pacific Islands ethnicity who were, where possible, ethnically matched to the potential participants visited mothers in their homes. Once eligibility was established and informed consent obtained, mothers participated in 1-hour interviews concerning the health and development of the child and family functioning. This interview was conducted in the preferred language of the mother and the survey instruments were made available in English, Samoan, Tongan, and Cook Island Maori. With consent, home visits were repeated approximately 1 year, 2 years, and 4 years postpartum. At the 6-week interview, 93 percent of mothers declared being of Pacific Islands ethnicity yet, of these, only 14 percent elected to use a Pacific language survey, and so all subsequent survey instruments were made available in English only. Compared with data available from Statistics New Zealand's 1996 and 2001 Censuses (13), the inception cohort was broadly representative of the Pacific census figures. Detailed information about the cohort, procedures, and data collection methods is described elsewhere (19).

Measures of Oral Health. All measures of oral health were ascertained from maternal reports made at the 4-year interview. Most questions had a dichotomous (yes/no) response, except child and maternal toothbrushing frequency (never, <1/day, 1/day, ≥2/day), child toothbrushing assistance (none, sometimes, mostly), age child first had his/her teeth checked (never checked, 1, 2, 3, 4 years), when mother last went to the dentist (never been, >5 years ago, ≤5 years ago), and reason for last dental visit (never been, routine checkup, relief of pain, other – specify).

Statistical Analysis. All infants who were singleton or first-born from multiple births were included in the analyses along with their mothers. Comparisons of categorical variables between the three major maternal ethnic subgroups were made using Fisher's exact test. Separate bivariable binary logistic regression models were used to relate available previously identified risk factors (4) to maternal reports of children's experience of fillings and extractions for those children who had attended the SDS at least once. To determine whether important differences existed between the three major maternal ethnic subgroups, multivariable binary logistic regres-

sion models were developed relating maternal reports of children's experience of fillings and extractions to mothers ethnic group controlling for potential risk factors identified in the bivariable analyses. Two parsimonious multivariable models were derived: one using backward elimination and one using stepwise selection procedures. The entry and exit significance level in the multivariable model development was 0.10 for all candidate variables except ethnicity, which was forced to stay in the model. Nagelkereke'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. SAS version 9.0 (SAS Institute Inc., Cary, NC) was used for all statistical comparisons, and the $\alpha = 5$ percent level was used to define statistical significance in all tests, except for the multivariable model development.

Ethics. Ethical approval was obtained from the Auckland Branch of the National Ethics Committee, the Royal New Zealand Plunket Society, and the South Auckland Health Clinical Board.

Results

In total, 1,708 mothers were identified, 1,657 invited to participate, 1,590 (96 percent) consented to an initial home visit and of these, 1,477 (93 percent) were eligible for the PIF study. Of those eligible, 1,376 (93 percent) mothers who had given birth to 1,398 infants participated in the 6-week interview. The 4-year interview was completed by 1,048 (76 percent) mothers, with a mean age 32.7 years (standard deviation 6.2 years). The infants' median age at interview was 4.0 years and 95 percent of interviews were completed with infants aged between 4.0 and 4.7 years. Table 1 gives the maternal and infant characteristics of the participants.

Table 1
Frequencies (Percentages) of Maternal and Infant Participant Characteristics

	n	(%)
Maternal characteristics		
Age (years)		
<25	121	(12)
25 to 29	287	(27)
30 to 34	252	(24)
35 to 39	251	(24)
≥40	137	(13)
Ethnicity		
Samoan	475	(45)
Tongan	224	(21)
Cook Island Maori	186	(18)
Other Pacific*	87	(8)
Non-Pacific†	76	(7)
Marital status		
Partnered	821	(78)
Single	227	(22)
Birthplace		
New Zealand	359	(34)
Elsewhere	689	(66)
Smoking status‡		
Nonsmoker	699	(67)
Smoker	341	(33)
Highest educational qualification at child's birth		
Postsecondary	302	(29)
Secondary	369	(35)
No formal qualifications	377	(36)
English fluency at child's birth		
Proficient	667	(64)
Otherwise	381	(36)
Household income (NZD) at child's birth		
≤$20,000	330	(31)
$20,001 to $40,000	550	(52)
>$40,000	133	(13)
Unknown	35	(13)
Infant characteristics		
Sex		
Female	511	(49)
Male	537	(51)
Multiplicity of birth		
Singleton	1,028	(98)
Twin	20	(2)

* Includes mothers identifying equally with two or more ethnic groups.
† Includes non-Pacific mothers who were eligible through the Pacific ethnicity of the father.
‡ Eight observations missing.

Maternal Self-Reported Measures of Oral Health. Maternally reported oral health practices appear in Table 2, together with these practices partitioned by the three major maternal ethnic subgroups. Nearly half (47 percent) of the children usually brushed their teeth ≤1 times/day, 47 percent had no assistance with their toothbrushing, and most (57 percent) snacked or drank something other than water just before going to bed. Overall, 31 percent were not enrolled with the SDS and of these, 54 percent responding mothers did not know that preschool children could enroll in this service free of charge. Mothers reported that 14 percent of children previously had fillings and 4 percent had extractions. Most children had

Table 2
Frequencies (Percentages) of Maternally Reported Oral Health Practices and Status of Their 4-Year-Old Pacific Children as a Group and Partitioned by the Three Major Maternal Ethnic Subgroups

	Total		Samoan		Tongan		Cook Island Maori		
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*P*-value*
Child's oral health									
Toothbrushing frequency (per day)									
<1	57	(5)	19	(4)	8	(4)	18	(10)	0.007
1	439	(42)	188	(40)	108	(48)	79	(42)	
>1	552	(53)	268	(56)	108	(48)	89	(48)	
Toothbrushing assistance provided									
Never	491	(47)	251	(53)	78	(35)	93	(50)	<0.001
Sometimes	401	(38)	172	(36)	107	(48)	59	(32)	
Mostly	153	(15)	52	(11)	39	(17)	33	(18)	
Does your child snack or drink (other than water) just before going to bed?									
No	449	(43)	245	(52)	59	(26)	68	(37)	<0.001
Yes	598	(57)	230	(48)	164	(74)	118	(63)	
Is your child enrolled with the school dental service?									
No	324	(31)	155	(33)	57	(26)	62	(33)	0.12
Yes	722	(69)	320	(67)	166	(74)	124	(67)	
Has your child ever had dental treatment?									
No	850	(82)	379	(81)	184	(83)	147	(81)	0.90
Yes	184	(18)	87	(19)	39	(17)	35	(19)	
Has your child ever had filling(s)?									
No	889	(86)	396	(85)	192	(86)	156	(86)	0.94
Yes	145	(14)	70	(15)	31	(14)	26	(14)	
Has your child ever had extraction(s)?									
No	996	(96)	445	(95)	214	(96)	176	(97)	0.83
Yes	38	(4)	21	(5)	9	(4)	6	(3)	
Has your child ever had filling(s) or extraction(s)?									
No	871	(84)	388	(83)	186	(83)	153	(84)	0.99
Yes	163	(16)	78	(17)	37	(17)	29	(16)	
Has your child ever had dental treatment under general anesthetic?									
No	986	(95)	442	(95)	214	(96)	170	(93)	0.51
Yes	48	(5)	24	(5)	9	(4)	12	(7)	
Age that child's teeth were first checked (years)									
Never checked	271	(26)	129	(28)	51	(23)	54	(29)	0.45
1	90	(9)	31	(7)	17	(8)	12	(6)	
2	285	(27)	117	(25)	68	(30)	53	(28)	
3	377	(36)	181	(39)	87	(39)	64	(34)	
4	17	(2)	11	(2)	1	(0)	3	(2)	
Maternal oral health									
Toothbrushing frequency (per day)									
<1	28	(3)	10	(2)	1	(0)	10	(5)	0.03
1	324	(31)	152	(32)	74	(33)	54	(29)	
>1	688	(66)	308	(66)	147	(66)	121	(65)	
When was your last dental visit?									
Never been	171	(16)	100	(21)	48	(21)	14	(8)	<0.001
>5 years ago	349	(33)	167	(35)	69	(31)	59	(32)	
≤5 years ago	527	(50)	207	(44)	107	(48)	113	(61)	
Reason for last dental visit									
Never been	171	(16)	100	(21)	48	(21)	14	(8)	<0.001
Routine checkup	255	(24)	121	(26)	38	(17)	42	(23)	
Relief of pain	268	(26)	108	(23)	88	(39)	41	(22)	
Treatment	351	(34)	143	(30)	50	(22)	89	(48)	

* *P*-values calculated using Fisher's exact test.

their first teeth checkup at 2 years (27 percent) or 3 years of age (36 percent), but many (26 percent) were yet to receive their first checkup. In the ethnic subgroup analysis, statistically significant differences emerged between maternal reports of children snacking or drinking something other than water prior to going to bed and the likelihood of child toothbrushing assistance. Specifically, 74 percent of Tongan mothers reported that their children snacked or drank something other than water prior to going to bed, compared with 48 percent of Samoan and 63 percent of Cook Island Maori mothers, while 65 percent of Tongan mothers reported mostly or sometimes providing toothbrushing assistance, compared with 47 percent of Samoan and 53 percent of Cook Island Maori mothers.

In terms of maternal oral health practices, just over a third (34 percent) of mothers usually brushed their teeth ≤1 times/day, 50 percent had never been or last saw a dentist over 5 years ago, and only 24 percent last saw their dentist for a routine checkup. Significant differences emerged between the three major maternal ethnic subgroups for all the considered maternal oral heath practices. Some 61 percent of Cook Island Maori mothers reported visiting a dentist ≤5 years ago compared with 44 percent of Samoan and 48 percent of Tongan mothers. Of those who had consulted a dentist within the past 5 years, 52 percent of Cook Island Maori mothers said the reason was for treatment, compared with 38 percent of Samoan and 28 percent of Tongan mothers.

Maternal Self-Report of Children's SDS and Dental Treatment History. Maternal reports of children's filling and extraction experience were available for 722 (69 percent) children whose mothers indicated they were enrolled in the SDS. Children were partitioned into dichotomous groups: those whose mothers reported that their children never had any fillings or extractions (n = 563, 78 percent) and those whose mothers reported that they had at least one filling or extraction (n = 159, 22 percent). These groups were then related to available previously identified risk factors for early childhood caries (4). Table 3 includes

Table 3
Frequencies (Percentages) of Previously Identified Oral Health Risk Factors Related to Maternal Reports of Children's Filling(s) and Extraction(s) Status at 4 Years of Age, Together With Associated Estimates of the Odds Ratios (ORs), 95% Confidence Intervals (95% CI), and *P*-Values Derived from Bivariable Logistic Regression Models

	Total	Filling(s) or extraction(s)				
	n	*n*	(%)	OR	(95% CI)	*P*-value*
Oral hygiene						
Child's toothbrushing frequency (per day)						
>1	404	79	(20)	1.0		0.07
≤1	318	80	(25)	1.4	(1.0, 2.0)	
Toothbrushing assistance for child						
Mostly	110	28	(25)	1.0		0.65
Sometimes	285	61	(21)	0.8	(0.5, 1.3)	
Never	326	70	(21)	0.8	(0.5, 1.3)	
Age child's teeth first checked (years)						
≤2	357	81	(23)	1.0		0.66
>2	361	77	(21)	0.9	(0.6, 1.3)	
Mother's toothbrushing frequency (per day)						
>1	498	95	(19)	1.0		0.003
≤1	220	64	(29)	1.7	(1.2, 2.5)	
Mother's last dental visit						
≤5 years ago	385	91	(24)	1.0		0.51
>5 years ago	221	46	(21)	0.8	(0.6, 1.3)	
Never been	115	22	(19)	0.8	(0.5, 1.3)	
Mother's reason for last dental visit						
Routine checkup	173	32	(18)	1.0		0.17
Relief of pain	190	40	(21)	1.2	(0.7, 2.0)	
Treatment	243	65	(27)	1.6	(1.0, 2.6)	
Never been	115	22	(19)	1.0	(0.6, 1.9)	
Dietary factors						
Does your child snack or drink (other than water) just before going to bed?						
No	311	58	(19)	1.0		0.05
Yes	410	101	(25)	1.4	(1.0, 2.1)	

Table 3 *Continued*

	Total	Filling(s) or extraction(s)				
	n	*n*	(%)	OR	(95% CI)	*P*-value*
Does your child have set times for snacks?						
Yes	439	87	(20)	1.0		0.08
No	283	72	(25)	1.4	(1.0, 2.0)	
Duration of any breastfeeding (weeks)						
≤6	34	3	(9)	0.2	(0.1, 0.8)	0.004
7 to 52	434	82	(19)	0.6	(0.4, 0.9)	
>52	228	65	(29)	1.0		
Age that formula milk or other milk introduced (weeks)						
≤12	277	50	(18)	1.0		0.009
>12	279	58	(21)	1.2	(0.8, 1.8)	
Never introduced	138	43	(31)	2.1	(1.3, 3.3)	
Age that solid foods introduced (months)						
≤3	103	19	(18)	1.0		0.58
4 to 6	487	111	(23)	1.3	(0.8, 2.2)	
>6	103	21	(20)	1.1	(0.6, 2.3)	
Sociodemographic factors						
Maternal age (years)						
<25	76	21	(28)	1.4	(0.7, 2.8)	0.79
25 to 29	188	40	(21)	1.0	(0.5, 1.8)	
30 to 34	181	40	(22)	1.0	(0.6, 1.9)	
35 to 39	180	37	(21)	0.9	(0.5, 1.7)	
≥40	97	21	(22)	1.0		
Mother's ethnicity						
Pacific	672	154	(23)	2.7	(1.0, 6.8)	0.04
Non-Pacific†	50	5	(10)	1.0		
Marital status						
Partnered	572	127	(22)	1.0		0.83
Single	150	32	(21)	1.0	(0.6, 1.5)	
Maternal smoking status						
Nonsmoker	497	113	(23)	1.0		0.30
Smoker	218	42	(19)	0.8	(0.5, 1.2)	
Mother's highest educational qualification at child's birth						
Postsecondary	228	49	(21)	1.0		0.55
Secondary	251	51	(20)	0.9	(0.6, 1.4)	
No formal qualifications	243	59	(24)	1.2	(0.8, 1.8)	
Household income (NZD) at child's birth						
Unknown	20	1	(5)	0.2	(0.0, 1.8)	0.23
≤$20,000	222	48	(22)	1.2	(0.7, 2.2)	
$20,001 to $40,000	378	91	(24)	1.4	(0.8, 2.4)	
>$40,000	102	19	(19)	1.0		
Infant's sex						
Female	349	79	(23)	1.0		0.70
Male	373	80	(21)	0.9	(0.7, 1.3)	
Other factors						
Does the child suck a pacifier at 2-year interview?						
No	677	148	(22)	1.0		0.86
Yes	15	3	(20)	0.9	(0.2, 3.2)	
Reported occurrence of headaches in the child						
No	655	145	(22)	1.0		0.82
Yes	67	14	(21)	0.9	(0.5, 1.7)	
Reported that child is too shy or timid						
No	389	76	(20)	1.0		0.08
Yes	332	83	(25)	1.4	(1.0, 2.0)	
Reported that child sleeps less than most children						
No	604	127	(21)	1.0		0.13
Yes	117	32	(27)	1.4	(0.9, 2.2)	

* *P*-values calculated from Wald's χ^2 test.

† Includes non-Pacific mothers who were eligible through the Pacific ethnicity of the father.

the frequencies and percentages of these associations, together with the odds ratios (OR) and associated 95 percent confidence intervals from the separate bivariable logistic regression models relating the risk factors to the children's reported oral health experience.

In terms of oral hygiene, mother's toothbrushing frequency ≤1 times/day (OR = 1.7) but not child's brushing frequency ≤1 times/day (OR = 1.4) was significantly associated with an increased odds of reported filling and/or extraction experience compared with those brushing >1 times/day. For the dietary factors, children snacking or drinking prior to bed was associated with an increased odds of filling and/or extraction experience (OR = 1.4), compared to those neither snacking nor drinking before bed. While the age that solid foods were introduced into the child's diet had no association with reported filling and/or extraction experience, both prolonged duration of breastfeeding and older age that formula or other milks were introduced into the child's diet were significantly associated with the increased likelihood of such an experience. None of the sociodemographic variables were significantly associated with filling and/or extraction experience. However, children of Pacific mothers were 2.7 times as likely as children of non-Pacific mothers to have filling and/or extraction experience.

When investigating maternal reports of children's filling and extraction experience for the three major maternal ethnic subgroups, there was no different in the crude bivariable analysis (see Table 4). Using candidate variables with *P*-value ≤0.10 in Table 3, two parsimonious multivariable models were derived: one using backward elimination and one using stepwise selection. Both methods yielded the same final model, which included variables corresponding to mothers' toothbrushing frequency, child snacking or drinking prior to bed, and duration of breastfeeding. While this multivariable model had adequate goodness-of-fit (Hosmer–Lemeshow goodness-of-fit *P*-value = 0.39), maternal ethnicity remained nonsignificant ($P = 0.74$), and the model explained only 5.8 percent of the variability in the children's filling and extraction experience.

Discussion

Consistent with international evidence (20), it is recommended in New Zealand that preschool children brush their teeth at least twice daily with adult assistance. This brushing frequency and assistance has been associated with reduced caries risk (21,22). However, nearly half the children in this study had toothbrushing frequencies less than this recommendation, and only 15 percent of children were assisted by an adult on most occasions. It is also recommended that the last toothbrushing episode occurs immediately prior to bed (20,21,23). Yet in this sample, 57 percent of children routinely had snacks or nonwater drinks before going to bed, thereby predisposing themselves to increased caries risk.

Many maternal self-reported oral health practices were also inconsistent with dental recommendations. Overall, 33 percent of mothers reported brushing frequencies less than the recommended twice daily, 50 percent had never been to or last saw a dentist over 5 years ago (annual visits are internationally recommended), and only 24 percent of mothers last attended the dentist for a checkup, signifying that symptomatic visits predominate. Various recommendations have been made to inform, support, and engage Pacific people with oral health care in New Zealand, both as users and deliverers (24). More efficacious approaches are essential in order to address the poor dental and oral health behaviors of Pacific mothers and children identified in this study.

A notable finding in this study was the ethnic differences in children's and maternal oral health practices. These finding have two important implications: first, ethnic differences in oral heath behaviors need to be recognized and understood so that culturally specific promotion strategies to increase oral health awareness and practices can

Table 4
Frequencies (Percentages), Estimates of the Odds Ratios (OR), 95% Confidence Intervals (95% CI), and *P*-Values for the Association between Maternal Report of Children's Filling(s) and Extraction(s) Status at 4 Years of Age for the Three Major Maternal Ethnic Subgroups

Mother's ethnicity	*n*	Filling(s) or extraction(s) *n* (%)	Crude model			Adjusted model*		
			OR	(95% CI)	*P*-value†	OR	(95% CI)	*P*-value†
Samoan	320	78 (24)	1.0		0.79	1.0		0.74
Tongan	166	37 (22)	0.9	(0.6, 1.4)		0.9	(0.5, 1.4)	
Cook Island Maori	124	27 (22)	0.9	(0.5, 1.4)		0.8	(0.5, 1.4)	
			Nagelkereke R^2 = 0.1% Hosmer–Lemeshow goodness-of-fit *P*-value = 0.99			Nagelkereke R^2 = 5.8% Hosmer–Lemeshow goodness-of-fit *P*-value = 0.39		

* Adjusted for mothers' toothbrushing frequency, child snacking or drinking prior to bed, and duration of breastfeeding.
† *P*-values calculated from Wald's χ^2 test.

be developed; and second, oral health statistics for Pacific Island ethnic groups should sometimes be reported separately rather than collapsed under a "Pacific" banner. The broad Pacific label serves to disguise the heterogeneity of oral health and behaviors within the Pacific population resident in New Zealand and important subgroup information vital for informing effective health promotion strategies is lost (25).

In this PIF study, 69 percent of children were reported as being enrolled in the SDS, a figure considerably higher than the 37 percent of Auckland preschool children (0 to 4 years) enrolled in SDS (26). However, as this study investigated children who were 4 years of age rather than spanning the 0 to 4 years age bracket, and SDS attendance is age dependent, the percentage observed in this study appears reasonable. Relatively few children were reported by their mothers to have had fillings (14 percent) or extractions (4 percent) compared to published Auckland data of caries prevalence in preschool (28 percent) and 5-year-old (50 percent) Pacific children (26). However, this does not necessarily imply that the children in this study had lower caries experience, as many children (26 percent) had never had their teeth checked and some may have developed caries since their most recent visit. Few (9 percent) children in this study had their teeth first checked within the first years of life, as recommended by international pediatric dental organizations (27).

When relating previously identified risk factors for caries (4) to maternal self-report of their child's dental restoration and tooth extraction experience, the estimated effect size directions were generally consistent with the literature. Maternal toothbrushing frequencies less than twice daily were significantly associated with past treatment. Given the large number of study participants brushing less than the recommended frequency (44 percent of mothers and 47 percent of the children, respectively), a targeted heath promotion message primarily aimed at this preventative strategy alone might considerably reduce the prevalence and severity of caries in this population. Dietary factors and behaviors were also significantly associated with children having had previous treatment, including snacking or drinking prior to bed, prolonged duration of breastfeeding, and whether formula or other milks were introduced. Again, with the large numbers of children snacking or drinking prior to bed (57 percent), this behavior should be targeted to reduce caries risk in many children.

While statistically significant, the relationship between breastfeeding and formula feeding to reported restorations/extraction experience is less clear. A recent systematic review found that the evidence of an association between breastfeeding duration and development of childhood caries is inconsistent (28). Indeed, these reviewers concluded that the suggested association between breastfeeding and caries is likely explained by other dietary factors not accounted for in the design of the studies (28). Only a specifically designed longitudinal study that accurately maps all components of infant's diets, the precise times foods/liquids are introduced, the method of delivery (i.e., in bottles/cups/spoons), and other relevant confounding variables onto an appropriately collected measure of dental health status will be able to establish a causal association. Unfortunately, such detailed information was not collected for the purpose of this study.

None of the previously described sociodemographic factors were globally significantly related to restorations/extraction experience in this sample. However, children of non-Pacific mothers were at significantly less odds of fillings and/or extractions than children of Pacific mothers. As many of the non-Pacific mothers were European (eligible to enroll in the study through the Pacific ethnicity of their partner), this ethnicity difference is consistent with the findings reported in New Zealand previously (15,16,26). However, in crude and multivariable analyses, no difference was seen between restoration/extraction experience between the three major maternal ethnic subgroups.

While the PIF study has many strengths, including its large sample size, representative inception cohort, high retention rate, nondifferential attrition, and longitudinal design (19), it also has weaknesses. Arguably, the most important limitation is the lack of reliable measures of caries experience [such as decayed, missing, and filled teeth (dmft) indices] and of oral health and dietary behaviors. Maternal report of their child's restorations and extractions dental history and of oral health and dietary behaviors is subject to recall and social desirability biases. That is, mothers may forget or report histories and behaviors in a way they believe to be socially acceptable or appropriate rather than accurate. Another issue is misclassification bias. In particular, children with caries may be misclassified as being caries-free if they had never visited a dental service and had undiagnosed and untreated caries, had incomplete treatments, or had caries develop since their most recent dental visit. While we limited this analytic sample to those reported to have attended the SDS at least once in logistic regression, the misclassification bias associated with postdental visit caries development remains. These misclassification and social desirability biases are likely to reduce effect sizes, dilute the statistical power in finding significant associations, and may partially explain the relatively few significant associations observed between restoration/extraction experience and predicted risk factors. However, the effect size and significance of the restoration/extraction experience between the Pacific and predominantly European non-Pacific mothers is consistent dmft data reported previously, and strengthens the validity of this study's findings.

The oral health of New Zealand's Pacific children is poor (15,26) and

the ethnic inequalities are worsening (16). The majority of mothers do not enroll their Pacific child with the SDS by age 1 year, and most have oral hygiene and dietary practices that do not meet national recommendations. So while we applaud the government in recognizing the importance and priority setting of oral health and its services (7), we also believe that it is timely for these most basic oral hygiene and dietary practices to be widely promoted – targeting Pacific mothers. We believe that community-based oral health promotion and prevention strategies focusing on a common risk factor approach and involving a range of allied health providers could reduce the dental health burden across the young and old alike. This approach is articulated in the Pacific Health and Disability Action Plan (29) and is endorsed by many Pacific communities and organizations. Through culturally appropriate health promotion strategies targeting these modifiable or preventable risk factors, oral health disparities could be moderated and conceivably eliminated.

Acknowledgments

The authors gratefully acknowledge the families who participated in the study, the Pacific Peoples Advisory Board, and the other members of the PIF research team.

References

1. Resolution WHA 53.17. World Health Assembly resolutions and decisions (document wha53/2000/REC/1). Geneva: WHO; 2000.
2. Petersen P. The world oral health report 2003. Geneva: WHO; 2003.
3. World Health Organization. Important target groups. Geneva: WHO; 2006 [cited 2006 May 30]. Available from: http://www.who.int/oral_health/action/groups/en
4. Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. Community Dent Health. 2004; 21:S71-85.
5. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ. 2005; 83:661-9.
6. Pine CM, Adair PM, Nicoll AD, Burnside G, Petersen PE, Beighton D, Gillett A, Anderson R, Anwar S, Brailsford S, Broukal Z, Chestnutt IG, Declerk D, Ping FX, Ferro R, Freeman R, Gugushe T, Harris R, Lin B, Lo EC, Maupome G, Moola MH, Naidoo S, Ramos-Gomez F, Samaranayake LP, Shahid S, Skeie MS, Splieth C, Sutton BK, Soo TC, Whelton H. International comparisons of health inequalities in childhood dental caries. Community Dent Health. 2004;21:S121-30.
7. Ministry of Health. Good oral health for all, for life: the strategic vision for oral health in New Zealand. Wellington: Ministry of Health; 2006.
8. New Zealand Labour Party. Revamping dental services for young NZers [press release]. Wellington: New Zealand Labour Party; 2005 [cited 2006 May 30]. Available from: http://www.labour.org.nz/news/ latest_labour_news/news-050831c/index.html
9. Hagre K, Kiro C, Stewart L, Logan R, Forgere G, Pearce N. Improving oral health inequalities. Wellington: Public Health Advisory Committee, National Advisory Committee on Health and Disability; 2003.
10. Statistics New Zealand. Pacific progress: a report on the economic status of Pacific peoples in New Zealand. Wellington: Statistics New Zealand; 2002.
11. Bathgate M, Donnell A, Mitikulena A. The health of Pacific Islands people in New Zealand. Analysis and monitoring report 2. Wellington. Public Health Commission. 1994.
12. Tukuitonga CR, Bell S, Robinson E. Hospital admission among Pacific children Auckland 1992–97. N Z Med J. 2000; 113:358-61.
13. Statistics New Zealand. New Zealand census of population and dwellings 2001: Pacific peoples. Wellington: Statistics New Zealand; 2002.
14. Thomson WM. Ethnicity and child dental health status in the Manawatu-Wanganui Area Health Board. N Z Dent J. 1993;89: 12-4.
15. Lee M, Dennison PJ. Water fluoridation and dental caries in 5- and 12-year-old children from Canterbury and Wellington. N Z Dent J. 2004;100:10-5.
16. Thomson WM, Williams SM, Dennison PJ, Peacock DW. Were NZ's structural changes to the welfare state in the early 1990s associated with a measurable increase in oral health inequalities among children? Aust N Z J Public Health. 2002; 26:525-30.
17. Petelo J, Jamieson L, Ayers K. Oral health and dental attendance patterns of Pacific people in Christchurch, New Zealand. N Z Dent J. 2004;100:82-7.
18. Hobdell M, Petersen PE, Clarkson J, Johnson N. Global goals for oral health 2020. Int Dent J. 2003;53:285-8.
19. Paterson J, Tukuitonga CR, Abbott M, Feehan M, Silva PA, Percival T, Carter S, Cowley-Malcolm E, Borrows J, Williams M, Schluter P. Pacific Islands families first two years of life study: design and methodology. N Z Med J [serial on the Internet]. 2006 [cited 2006 Nov 7];119:U1814. Available from: http://www.nzma.org.nz/journal/119-1228/1814/content.pdf
20. Scottish Intercollegiate Guidelines Network. Prevention and management of dental decay in the pre-school child. Edinburgh: SIGN; 2005.
21. Ministry of Health. School dental service guidelines: use of fluorides. Wellington: Ministry of Health; 2004.
22. Wendt LK, Hallonsten AL, Koch G, Birkhed D. Oral hygiene in relation to caries development and immigrant status in infants and toddlers. Scand J Dent Res. 1994;102:269-76.
23. Davies RM, Davies GM, Ellwood RP. Prevention. Part 4: toothbrushing: what advice should be given to patients? Br Dent J. 2003;195:135-41.
24. Lindberg K. Counties Manukau oral health plan. Auckland: Counties Manaukau District Health Board; 2005.
25. Tukuitonga C, Finau SA. The health of Pacific people in New Zealand up to the early 1990's. Pac Health Dialog. 1997;4: 59-67.
26. Galgali G, Jack F. An update: dental health status of children in the Auckland region. Auckland: Waitemata District Health Board; 2004.
27. American Academy of Pediatric Dentistry. Guideline on periodicity of examination, preventive dental services, anticipatory guidance, and oral treatment for children. Pediatr Dent. 2003;25:S84-6.
28. Valaitis R, Hesch R, Passarelli C, Sheehan D, Sinton J. A systematic review of the relationship between breastfeeding and early childhood caries. Can J Public Health. 2000;91:411-17.
29. Ministry of Health. The Pacific health and disability action plan. Wellington: Ministry of Health; 2002.