Dietary Intake in Infants and Young Children in the Marshall Islands

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ABSTRACT
Changes in traditional foodways associated with increasing modernization have affected the feeding patterns of infants and young children. Declines in the duration of exclusive breastfeeding have been associated with poor nutritional status and increased morbidity from infectious diseases. We conducted a cross-sectional survey of dietary intake in children under six in four settings in the Republic of the Marshall Islands in Micronesia. The mean duration of breastfeeding in the sample was 11 months, however only 16% of subjects were exclusively breastfed for the first six months, which is recommended by the WHO, UNICEF and other policymakers. Among non-exclusively breastfed infants, supplemental foods were introduced as early as 2 months. Mean intakes for total energy, protein, carbohydrates, fat and iron were calculated for subjects providing recalls. Intake levels for energy, protein, carbohydrates and iron varied by location. Recommendations for future research and program intervention are outlined.

Key Words: *Dietary intake, breastfeeding, weaning, nutritional status, infants, children, Micronesia, foodways*

Introduction

Throughout the developing world, modernization and increasing reliance upon the global economy has effected significant change in traditional foodways, and consequently, infant and child feeding patterns. Of particular concern has been a shift from breast to bottle-feeding, despite policy guidelines from the World Health Organization, UNICEF, and the American Academy of Pediatrics that support six months of exclusive breastfeeding[1,2,3]. Inadequate breastfeeding, premature introduction and increased feeding of complementary foods have been associated with increases in early childhood morbidity and declines in nutritional status[4,5].

Research was conducted in the Republic of the Marshall Islands (RMI) to examine breastfeeding practices and child and infant feeding patterns in settings representing a continuum of exposure to western, "modernizing" influences. The objectives of this paper are to:[1] describe infant and early childhood feeding in a Micronesian society undergoing significant change in traditional foodways; and[2] examine specific nutrient intake patterns in preschool children in urban and remote locations.

The social, demographic, economic, and nutritional transitions documented throughout Oceania have begun to affect this small island nation where under- and over-nutrition are both prevalent[6,7,8]. In children <5, under-nutrition accounted for 17% of reported deaths in the 1990s[9]. Nutritional survey data suggest that micronutrient deficiency is also a significant public health problem among preschool children in the RMI[10,11,12]. While a significant body of infant and child feeding data exists for other islands in the region, recent data for the RMI are limited[13].

Methods

Study Population.

RMI comprises 28 atolls and many small islets in northeastern Micronesia. While RMI has an estimated area of 750,000 square miles, its dry-land mass totals only 72 square miles[14,15]; the majority of inhabited atolls are quite isolated and distant from the two "urban" centers on Majuro and Kwajalein atolls. Western influences affecting indigenous cultural patterns and foodways vary considerably within and between atolls.

On the two "urban" atolls, imported foods are available through retail and wholesale outlets. Neighbourhood grocery stores and kiosks supply a large variety of "western" foods; white rice, canned meats and fish, snack foods and soda are ubiquitous. Large and small retailers commonly stock and sell outdated or expired goods. Individual retailers' prices vary, but generally run 30-40% higher than stateside.

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Neighbourhood grocers commonly sell expensive items in smaller quantities than the supermarkets (e.g., single servings of alcohol, tobacco products, prepared lunch "plates" and other homemade snacks) and most carry snack foods, canned goods and infant formula. The inventories of outer island kiosks are limited to "essential" goods such as rice, white flour, white sugar, canned meat, cooking oil, matches, fuel, soda, snack foods and cigarettes.

Most stores stock a limited selection of imported produce and local agricultural products such as coconut, breadfruit, pandanus, banana, taro, arrowroot, yam, pumpkin, papaya and mango. In addition to countless aquatic species, domesticated pig and chicken may also be purchased at local supermarkets.

The Sample.

This study employed a cross-sectional survey design. Sites were selected purposively to represent a range in population density and degree of urbanization. The most "urban" site, Majuro, is the nation's capital; Laura is a peri-urban area on the Majuro atoll 20 miles west of the capital and the atoll's center of agricultural production. Arno and Namdrik atolls, which have no electricity, public water and sanitation infrastructure were selected as "remote" research sites.

Households, defined as the group of people who regularly eat from the same cook house or "*ainbat*" [iron pot], were identified through a multi-stage sampling procedure[16]. Subjects < 72 months were identified from a subset of 89 households from four sites on three atolls (Table 1). Informed consent was granted by participants in each household

Table 1. Characteristics of Study Sample (n=150)

	N	%
Community		
Rita (Urban)	62	41.3
Laura (Peri-urban)	41	27.3
Arno (Semi-remote)	16	10.7
Namdrik (Remote)	31	20.7
Sex		
Male	79	52.7
Female	71	47.3
Age Group (months)		
Birth to 11.99	14	9.3
12-23.99	35	23.3
24-35.99	29	19.3
36-47.99	21	14.0
48-59.99	32	21.3
60-71.99	19	12.7

Survey Components.

The survey consisted of four data components: socio-demographic, infant feeding history, 24-hour dietary recall, and anthropometry. The first three components will be addressed in this paper.

Demographic data.

Demographic data were collected through a series of 2-5 interviews with the child's primary caregiver (PC) conducted in Marshallese (Table 2).

Infant Feeding History.

An infant feeding history was conducted with each child's PC. Topics included commencement, duration and exclusivity of breastfeeding; utilization and duration of formula feeding; age at introduction and types of early weaning foods. A series of "data-checks" and "probes" were included to ascertain if breastfeeding was the "exclusive" or "predominant" mode of nutrition during the period stated. Variables such as duration of breast and/or bottle-feeding were calculated from the responses to questions on commencement and cessation of breast/bottle feeding. Recipes for traditional weaning foods were collected in each setting.

Table 2. Demographic Characteristics of Subject's Primary Caregiver

	N	%	Mean (s.d.)
Child/Caregiver Relationship	150	100	
Birth Mother	113	75.3	
"Adoptive mother"	19	12.6	
Grandmother	14	9.3	
Other	4	2.7	
Caregiver Age	97	100	31.34 (9.7)
25th percentile	24	24.7	21.37 (1.7)
50th percentile	25	25.8	27.05 (1.0)
75th percentile	24	24.7	32.01 (2.7)
100	24	24.7	45.10 (7.7)
Marital Status	95	100	
Married	35	36.8	
Koba	47	49.5	
Other	13	13.7	
(Single/widowed/separated)			
Parity	96	100	4.02 (2.9)
0-1	19	19.8	
2-3	33	34.4	
4-6	27	28.2	
>6	17	17.7	
Educational Level (Yrs)	94	100.0	9.71 (2.6)
0-8	31	33.0	
9-12	57	60.6	
≥13	6	6.4	

Twenty-four Hour Dietary Recalls.

Three 24-hour dietary recalls were conducted with the PC providing a proxy recall for the subject child. The recalls were conducted on non-consecutive days, using a standardized data collection form. Local utensils and serving dishes were used as recall aids, and the volume of each item was measured using standardized measuring implements. Actual-size food photographs of standard servings were used to validate reported amounts. For each food item, the respondents were asked: food name, brand name if applicable, quantity/serving size, preparation method, amount of serving consumed, and whether the child shared a plate or had his/her own. Breastfeeding mothers were asked to estimate the frequency and duration of feeding episodes, however neither breast milk volume nor estimated nutrient content were included in the dietary analyses due to the difficulty in estimating volume.

Coding and Entry of Dietary Data.

All dietary data were coded and entered into ESHA Food Processor™ (ver. 7.50), a nutritional analysis software program. Recipes for common dishes were collected from respondents and key informants. Mixed recipes were entered as food lists and converted to food items. For commonly consumed indigenous mixed recipes an average recipe was used unless the ingredients were provided for that household's recipe. Nutrient data from The Pacific Islands Food Composition Tables were used[17] for indigenous foods.

Multiple, in-depth interviews were conducted with key informants on Majuro and Arno[18,19] on the nature and composition of weaning foods. Systematic interviewing techniques were used to explore the cultural domain of "weaning foods"[20]. These procedures were used to both generate explanatory hypotheses and to provide an "ethnographic picture" of emic beliefs that could provide context for the quantitative survey data.

Statistical Analyses.

Survey data were managed using Microsoft Access 97® and SPSS 7.5® was used for statistical analyses. Qualitative data were analyzed using Anthropak®. Individual nutrient means are the average of each individual's one-day recalls. Analysis of variance (ANOVA) procedures were conducted to evaluate the equality of group means for dependent variables and inter- versus intra-subject variation of group nutrient intakes. *Post hoc* multiple comparisons were made using Bonferroni's test. The chi-square test for independence was applied to nominal variables.

Results

Infant feeding histories were completed or 137 of 150 subjects (Table 3). Among (ever) breastfed children (n=126), the duration of breastfeeding ranged from 1 to 30 months across sites. Subjects were classified as exclusively breastfed (EBF) if they received no alimentation other than breastmilk, including water. Non-EBF subjects received water or other breastmilk supplements. Overall, the duration of exclusive breastfeeding was 2.45 months; 16.4% of subjects were breastfed exclusively until six months. The youngest quartiles of caregivers had significantly lower parities than the oldest caregivers (2.79 vs. 6.11, p<.001) and breastfed their children significantly longer (12.64 vs. 8.01 months p<.001); this may reflect fewer competing demands on these caregivers within the household from other siblings. No statistically significant differences were found in the PC's education level, nor in the number of children in the household between EBF and non-EBF subjects.

Table 3. Infant Feeding Characteristics (n=126)

Breastfeeding Type	Months of Exclusive Breastfeeding	Age Non-Breastmilk Liquids Introduced (months)	Age Weaning Foods (months)	Total Duration of Breastfeeding (months)
Exclusively BF >= 6 mo (n=22)*	5.92* (0.38)	6.00 (0.00)	6.10 (0.44)	11.59 (7.66)
Non-Exclusively BF (n=104)	1.72 (1.80)	1.80 (1.88)	5.00 (1.14)	10.54 (8.09)
Total (n=126)	2.45 (2.30)	2.34 (2.25)	5.18 (1.13)	10.72 (8.00)
Significance	.0001	.0001	.0001	NS

* Includes one EBF 4- month old infant

The duration of EBF also varied across locales; pairwise comparison of mean differences in duration of exclusive breastfeeding between Laura and Namdrik were found to be significant at p<.05. No locale-BF type interactions were found. The duration of exclusive breastfeeding among infants who were not exclusively breastfed for the recommended six-month period was significantly longer in Laura than in either Rita or Namdrik (Table 4).

Table 4. Months Exclusive Breastfeeding by Atoll and Breastfeeding Type

ATOLL (n)	EBF Infants (duration in months)	Non-EBF Infants (duration in months)	Mean
Rita (Urban) (n=55)	5.84	1.63	2.47
Laura (Peri-urban) (n=16)	6.00	3.17*	3.88*
Arno (Semi-remote) (n=32)	6.00	1.83	2.22
Namdrik (Remote) (n=23)	6.00	0.84*	1.90*
Total (n=126)	5.92	1.72	2.45

*p<.05

Early Complementation and Weaning Foods.

Among non-EBF infants, the most common dietary supplements included water, infant formula, ni (green coconut water), and reconstituted, canned evaporated milk. The mean age at introduction for these items was 1.8 months, versus 6 months for EBF subjects (p.<.001) (Table 3). In Namdrik, children were introduced to non-breastmilk liquids earlier than in any other locale (28.5 days) (p<.05). Weaning foods were introduced significantly earlier among non-EBFs than among EBFs (4.9 months versus 6.1; p<.0001), but no significant differences were observed between study sites (Table 4).

An open-ended inquiry about the child's "first foods," elicited a list of 41 distinct early weaning foods (EWFs) (Table 5). The majority of foods mentioned were primarily traditional and local in origin. Juices, pureed fruits or vegetables accounted for 26% of the EWFs; a principal variant, such as fruit pureed with canned milk, accounted for an additional 5%.

Coconut *(Cocos nucifera)* products are common in traditional Marshallese weaning foods. Ten of the 41 unique items elicited were coconut-based foods. These products may vary significantly in their nutrient composition, typically with the products of embryonic/germinating and immature coconuts being lower in nutrient density. For example, immature coconut meat contains 77 kcals/100g versus 273 kcal/100g for mature flesh[21]. EWFs may contain coconut water, coconut milk or evaporated cow's milk. "*Kalel*," a ubiquitous Marshallese dish which is commonly created with rice, *baanke* (field pumpkin), *ma* (breadfruit), *bop* (pandanus), banana or *makmok* (arrowroot) combines "heavier," more energetically dense coconut products such as coconut cream and/or waine (a diluted coconut cream product) fruits and vegetables. In addition to energetic density, foods based on mature coconut products can be an important source of minerals: a 100-gram serving provides 10% of the iron and +/- 60% and 37% of the daily recommended intake (DRI) for magnesium in children 6-36 months and 4-6 years respectively[20,22].

Another common EWF is "flour gravy" which is typically a suspension of flour and water or flour and diluted canned milk. A similar dish, *likobla*, is created with arrowroot starch and water or diluted canned milk. *Jaibo*, a dough dumpling, is a third variant of the flour and water/milk combination. Flour gravy and *likobla* both have a lower caloric density (70-98 kcal/100g) than *jaibo* (370 kcal/100g), based on the average of key informants' recipes for these dishes. Starch-based soups of varying composition and nutrient density, such as pumpkin, breadfruit or rice, combined with a chicken or fish broth are also found in the Marshallese weanling's diet.

While only three commercial baby food products such as Gerber baby food, and "baby cereal," most specifically oatmeal, were mentioned, these accounted for 24% of all the items elicited. In Namdrik, 18.5% of subjects received commercial baby food products compared to 12% in Arno, 75% in Laura and 88% in Rita.

As with home-prepared food items, the nutrient- and energy-density of these items varied greatly: an average of 40 calories per serving for vegetable puree to 100 calories for a strained meat preparation. Cereals, which ranged from 105-115 kcals/100g, were the most energy-dense of the commercial products named. Reconstituted evaporated milk, mentioned as a drink, rather than a "food," was commonly elicited in the dietary recalls although it was only named twice as a specific weaning food.

Nutrient Intakes.

A nutrient intake profile was created for each subject for the following macro- and micronutrients: total energy, protein, carbohydrates, fat, and iron. Table 6 summarizes the mean, standard deviation, and ratio of within- versus between-subject variance estimate (W/B) for each nutrient by age group. The year-to-year differences were not found to be statistically significant, nor were differences in the observed mean intakes by sex.

Table 6. Mean Daily Intake of Select Nutrients by Age and Ratio of Variance Within-to-Between Individuals.

Age-Group	Energy (kcals)	Protein (g)	Carbo-hydrates (g)	Fat (g)	Iron (mg)
	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)
Birth-11.9 mo. (n=3)	1147.83 (176.9)	39.67 (6.6)	150.36 (43.2)	37.42 (22.6)	9.86 (1.6)
12-23.9 mo. (n=21)	1388.26 (446.1)	65.29 (29.7)	175.33 (72.0)	43.96 (20.0)	8.70 (3.6)
24-35.9 mo. (n=21)	1676.74 (454.7)	66.33 (25.3)	231.53 (68.0)	50.17 (16.5)	9.69 (3.6)
36-47.9 mo. (n=21)	1844.53 (781.4)	82.39 (65.0)	247.29 (83.2)	56.07 (32.3)	10.41 (4.0)
48-59.9 mo. (n=32)	1650.16 (533.5)	68.52 (30.4)	229.61 (88.4)	48.12 (16.0)	10.96 (5.7)
60-71.9 mo. (n=19)	1755.08 (763.7)	71.79 (43.1)	255.21 (105.3)	47.89 (21.4)	10.31 (5.9)
Total (n=117)	1646.97 (608.3)	69.83 (39.8)	225.51 (87.0)	48.85 (21.5)	10.09 (4.7)
Variance	W/B 0.75	(across groups) 0.69	0.80	0.96	1.86

Both inter- and intra-subject variation was estimated for each nutrient and is presented as a ratio (W/B). For most nutrients, intra-subject variation is typically greater than inter-subject variation[23,24]. The converse relationship was generally observed in this sample, suggesting that dietary variation may be greater between-subjects than within- among young Marshallese children. A generally homogenous diet may contribute to this pattern.

One exception, however, was the variance of the estimated iron intake which was nearly two times greater within-subjects than between them. This estimate was influenced by several observations reflecting a periodic surfeit of shellfish; a normal variation in island diets. The high W/B ratio suggests that a mean based upon more observations would provide a better estimate of iron intake.

The mean dietary intake of energy, protein, carbohydrates, fat and iron of fully weaned subjects (n=117) was estimated (Table 7). Significant variation in the mean intake of total energy, protein, carbohydrates and iron was found across locales (p<.0001). Mean intake of total fat in grams did not vary significantly by location. The most marked difference in total energy intake was observed between Rita, the most "urban" location and Namdrik, the most "remote" of the four study sites. Subjects in Namdrik consumed 563 more kcals than those residing in Rita ($p<.01$); they also reported significantly higher intakes of carbohydrates, protein, and iron than subjects in Rita. Significantly higher intakes of both total energy and carbohydrates were reported in Laura, the semi-urban location on the west end of Majuro atoll than its urban counterpart. No significant differences were observed for energy, protein, carbohydrates or fat intake between the two "remote" locations, Namdrik and Arno. A mean difference of 3.69 mg in iron intake between Namdrik and Arno was significant at $p<.05$. Significant differences in mean iron intake were observed among all other locations, except Namdrik and Laura, where the mean difference of .83 mg was not significant.

Table 7. Mean Intake of Energy, Carbohydrates, Protein and Iron by Location

Study Site	Energy (kcals)	Protein (g)	Carbo-hydrates (g)	Fat (g)	Iron (mg)
Laura (n=12)	1985.04	77.11	285.40	59.14	13.32
Arno (n=33)	1591.35	69.93	221.98	44.73	8.79
Rita (n=46)	1412.49	53.35	183.69	46.62	8.84
Namdrik (n=26)	1976.38	95.49	276.34	53.30	12.48
Total (N=117)	1646.97	69.83	225.51	48.85	10.09
Pairwise Comparisons	**(I) Site**	**(J) Site**	**Mean Differ-ence (I-J)**	**Std. Error**	**Sig.**
Energy	Laura	Rita	572.55	183.21	0.01
	Rita	Namdrik	-563.89	138.68	0.00
Protein **(gm)**	Rita	Namdrik	-42.14	9.05	0.00
Carbohydrates (gm)	Laura	Rita	101.71	25.27	0.00
	Rita	Namdrik	-92.66	19.13	0.00
Iron (mg)	Laura	Arno	4.53	1.47	0.02
		Rita	4.48	1.42	0.01
	Arno	Namdrik	-3.69	1.15	0.01
	Rita	Namdrik	-3.64	1.07	0.01

Total energy intake was examined as a percent of the (age-specific) Recommended Daily Allowance (RDA)[25] (Table 8). Mean energy intake was > 100% of the RDA for energy from birth through age three though it declined significantly from 142% to 92% by age four. The PRDA increased by approximately 5% during the fifth year; this was not significantly different from the PRDA during the 4th year, but remained significantly different than the PRDA of three-year old subjects.

Table 8. Mean Energy Intake and Percent of Recommended Daily Allowance for Energy, by Age

	RDA	Mean Energy	% Energy RDA
Age Group	Energy	Intake (kcals)	(kcals)
0	850*	1147.83	1.35
1	1300	1388.26	1.07
2	1300	1676.74	1.29
3	1300	1844.53	1.42
4	1800	1650.16	0.92
5	1800	1755.08	0.98
Total		**1646.97**	**1.12**

* Estimate for non-BM foods

Discussion

In this study, breastfeeding, weaning practices and dietary intake patterns were examined in four settings representing a continuum of exposure to western influence. We found that 98.5% of subjects received breastmilk for just less than one year, consistent with reports that children are typically breastfed through *kamem*, the first birthday, a date of considerable cultural significance. Exclusive breastfeeding lasted only 2.45 months and only 16.4% of the sample achieved the recommended six months of EBF.

The introduction of non-BM liquids and early weaning foods were both characterized by a six-month range, with liquids entering the diet between birth and six months and weaning foods anywhere from two to eight months. Low rates of exclusive breastfeeding through six months may be implicated as a public health issue of some significance, given its association with infant morbidity, particularly diarrhea, and ARI in other parts of the world.

Location-specific patterns related to the duration of EBF and age at introduction of non-breastmilk liquids and weaning foods were unexpected. Remote locations were characterized by the shortest periods of EBF and earlier introduction of liquids and weaning foods than their urban and peri-urban counterparts. This may be attributable to time allocation patterns of female caregivers in each area. In Namdrik, subsistence activities such as food collection, production and craft work may, like work in the formal sector, be a barrier to EBF. The pattern was not entirely clear, however, as subjects from Laura, the peri-urban location, enjoyed a longer period of EBF, and later introduction to liquids and weaning foods than their urban counterparts. Urban and *peri*-urban mothers may have greater exposure to health education messages which support longer, exclusive breastfeeding. The variation in patterns of EBF duration merit further research with a larger sample.

Current recommendations from WHO and UNICEF support six-months of exclusive breastfeeding followed by "nutritionally adequate" weaning foods. The composition of weaning foods in the Marshall Islands varied greatly in terms of origin, caloric and nutrient density. Acculturative processes clearly affected the dietary preferences of caregivers, particularly in areas where consumers had a choice. Gerber baby foods and cereals, infant formulas, "junk" foods, candies and instant coffee were items recalled predominately among the urban sample. Prepared, store-bought infant foods were considered "healthy foods" and were popular, despite the high per-serving cost relative to traditional preparations such as fruit or vegetable purees. One mother reasoned that the instant coffee she bottle-fed her 10 month-old infant "must be good because it's American and it's expensive." Uninformed choices such as this may have inadvertent but significant effects on the diet, such as caffeine-induced appetite suppression and diuresis.

This perception of imported "healthiness" also held for canned evaporated milk, but rather than being a positive feature of the diet, it was typically a poor food supplement due to excessive dilution. Caregivers rarely diluted the solution 1:1 as directed, instead diluting it 1.5 to 5 times with a resulting decrease in nutrient density. Some caregivers explained that over-dilution was due to cost and to taste: children unused to drinking milk preferred it diluted. Practices dictated by dietary preference are difficult to change and may diminish nutritional adequacy, particularly in the case of weaning foods. Additional research into dietary preferences in early childhood is warranted, particularly to aid in developing behavioral interventions to increase the nutrient density of common weaning foods.

Further research on the composition of traditional weaning foods in RMI may contribute to the promotion of higher quality weaning foods and improvement of existing traditional recipes (e.g., more nutrient-dense preparations) in urban and remote Marshallese settings.

This study had several limitations. Accurate estimation of serving size posed a significant challenge, particularly for fish, a dietary staple. Serving sizes of fish were found to be uniformly large across the sample, largely because respondents either described the servings in spoon measures or by using the index finger and hand as a guide to the fish size, a technique used in previous surveys[11]. In spite of this methodological problem which may have resulted in an overestimation of protein, there is reason to believe that the cyclic and periodic nature of the diet—particularly in remote areas—creates an intermittent surfeit of protein in the diet which may result in variability in the estimate.

The inability to measure breastmilk consumption in this setting poses a second limitation. Efforts to characterize the nutrient intakes of breastfed children should include nutrients provided by breastmilk. Estimation of breastmilk intake by pre- and post-feeding weight measurements or more precise biochemical measures were both infeasible and culturally unacceptable in this population.

A third limitation is the lack of a socioeconomic status (SES) indicator. SES data were collected via a "material style of life" scale during the first wave of data collection in 1996. Severe damage caused by Typhoon Paca in 1997 resulted in major economic losses and this made a scale based on "material style of life" invalid during the years immediately following the typhoon.

Despite these limitations, estimation of nutrient intake was accomplished successfully through the use of repeated 24-hour recalls. Though somewhat labor-intensive given the use of measuring implements, food models and photos to assess serving size, it was nonetheless the method of choice given the low levels of literacy in RMI. The repeat visits also provided an opportunity for rapport-building which facilitated more in-depth qualitative interviews later in the study.

The data suggest that for the nutrients examined, there was less variation in nutrient intake within individuals than between, with the exception of iron in females. While somewhat unusual, this was not surprising in this setting given the overall homogeneity of the diet. While traditional recipes and preparation methods varied across locales, ingredients often varied little, incorporating island basics such as fish, coconut, pandanus, and breadfruit with imports such as rice, flour or canned milk and cooking oil.

Site-specific differences in nutrient intakes were observed among fully-weaned subjects. The highest intakes of energy, carbohydrates, fat and iron were reported in Laura, the peri-urban site; intakes on Namdrik, the most remote site, were unexpectedly similar to those in Laura. Rita reported the lowest mean intakes for all nutrients except iron. At first glance, this may appear counter-intuitive, as one would think the urban diet would be more nutrient-dense given the role of imported foods in the diet. Total intake rather than nutrient density may be a differentiating factor. Urban children may have a lower overall intake than their rural counterparts because caregivers are present less in the home because of work obligations or because urban households, more reliant upon the cash economy, have a greater dependence upon store-bought foods requiring both cash and preparation rather than foods that can be gathered without preparation, such as fish or fruit. Anecdotal data also suggest that while the inhabitants of urban Majuro have higher rates of formal employment and thus higher (reportable) incomes than their rural counterparts, the cost of living is greater, leaving urban dwellers with less disposable income for food purchases.

While the urban setting had generally been believed to confer an advantage, research suggests that the *type* of urban setting differentiates risk from advantage in understanding health disparities in developing country settings[26]. Although SES data were not collected during this phase of the study, government data suggest that the country's urban centers are the most impoverished areas. Environmental risk factors characteristic of urban centers such as overcrowding, poor sanitation, and an inadequate supply of potable water, have the potential to affect child health through a variety of pathways including increased morbidity from diarrhea, ARI, and other infectious diseases that may, in turn, affect both intake and metabolism of nutrients.

Conclusion

Nutrition education is a valued and integral part of the current Ministry of Health Primary Care Program. Although efforts are underway to increase the rates of exclusive breastfeeding and maternal knowledge around infant and child feeding, results from this study suggest that additional research could contribute in several ways. First, the role of extended family members and health care providers on the decision-making processes involved in breastfeeding and infant feeding practices should be examined further. In addition, the degree to which infant and child feeding is passive or active, and how this varies by location, SES or gender has not been fully examined in this setting.

Health education strategies currently used in the RMI require evaluation to understand factors affecting the low rates of EBF despite a widespread and primary health care-integrated campaign to promote EBF. These data may inform future efforts to prolong the duration of exclusive breastfeeding, as well as to appropriately time the introduction of weaning foods. Further research on the composition of traditional weaning foods in RMI may contribute to the promotion of higher quality weaning foods and improvement of existing traditional recipes (e.g., more nutrient-dense preparations) in urban and remote Marshallese settings. Given the high rates of under-nutrition in RMI, improvements to the weaning diet may be of particular value to this at-risk segment of the Marshallese population.

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Table 5. Weaning Foods Reported in the Marshall Islands (n=132)

Food category and names	Frequency	Percent	Energy density
Fruits and Vegetables			kcals/100g
Breadfruit	15	3.71	71
Papaya/Banana/Pandanus/Juice or Puree	27	6.68	39/103/144/
Pumpkin/sweet potato/yam puree	13	3.22	20/105/105
Mashed Potato	3	0.74	83
Mokwan (Pandanus juice cooked and preserved)	58	14.36	326
Banana/ Papaya/ Pumpkin/ Pandanus/ Breadfruit w/			
Canned-milk	21	5.20	
Subtotal		**137**	**33.91**
Coconut recipes			
Rice kalel	7	1.73	142+
Breadfruit kalel or breadfruit jekaro (coconut sap)	15	3.71	33
Pandanus /Pumpkin kalel	18	4.45	
Flour Gravy w/ kalel	2	0.50	=/- 98
Tubur (Variant of banana kalel, steamed in pandanus leaf)	11	2.72	
Aikiu (Spongy coconut meat and arrowroot) or w/ papaya	8	1.98	81
Iu (Spongy meat of sprouted coconut)	2	0.50	72
Subtotal	**63**	**15.60**	
Mixed dishes			
Flour gravy (Flour with water or milk)	39	9.65	98
Jaibo (Dough dumpling)	10	2.47	70-375
Likobla (Arrowroot starch and water)	8	1.98	+/- 30
Flour gravy w/ banana	1	0.25	

cont. next page

Food category and names	Frequency	Percent	Energy density
Soup Rice Fish	9	2.23	
Soup rice	5	1.24	
Jokkwop (Soup w/ soft rice and breadfruit) or pumpkin	14	3.47	
Meat/fish gravy	2	0.50	183-214
Fish/crab	2	0.50	
Subtotal	**90**	**22.28**	
Commercial products/ Miscellaneous			
Gerber products/"baby food"	70	17.33	40--100+
Cereals/oatmeals	27	6.68	379-398
Plain rice	6	1.49	130
Canned, evaporated milk	3	0.74	127
Ramen	3	0.74	480
Anything/ Table Food/Misc	5	1.24	
Subtotal	**114**	**28.22**	
Total Items Elicited	**404**	**404**	**100.00**

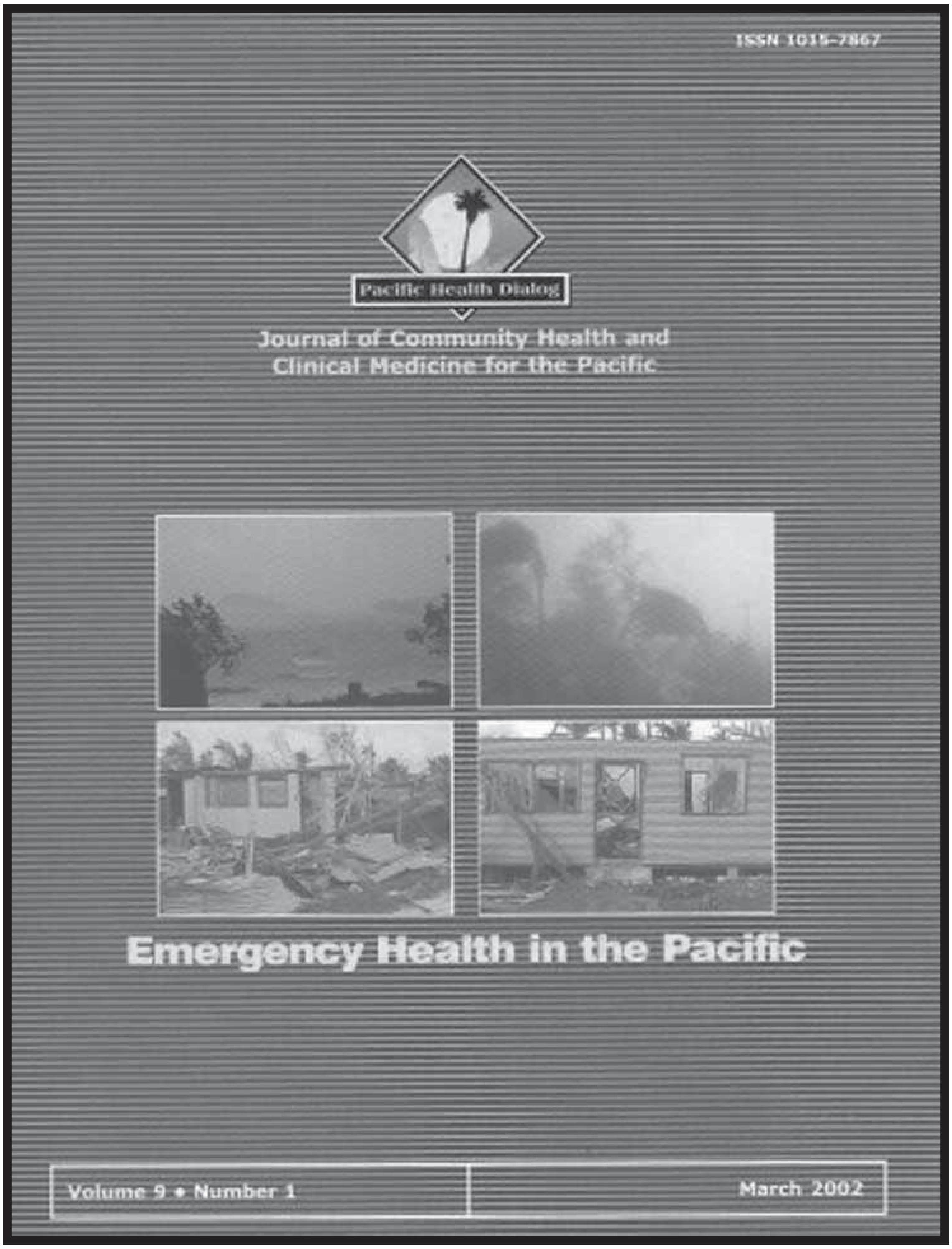
References

1. WHO Nutrition Unit. WHO Global Data Bank on Breast-Feeding. Geneva, Switzerland. 1996.
2. WHO Global strategy for infant and young child feeding. Geneva, Switzerland. 2003.
3. American Academy of Pediatrics, Working Group on Breastfeeding. Breastfeeding and the use of human milk. Pediatrics 1997;100:1035-9.
4. Popkin BM. The nutrition transition and its health implications in low income countries. Public Health Nutr. 1998;1:5-21.
5. López-Alarcón P, Villalpando S, Fajardo A. Breastfeeding lowers the frequency and duration of acute respiratory infection and diarrhea in infants under six months of age. J Nutr 1997;127:436-43.
6. Pollock NJ. The risks of dietary change: a Pacific atoll example. Gastronomy: The anthropology of food and food habits. The Hague: Moueton 1975:121-30
7. Taylor R, Badcock J, King H et al. Dietary intake, exercise, obesity and noncommunicable disease in rural and urban populations of three Pacific island countries. Journal of the American College of Nutrition 1992;11:283-93.
8. Gittelsohn J, Haberle H, Vastine AE, Dyckman W, Palafox N. Macro- and microlevel processes affect food choice and nutritional status in the Republic of the Marshall Islands. J. Nutr. 133: 310S-313S, 2003.
9. Ministry of Health and Environment, Bureau of Health Planning and Statistics. Marshall Islands Vital and Health Statistics Abstract, 1990-1994. Majuro, Marshall Islands. 1996.
10. Ministry of Health and Environment. National Nutrition Survey 1991. Report. Majuro, Republic of the Marshall Islands. 1991.
11. Palafox NA, Gamble MV, Dancheck B, Ricks MO, Briand K, Semba RD. Vitamin A deficiency, iron deficiency, and anemia among preschool children in the Republic of the Marshall Islands. Nutrition. 19(5):405-8, 2003 May.
12. Dignan C, Calf J, Webb K, Mackerras D, Franke B. Dietary Survey of Rongelapese Living on Mejatto Island. Report, Manila, the Philippines, April 1994.
13. Dickson J, Hunt D. The prevalence of Vitamin A deficiency in 1994 on an atoll in the Marshall Islands and its relationship to locally grown food.
14. Hunter C. The Marshall Islands. In: Lewis WR, ed. National security and international trusteeship. Annapolis: Naval Institute Press 1972:133-47.
15. Massaar J. Internal migration in the Marshall Islands. An explorative study. Netherlands: University of Groningen, 1993.
16. Gittelsohn J, Maas L, Gammino V, and Palafox N. Overnutrition and undernutrition in the Republic on the Marshall Islands. Report to the RMI MOHE. Baltimore, Maryland, John Hopkins University. 1998.
17. Dignan CA, Burlingame BA, Arthur JM, Quigley RJ, and Milligan GC. The Pacific Islands Food Composition Tables. New Caledonia, South Pacific Commission. 1994.
18. Spradley J. The ethnographic interview. New York: Holt, Rinehart, Winston, 1979.
19. Bernard HR. Research Methods in Anthropology. Qualitative and quantitative approaches. Walnut Creek, CA: AltaMira Press, 1995.
20. Weller SC, Romney AK. Systematic Data Collection. Newbury Park, CA: Sage Publications, 1988.
21. Dignan CA, Burlingame BA, Arthur JM, Quigley RJ, and Milligan GC . Dignan, Cecily A. The Pacific Islands Food Composition Tables. 94. New Caledonia, South Pacific Commission.

22. ood Processor Manual, ver.7.50. ESHA Research. Salem, OR.2001.
23. Gibson, Rosalind S. Principles of Nutritional Assessment. New York, Oxford University Press. 1990.
24. Sempos CT, Looker AC, Johnson CL, Woteki CE. The importance of within-person variability in estimating prevalence. In: Monitoring Dietary Intakes. New York: Springer-Verlag; 1991.
25. National Research Council. Recommended Dietary Allowances. Washington, DC: National Academy Press, 1989.
26. Schell LM, Smith MT, Bilsborough A. Urban Ecology and Health in the Third World. New York: Cambridge University Press, 1993.

"There is nothing like looking, if you want to find something. You certainly usually find something, if you look, but it is not always quite the something you were after."

- J.R.R. Tolkien quotes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