Type, Timing, and Diversity of Complementary Foods Among Native Hawaiian, Pacific Islander, and Filipino Infants

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Abstract

Prevention is the recommended strategy for addressing childhood obesity and may be particularly important for minority groups such as Native Hawaiians, Pacific Islanders, and Filipinos (NHPIF) who display poorer health outcomes than other race/ethnic groups. Complementary feeding is a critical milestone in the first 1,000 days of life and plays a critical role in growth and eating habit formation. This cross-sectional study recruited NHPIF infants between 3 – 12 months of age residing on O'ahu, Hawai'i to examine timing and types of complementary foods introduced first as well as the dietary diversity of those infants 6 – 12 months of age. Basic demographic information and early feeding practices were assessed via online questionnaire. Diet was evaluated using the image-based mobile food record completed over 4-days. Images were evaluated to derive the World Health Organization's minimum dietary diversity (MDD) score. Data were analyzed using descriptive statistics and linear regressions. Seventy participants completed the study with a majority being between the ages of 6 – 12 months (n=56). About half of the participants were provided a complementary food prior to 6 months of age with the most common first complementary food being poi (steamed, mashed taro). Grains were the most commonly reported food group while the high protein food groups was the least commonly reported. Approximately 25% of infants 6 – 12 months of age met MDD all four days. Meeting MDD was significantly associated with age. Findings illuminate opportunities for improvement (eg, delayed introduction) and for promotion (eg, cultural foods) in NHPIF complementary feeding.

Keywords

Dietary complementary feeding, Diversity, Infants

Abbreviations

ANOVA = Analysis of variance
IRB = Institutional Review Board
MDD – Minimum Dietary Diversity
mFR – Mobile Food Record™
NHPIF – Native Hawaiian/Pacific Islander/Filipinos
WHO – World Health Organization
WIC = Supplemental Nutrition Program for Women, Infants and Children

Introduction

Early feeding practices, including the type, timing, and diversity of complementary foods shape long-term eating and health behaviors. This period is linked with rapid growth and likely influences risk for obesity, chronic disease, and other health conditions later in life.[1] Recent data from the Supplemental Nutrition Program for Women, Infants and Children (WIC) found that few infants frequently consumed fruits (14.4%) and vegetables (7.0%) and 14.0% had no exposure to sugary beverages.[2] The only assessment of complementary food practices in Hawai'i,[3] a location with a high proportion of Native Hawaiians, Pacific Islanders, and Filipinos (NHPIF), found that many infants did not meet complementary food timing recommendations, which is not unlike current national trends[4] or what has been documented in the Asia Pacific region.[5]

Prevention is a recommended strategy for addressing child obesity and starts with nutrition in the first 1,000 days of life.[1] There are many external influences on infant feeding practices that include personal beliefs, family, socioeconomic status, and culture.[6] Early feeding may be a significant disease prevention and health promotion stage in life especially for underserved minority populations like NHPIF, who are one of the highest-risk populations in the United States (US) with increased prevalence rates of diabetes, obesity, and cardiovascular risk factors and the poorest healthy life expectancies in comparison to other population groups.[7-9] In early childhood, the prevalence of obesity in NHPIF children 2 – 8 years of age was second only to American Indians and Alaska Natives in comparison to other racial or ethnic groups in the US Affiliated Pacific Region.[10] Data from the largest federally qualified community health center in Hawai'i, which represents a community with a high proportion of NHPIF, found that children who underwent rapid growth between 12 months and 23 months were at the highest risk for child obesity in Pre-Kindergarten.[11] Additional data from the Hawai'i WIC found that 17.5% of Samoan children 12 months of age were at or above the 95th percentile of weight-for-age in comparison to 5.9% of white children; moreover, by 2 – 4 years of age, Samoan children were almost 4 times as likely to have a body mass index at or above the 95th percentile in comparison to white children of the same age.[12] Researchers from those studies hypothesized that overall feeding patterns influenced these findings; however, it is unknown how complementary feeding, ie, foods added to the diet in addition to human milk (or infant formula), have contributed individually to these numbers.

No recent examination has assessed the infant diet quality of NHPIF. Unfortunately, data for NHPIF subpopulations are consolidated into the "other" category in national surveillance summaries. As a result, national monitoring efforts do not allow for meaningful interpretations of NHPIF popula-

tions.[13] Consuming diverse foods to meet one's nutrient needs is one tenet of a healthful diet. Among infants, Moursi, et al, reported the variety of food groups consumed was found to predict micronutrient density and dietary quality.[14] Similarly, Steyn, et al, reported dietary diversity can act as a simple and quick indicator of the micronutrient adequacy of the diet.[15] A longitudinal examination of infant dietary diversity among an international cohort of urban, predominantly human milk fed infants 6 – 12 months found that infants in Cincinnati (US) had a lower dietary diversity than infants in Shanghai (China) and Mexico City (Mexico).[16]

The aim of this study was twofold. First, to examine timing and types of complementary foods introduced first to NHPIF infants ages 3 – 12 months residing on O'ahu, Hawai'i. Second, to examine dietary diversity of those NHPIF infants 6 – 12 months of age. These findings will provide an indication of complementary feeding practices as well as the healthfulness of the infant diet.

Methods

Study Sample

The target population for this cross-sectional study was NHPIF infants between 3 – 12 months of age residing on O'ahu, Hawai'i. The 3 – 12 month age range was selected based on previous research documenting that complementary food introduction occurs as early as 3 months.[3] To be eligible to participate, the infant's caregiver(s) had to be 18 years of age or older, have an iOS mobile device, and have reliable access to the Internet. Recruitment for a convenience sample of NHPIF infants was primarily community-based and occurred through community events (eg, Baby Expo), programs (eg, WIC), and networking. Seventy infants and their caregivers completed the study. Institutional Review Board (IRB) exemption from the University of Hawai'i was received prior to the collection of data (IRB reference number: 2017-00845). Consent was obtained in writing from the caregivers for both their participation and their infant's participation prior to collecting any data.

Questionnaire

All caregivers were asked to complete an online questionnaire administered through a research web application about themselves and their infant(s) at study onset. Caregivers reported basic demographic information and early life feeding practices such as timing and type of introduction of complementary food.

Dietary Assessment

Dietary assessment of the infant occurred through surrogate reporting via caregiver with the mobile food record™ (mFR™; Purdue University, 1.2.1firstfoods-MF, Updated January 29, 2019, West Lafayette, IN). The mFR is an application designed specifically for assessment of dietary intake which uses the camera on a mobile device to capture food and beverage intake, which is then used to estimate energy and nutrient intakes. The use of the mFR has resulted in increased accuracy of diet data collected for children,[17] adolescents, and adults.[18] Adults (18-49 years) are the highest adopters of mobile devices and represent the majority of parents with young children. This study is the first time that an image-based dietary assessment approach has been used with infants.[19] The mFR was loaded on to the caregiver's mobile device and training on the mFR application was completed prior to data collection. Caregivers were instructed to complete a 4-day food record (Thursday – Sunday) using the mFR. They were instructed to take pre- and post-images of all foods and beverages the participant consumed over the 4 day period. Breastfeeding events were recorded with a timer available on the mFR. As this was the first time this method has been applied to infants, study days were selected following previous studies.[17,20] After the collection period concluded, a member of the research team reviewed the images from the mFR with caregivers to verify content, as needed, and to probe for any forgotten foods or beverages. At the end of the data collection period, caregivers were given a $40 gift card.

Dietary Diversity Score

Diet quality index scores like the healthy eating index do not currently exist from birth to 24 months due to the US Dietary Guidelines only applying to the population 2 years of age and older. Therefore, the global metric Minimum Dietary Diversity (MDD) score from the World Health Organization (WHO) was used to examine infant diet quality in this study.[21] To the authors' knowledge, the WHO MDD has rarely been used in developed countries and never in NHPIF populations. To calculate, the number of solid foods and liquids consumed in any amount more than a condiment was counted in the mFR recorded images each day. Using the WHO MDD metric, solids and liquids consumed in a day were categorized into seven food groups: (1) grains, roots, and tubers [grains]; (2) legumes and nuts [legumes]; (3) dairy products (milk, including formula, yogurt, cheese) [dairy]; (4) flesh foods (meat, fish, poultry, liver/organ meats) [flesh]; (5) eggs [eggs]; (6) vitamin A-rich fruits and vegetables [vitamin A FV]; and (7) other fruits and vegetables [other FV]. MDD is predictive of micronutrient density of the infant's diet and considered met if the infant is reported to have consumed four or more of the seven food groups in a given day.[21] Human milk is not counted in a food group as the WHO MDD metric is examining foods provided in addition to human milk.

Analysis

Descriptive statistics (frequency [percentage], mean [standard deviation (SD)]) were used to summarize the data. The MDD score was calculated as the mean number of food groups recorded across the four days of the mFR. The infants were further grouped by age (3 – 5 months versus 6 – 12 months),

by the mode of feeding (liquids only versus solids only versus liquids and solids), and by liquid food type (human milk versus formula versus both). It has been documented that dietary diversity is inherently different between infants fed human milk versus formula.[22] Quantitative variables were compared among subgroups using analysis of variance (ANOVA) methods while categorical variables were compared using Chi-squared tests. The proportion meeting or not meeting the MDD (≥4 food groups) was also examined in the participants 6 – 12 months of age subgroup only, across all four days of the mFR with all modes of feeding combined as it is not recommended to compare dietary diversity across mode of initial feeding (eg, human milk or not human milk only). Linear regression was utilized in participants 6 – 12 months of age with age as the independent variable and the number of days meeting MDD as the dependent variable, sequentially adjusting for sex, food assistance, and human milk only consumption. Statistical significance was set at P-value < .05. All analyses were conducted in IBM SPSS Statistics Version 25.0 (SPSS Inc: Chicago, IL).

Results

A total of 70 infants completed the study. The majority of participants were between the ages of 6 – 12 months (Table 1). Approximately half of the participants were boys and over 70% were reported as Native Hawaiian or Part Native Hawaiian. Participants came from all regions of the island of O‘ahu. Over 60% of the infants were fed a combination of human milk and formula and slightly over 30% had only been fed human milk. At the time of the study over 50% of infants were still receiving human milk.

About half of the participants were introduced to complementary foods prior to 6 months of age (Table 1). The mean age of introduction was similar across participants fed human milk only, formula only, or both human milk and formula. A traditional Hawaiian dish, *poi* (steamed and mashed taro), alone or in combination with another food item (eg, human milk, infant cereal) was the first most commonly introduced complementary food followed by infant cereal (Table 2).

The images collected in the mFR were examined to count the number of food groups recorded (see Figure 1). With the exception of the dairy food group, complementary foods that were liquid in origin contributed a neglible amount to the food groups consumed by the participants. For both age groups, the legumes, flesh, and egg food groups were not major contributors to dietary diversity. The other FV group was significantly higher for the 6 – 12-month-old group than the 3 – 5-month-old group. The grains and flesh food group were recorded significantly more by the formula-fed only participants in comparison to infants fed both human milk and formula. Participants who consumed human milk only recorded significantly less dairy than infants fed both human milk and formula (Figure 2).

Table 1. Summary of Demographic, Early Infant Feeding and Complementary Food Introduction of Infants 3 – 12 Months (n=70)

Variable	Mean (SD)
Age of the infants in months (n=70)	7.4 (2.1)
	n (%)[a]
Age group	
3 – 5 months	14 (20)
6 – 12 months	56 (80)
Sex	
Boy	38 (54)
Girl	32 (46)
Race/Ethnicity[b]	
Part-Native Hawaiian or Native Hawaiian	50 (71)
Pacific Islander only	4 (6)
Part-Filipino/Filipino	35 (50)
Region on O‘ahu participant resided in	
Central	15 (21)
Leeward	12 (17)
North Shore	14 (20)
Windward	12 (17)
Town	17 (24)
Received assistance to pay for food[d]	26 (37)
Human milk or formula feeding	
Human milk only	22 (31)
Human milk and formula[e]	44 (63)
Formula only	4 (6)
Currently receiving human milk	40 (57)
Timing of complementary food introduction	
Before 6 months	37 (53)
3 months or Less	4 (6)
4 – 5 months	33 (47)
6+ months	30 (43)
Missing response	3 (4)
	Mean (SD)
Timing of complementary foods in months by milk type	
Human milk only (n=21, missing response=1)	4.9 (1.4)
Human milk and formula (n=42, missing response=2)	5.2 (1.2)
Formula only (n=4)	4.6 (1.3)

[a] May not add up to 100% due to rounding
[b] More than one race/ethnicity may have been self-selected, therefore will not add to 100%
[c] Self-reported Pacific Islander ethnic groups included Chamorro, Samoan, Tongan, Maori, Tahitian, and Micronesian
[d] Includes assistance from Supplemental Nutrition Education Program (SNAP) and Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)
[e] Includes infants who have received infant formula at some point or are currently receiving infant formula
SD = Standard Deviation

Table 2. Frequency of the First Complementary Food Provided to Infants 3 – 12 Months as Reported by Caregivers via Online Questionnaire (n=70)

Food	n	%[a]
Poi (steamed mashed taro with water)	20	29
Infant cereal[b]	19	28
Baby food	7	10
Water	3	4
Avocado	2	3
Carrot	2	3
Response not recorded	2	3
Baby cracker	1	2
Banana	1	2
Banana mixed with juice	1	2
Green beans	1	2
Poi mixed with human milk	1	2
Poi mixed with infant cereal	1	2
Poi mixed with sweet potato and banana	1	2
Rice mixed with eel	1	2
Rice mixed with soup	1	2
Rice, oatmeal, bread	1	2
Sugar water	1	2
Sweet potato	1	2
Sweet potato mixed with banana	1	2
Peas mixed with water	1	2
Pumpkin pie cheese cake	1	2

[a] Total may not add up to 100% due to rounding
[b] Infant cereal includes responses such as baby cereal and rice cereal

The mean number of days participants 6 – 12 months of age met MDD was 2.0 (SD = 1.6). Girls met MDD on more days than boys (2.6 days [1.5 SD] vs 1.5 days [1.5 SD], respectively, *P*-value = .014 *data not shown*). Only about a quarter (27%) of participants 6 – 12 months of age met MDD for all 4 days with no difference in the proportion meeting MDD by day (Table 3). However, age seemed to be significantly associated with the likelihood of meeting MDD, in all the models considered (Table 4).

Table 3. The Number of Days Infants 6 – 12 Months of Age (n=56) Met the Minimum Diet Diversity (MDD)[a] Score by Number of Days and Day of Week

Number of Days Met MDD	n	%[b]
0	15	27
1	10	18
2	5	9
3	11	20
4	15	27
Met MDD By Day of Week[c]	**n**	**%**
Thursday	32	57
Friday	29	52
Saturday	26	46
Sunday	26	46

[a] Meet MDD is considered met if the infant is reported to have consumed four or more of the seven food groups
[b] Numbers may not add up to 100% due to rounding
[c] Chi-squared tests were found to not be significantly different between the proportion meeting MDD by day of week ($\chi 2$ (3, n = 224) = 1.77, *P*-value = .62).

Table 4. Linear Regression Results Examining the Association Between the Number of Minimum Dietary Diversity Days and Age in Infants 6 – 12 Months (n=56)

	Model 1 B (SE)	Model 2 B (SE)	Model 3 B (SE)	Model 4 B (SE)
Constant	-2.08 (0.97)	-3.36 (1.03)	-2.08 (1.23)	-1.78 (1.23)
Age	0.50 (0.12)***	0.49 (0.11)***	0.46 (0.11)***	0.44 (0.11)***
Sex		0.96 (0.35)	0.98 (0.35)	0.97 (0.34)
Food Assistance			-0.65 (0.36)	-0.62 (0.35)
Human Milk				-0.56 (0.37)
R-Squared	0.26	0.35	0.39	0.41
Adjusted R-Squared	0.24	0.32	0.35	0.37

*** indicates *P*-value<.001
Model 1: Age
Model 2: Age + Sex
Model 3: Age + Sex + Food Assistance
Model 4: Age + Sex + Food Assistance + Human Milk

Figure 1a. Solids and Liquids Combined

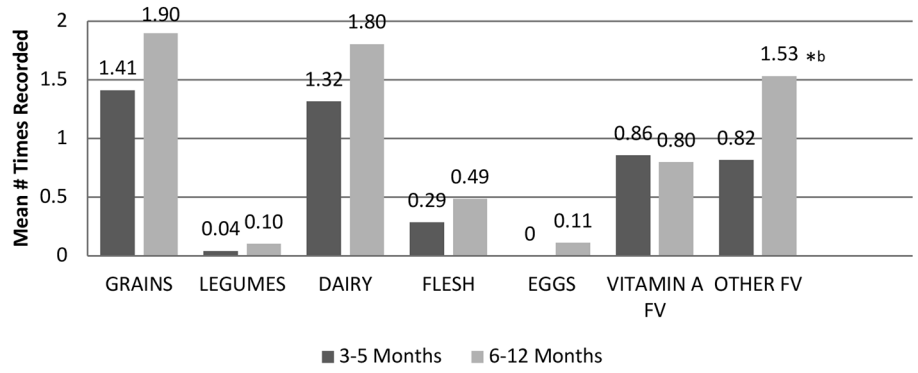

Figure 1b. Solids only

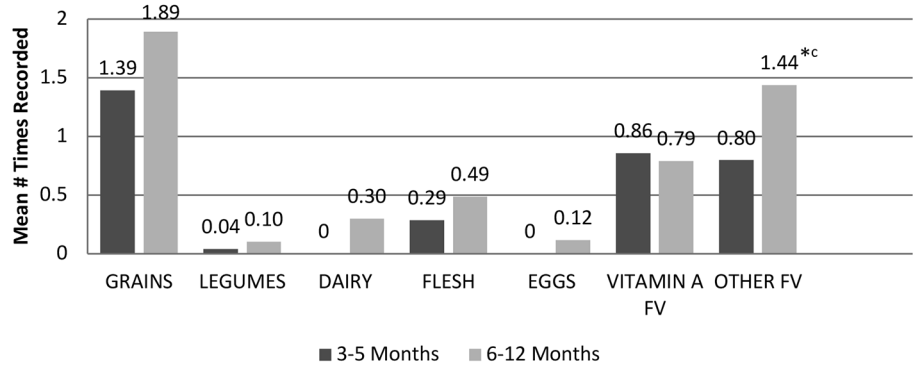

Figure 1c. Liquids only.

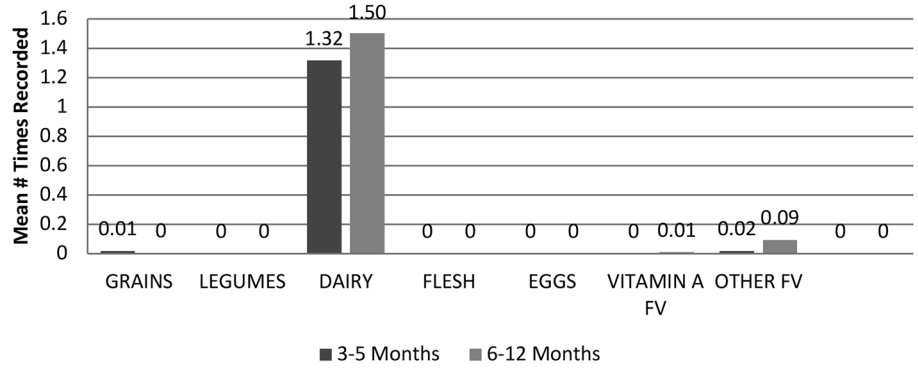

Figure 1. The Mean Number of Food Groups Recorded Across 4 days[a] of Infants 3 – 12 Months (n=70), by Mode of Feeding and Age Subgroup.

FV = Fruits and Vegetables

3 – 5 months old n=14, 6 – 12 months old n=56

[a] Only 1 participant did not complete all 4 days of the mobile food record (participant was between 3 – 5 months old and only completed 3 days)

[b] Infants 6 – 12 months were significantly higher (*P*-value=.011) than infants 3 – 5 months

[c] Infants 6 – 12 months were significantly higher (*P*-value=.016) than infants 3 – 5 months

* Indicates a significant difference (*P*-value <.05, based on ANOVA)

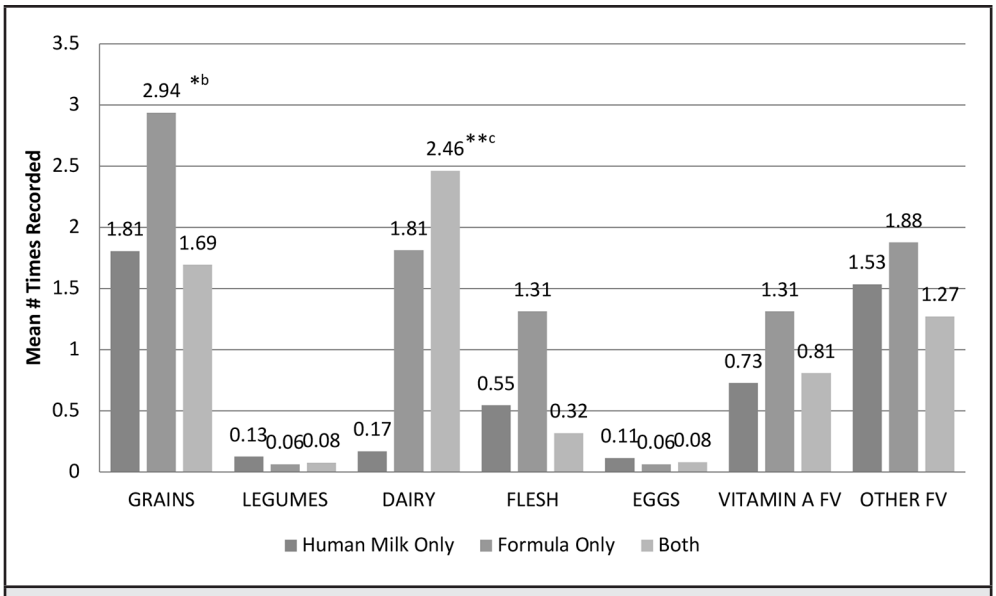

Figure 2. The Mean Number of Solid and Liquid Food Groups Recorded Across 4 days[a] by Mode of Feeding (Human Milk Only, Formula Only, or Both) of Infants 3 – 12 Months (n=70)

FV = Fruits/Vegetables

Human milk only n=22, Formula only n=4, Both human milk and formula n=44

[a] 1 participant did not complete all 4 days of the mobile food record (participant was between 3 – 5 months old and only completed 3 days)

[b] Formula only fed infants were significantly higher (*P*-value=.036) than infants fed both human milk and formula-fed

[c] Infants fed human milk only were significantly lower (*P*-value=.000) than infants fed both human milk and formula

* Indicates a significant difference (*P*-value <.05, based on ANOVA)

** Indicates a significant difference (*P*-value <.001, based on ANOVA)

Discussion

This study is the first to report timing and type of complementary foods introduced specifically in NHPIF infants. Guidelines recommend that infants are not developmentally ready to begin consuming complementary foods until approximately 6 months of age.[23] Nevertheless, similar to a study published in 1995 on complementary feeding practices in Hawai'i,[3] this study found that half of the participants were introduced to complementary food prior to this 6 months recommendation.[23] This is consistent with a recent United Nations International Children's Emergency Fund finding that the East Asia and Pacific regions have the highest proportion of infants in the world introduced to complementary food prior to 6 months of age.[24] The relationship between the early introduction of complementary foods and obesity is unclear due to studies reporting conflicting results.[25,26] It has nevertheless been proposed that dietary diversity is one of the 10 recommended approaches to prevent childhood obesity.[27]

Several studies have documented that a high proportion of infants consume foods from the grains group.[16,24] This may be of particular significance to Native Hawaiian and Pacific Islanders who attribute significant cultural value to tubers such as taro and sweet potato, classified in the grains group, due to their nutrient composition. For Native Hawaiians in particular, poi is traditionally considered the perfect first complementary food for infants.[28] Indeed, poi, nutrient dense, hypoallergenic, and easily modified to meet a semi-liquid food texture suitable for complementary food,[29] was the most common first complementary food in our study. Future studies should consider examining which food(s) within a food group contribute the most to inform future research protocols and health promotion efforts.

The authors found a significant difference in the dairy food group between infants fed formula only or both formula and human milk in comparison to those fed human milk only. Since formula in contrast to human milk is included in the Dairy food group of the WHO MDD metric, there is notable concern that dietary diversity may appear higher for infants fed formula versus those fed human milk.[21] Accordingly, reaching MDD was not assessed comparing human milk to formula. Recently, the WHO MDD scoring system was updated to include an eighth food group for human milk.[30] Unfortunately, this study was completed prior to the publication of the updated WHO MDD metric. In addition, the 2020 US Dietary Guidelines for the first time will include dietary recommendations for pregnancy, infants, and toddlers less than two years of age. Despite these additional guidelines, the development of a diet quality index score for ages 1 – 2 years, like the healthy eating index, is currently unclear.[31]

Another important finding of this study was the low quantity of foods in the high protein groups (eggs, legumes, and flesh), consistent with the findings of a previous study that examined dietary diversity in three international cohorts.[16] As six of the top eight food allergens fall into one of these high protein food groups (eggs, peanuts, tree nuts, fish, shellfish, and soy), the low consumption of these foods may delay the development of food allergies in childhood, as previously suggested.[32,33] However, recommendations on the timing of the introduction of high allergen foods are now shifting as evidence now suggests that early introduction of these foods will reduce the likelihood of developing a food allergy in childhood.[34-36] Hence, there is limited clarity in the relationship between dietary diversity and the development of food allergies.[37,38]

This study is the first to examine dietary diversity in NHPIF infants 6 – 12 months of age. Results are similar to a study on infant diet quality in the US. In that study, the mean number of WHO food groups consumed over a 24-hour period was 2.4 groups for infants 6 months of age.[16] Moreover, only 28% of the infants, ages 8 – 12 months, meet the MDD. However, the study was conducted in a predominately white, urban, US infant population that was primarily fed human milk. This is noteworthy since dietary diversity is significantly influenced by the consumption of human milk.[22] The interaction between infant diet diversity and human milk intake is important to consider as more than half of the infants in the present study received both human milk and formula. This additional layer of complexity highlights the need for further exploration of the influences on infant diet diversity.

The association between age and dietary diversity found in this study aligns with other studies documenting a higher proportion of infants at 12 months of age meeting MDD, in contrast to younger infants of 6 months of age.[16,43] As an infant develops head control, accepts and swallows foods of developmentally appropriate textures, it is instinctively anticipated that the number of complementary foods introduced into the diet will increase.

Finally, this study employed a cross-sectional design to provide data on the timing and types of complementary foods introduced to a cohort of NHPIF infants ages 3 – 12 months, as well as dietary diversity of a sub-sample of infants 6 – 12 months, residing on Oʻahu, Hawaiʻi. Hence, the use of a convenience sample may not be representative of the broader racial or ethnic targeted groups. Despite several areas of concern, such as a high proportion of infants being introduced to complementary foods before the recommended six months of age, and a low proportion of infants meeting MDD, the healthy and culturally informed complementary feeding practice of providing poi was identified. Moreover, an innovation employed in the study was the first time use of an image-based dietary assessment tool to enumerate the dietary intake of infants. The use of an image-based dietary assessment approach improves accuracy and reduces the risk of recall bias.[19] Other important factors to consider when examining infant diet diversity, such as its relationship with obesity in later life,[39] was beyond the scope of this study. In addition, the study was limited to caregivers with access to an iOS mobile device. The application used to collect data was of original design, developed only for the iOS platform. Future studies will include other mobile device platforms such as Android. Future studies should also examine dietary diversity of NHPIF infants in more depth with an updated WHO MDD metric using an image-based dietary assessment approach to determine how dietary diversity is associated with other indicators of health such as obesity over a period of time.

Conflict of Interest

None of the authors identify any conflict of interest.

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References

1. Fewtrell M, Bronsky J, Campoy C, et al. Complementary feeding: A position paper by the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2017;64(1):119-132.
2. Au LE, Gurzo K, Paolicelli C, Whaley SE, Weinfield NS, Ritchie LD. Diet quality of US infants and toddlers 7–24 months old in the WIC Infant and Toddler Feeding Practices Study-2. *J Nutr.* 2018;148(11):1786-1793.
3. Goldberg DL, Novotny R, Kieffer E, Mor J, Thiele M. Complementary feeding and ethnicity of infants in Hawaii. *J Am Diet Assoc.* 1995;95(9):1029-1031.
4. Barrera CM, Hamner HC, Perrine CG, Scanlon KS. Timing of introduction of complementary foods to US infants, National Health and Nutrition Examination Survey 2009-2014. *J Acad Nutr Diet.* 2018;118(3):464-470.
5. Inoue M, Binns CW. Introducing solid foods to infants in the Asia Pacific region. *Nutrients.* 2014;6(1):276-288.
6. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics.* 1998;101(3 Pt 2):539-549.
7. Mau MK, Sinclair K, Saito EP, Baumhofer KN, Kaholokula JK. Cardiometabolic health disparities in native Hawaiians and other Pacific Islanders. *Epidemiol Rev.* 2009;31:113-129.
8. Wu Y, Uchima O, Browne C, Braun K. Healthy life expectancy in 2010 for Native Hawaiian, White, Filipino, Japanese, and Chinese Americans living in Hawai'i. *Asia Pac J Public Health.* 2019;31(7):659-670.
9. Wu Y, Braun K, Onaka AT, Horiuchi BY, Tottori CJ, Wilkens L. Life expectancies in Hawai'i: A multi-ethnic analysis of 2010 life tables. *Hawaii J Med Public Health.* 2017;76(1):9-14.
10. Novotny R, Li F, Fialkowski MK, et al. Prevalence of obesity and acanthosis nigricans among young children in the children's healthy living program in the United States Affiliated Pacific. *Medicine (Baltimore).* 2016;95(37):e4711.

11. Okihiro M, Davis J, White L, Derauf C. Rapid growth from 12 to 23 months of life predicts obesity in a population of Pacific Island children. *Ethn Dis.* 2012;22(4):439-444.
12. Baruffi G, Hardy CJ, Waslien CI, Uyehara SJ, Krupitsky D. Ethnic differences in the prevalence of overweight among young children in Hawaii. *J Am Diet Assoc.* 2004;104(11):1701-1707.
13. Anater AS, Catellier DJ, Levine BA, et al. The Feeding Infants and Toddlers Study (FITS) 2016: Study design and methods. *J Nutr.* 2018;148(9S):1516S-1524S.
14. Moursi MM, Arimond M, Dewey KG, Trèche S, Ruel MT, Delpeuch F. Dietary diversity is a good predictor of the micronutrient density of the diet of 6- to 23-month-old children in Madagascar. *J Nutr.* 2008;138(12):2448-2453.
15. Steyn NP, Nel JH, Nantel G, Kennedy G, Labadarios D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutr.* 2006;9(5):644-650.
16. Woo JG, Herbers PM, McMahon RJ, et al. Longitudinal development of infant complementary diet diversity in 3 international cohorts. *J Pediatr.* 2015;167(5):969-974.
17. Aflague TF, Boushey CJ, Guerrero RT, Ahmad Z, Kerr DA, Delp EJ. Feasibility and use of the mobile food record for capturing eating occasions among children ages 3-10 years in Guam. *Nutrients.* 2015;7(6):4403-4415.
18. Daugherty BL, Schap TE, Ettienne-Gittens R, et al. Novel technologies for assessing dietary intake: evaluating the usability of a mobile telephone food record among adults and adolescents. *J Med Internet Res.* 2012;14(2):e58.
19. Boushey CJ, Spoden M, Zhu FM, Delp EJ, Kerr DA. New mobile methods for dietary assessment: review of image-assisted and image-based dietary assessment methods. *Proc Nutr Soc.* 2017;76(3):283-294.
20. Shoneye CL, Dhaliwal SS, Pollard CM, et al. Image-based dietary assessment and tailored feedback using mobile technology: Mediating behavior change in young adults. *Nutrients.* 2019;11(2):435.
21. World Health Organization. *Indicators for assessing infant and young child feeding practices: Part 1 Definition.* Geneva, Switzerland: World Health Organization Press, 2008.
22. Byrne R, Magarey A, Daniels L. Food and beverage intake in Australian children aged 12-16 months participating in the NOURISH and SAIDI studies. *Aust N Z J Public Health.* 2014;38(4):326-331.
23. World Health Organization. *Infant young child feeding: Model chapter for textbooks for medical students and allied health professionals.* Geneva, Switzerland: World Health Organization Press, 2009.
24. White JM, Bégin F, Kumapley R, Murray C, Krasevec J. Complementary feeding practices: Current global and regional estimates. *Matern Child Nutr.* 2017;13(S2):e12505.
25. Barrera CM, Perrine CG, Li R, Scanlon KS. Age at introduction to solid foods and child obesity at 6 years. *Child Obes.* 2016;12(3):188-192.
26. Pearce J, Langley-Evans SC. The types of food introduced during complementary feeding and risk of childhood obesity: a systematic review. *Int J Obes (Lond).* 2013;37(4):477-485.
27. Pietrobelli A, Agosti M, Group M. Nutrition in the first 1000 Days: Ten practices to minimize obesity emerging from published science. *Int J Environ Res Public Health.* 2017;14(12):1491.
28. Brown AC, Valiere A. The medicinal uses of poi. *Nutr Clin Care.* 2004;7(2):69-74.
29. Marduel Boulanger A, Vernet M. Introduction of new food textures during complementary feeding: Observations in France. *Arch Pediatr.* 2018;25(1):6-12.
30. World Health Organization. *Global nutrition monitoring framework: Operational guidance for tracking progress in meeting targets for 2025.* Geneva, Switzerland: World Health Organization Press, 2017.
31. United Food and Nutrition Service. Pregnancy and Birth to 24 Months. https://www.fns.usda.gov/resource/pregnancy-and-birth-24-months. Published 2019. Updated January 31, 2019. Accessed May 24, 2019.
32. Agostoni C, Decsi T, Fewtrell M, et al. Complementary feeding: A commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2008;46(1):99-110.
33. Maloney JM, Sampson HA, Sicherer SH, Burks WA. Food allergy and the introduction of solid foods to infants: a consensus document. *Ann Allergy Asthma Immunol.* 2006;97(4):559-560.
34. Abrams EM, Chan ES. It's not mom's fault: Prenatal and early life exposures that do and do not contribute to food allergy development. *Immunol Allergy Clin North Am.* 2019;39(4):447-457.
35. Devonshire AL, Robison RG. Prevention of food allergy. *Allergy Asthma Proc.* 2019;40(6):450-452.
36. Simons E, Balshaw R, Lefebvre DL, et al. Timing of introduction, sensitization and allergy to highly-allergenic foods at age 3 years in a general-population Canadian cohort. *J Allergy Clin Immunol Pract.* 2020;8(1):166-175.
37. Nwaru BI, Takkinen HM, Kaila M, et al. Food diversity in infancy and the risk of childhood asthma and allergies. *J Allergy Clin Immunol.* 2014;133(4):1084-1091.
38. Joseph CL, Ownby DR, Havstad SL, et al. Early complementary feeding and risk of food sensitization in a birth cohort. *J Allergy Clin Immunol.* 2011;127(5):1203-1210.e1205.
39. Azadbakht L, Esmaillzadeh A. Dietary diversity score is related to obesity and abdominal adiposity among Iranian female youth. *Public Health Nutr.* 2011;14(1):62-69.
40. Arimond M, Ruel MT. Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *J Nutr.* 2004;134(10):2579-2585.
41. Jones AD, Ickes SB, Smith LE, et al. World Health Organization infant and young child feeding indicators and their associations with child anthropometry: a synthesis of recent findings. *Matern Child Nutr.* 2014;10(1):1-17.
42. Seto J, Davis J, Taira DA. Examining the association between different aspects of socioeconomic status, race, and disability in Hawaii. *J Racial Ethn Health Disparities.* 2018;5(6):1247-1253.
43. Mok E, Vanstone CA, Gallo S, Li P, Constantin E, Weiler HA. Diet diversity, growth and adiposity in healthy breastfed infants fed homemade complementary foods. *Int J Obes (Lond).* 2017;41(5):776-782.