

# Maternal Race Trends in Early Infant Feeding Patterns in Hawai'i Using Newborn Metabolic Screening-Birth Certificate Linked Data 2008–2015

Donald K. Hayes MD MPH; Ellen O. Boundy ScD, MS, RN, CNM; Heidi Hansen-Smith BA; and Carol L. Melcher MPH, RN

## Abstract

*Breastfeeding provides optimal nutrition for infants, including short- and long-term health benefits for baby and mother. Maternity care practices supporting breastfeeding after delivery increase the likelihood of exclusive breastfeeding. This study explores trends in early infant feeding practices by maternal race and other characteristics in Hawai'i. Data from a linked 2008–2015 Hawai'i Newborn Metabolic Screening and Birth Certificate file for 128 399 singleton term infants were analyzed. Early infant feeding occurring 24–48 hours after delivery and before discharge was categorized: Early formula feeding; early mixed feeding; and early exclusive breastfeeding. Differences were assessed over time by maternal race and other socio-demographic characteristics. Further assessment of maternal race included a generalized logit model adjusting for maternal age, marital status, county of residence, type of birth attendant, and birth year. Statewide, early exclusive breastfeeding increased from 58.8% in 2008 to 79.1% in 2015 (relative increase=+35%); early mixed feeding declined from 31.1% to 16.0% (relative decrease=-49%) and early formula feeding declined from 10.1% to 4.9% (relative decrease=-51%). Most maternal race subgroups experienced increases in early exclusive breastfeeding and decreases in mixed and formula. Japanese mothers were 2.15 (95%CI=1.90–2.42) and Korean mothers were 1.73 (95%CI=1.37–2.18) times more likely to practice early exclusive breastfeeding compared with white mothers. Several subgroups were less likely to practice early exclusive breastfeeding compared with white mothers. Substantial increases in early exclusive breastfeeding in Hawai'i occurred across all subgroups. Development of culturally appropriate hospital practices, particularly in those with persistently lower estimates, could help improve early exclusive breastfeeding.*

## Keywords

early infant feeding, breastmilk, disparities, exclusive breastfeeding, Native Hawaiian, Other Pacific Islanders, Asians, Hawai'i

## Abbreviations

NHOPI = Native Hawaiian or Other Pacific Islander  
OHSM = Office of Health Status and Monitoring  
PRAMS = Pregnancy Risk Assessment Monitoring System  
WIC = Special Supplemental Nutrition Program for Women, Infant, and Children

## Background

Breastfeeding is cost-effective and provides medical, nutritional, developmental, psychological, social, economic, and environmental advantages for the health of both mother and child.<sup>1</sup> In contrast, formula-fed children may require more doctor visits and are at higher risk for childhood obesity, diabetes, asthma, and other health issues.<sup>2–4</sup> To increase the uptake of breastfeed-

ing, several organizations endorse its benefits. For example, the American Academy of Pediatrics, American College of Obstetricians and Gynecologists, and the American Academy of Family Physicians promote exclusive breastfeeding for approximately the first 6 months after delivery, followed by continued breastfeeding with complementary foods introduction, and ongoing support of breastfeeding for at least one year or as long as mutually desired by mother and child.<sup>5–7</sup>

The Ten-Steps to Successful Breastfeeding (Ten-Steps) is accepted as the standard of care for maternity care in hospitals in establishing and promoting breastfeeding.<sup>8–11</sup> These steps are a set of evidence-based practices that improve the maternity care provided to patients in the hospital that support optimal breastfeeding outcomes and include: written policies; ensure appropriate training of staff; inform all pregnant women on the benefits and management of breastfeeding; timely initiation of breastfeeding; ensure women are educated on maintaining lactation; ensure no food or drink other than breast milk are provided to infants unless medically indicated; practice rooming in (sharing a bedroom with the infant); encourage breastfeeding on demand; no use of teats or pacifiers; and foster breastfeeding support groups that women can access upon discharge.<sup>9</sup>

In 2010, the Hawai'i State Department of Health developed an initiative to promote breastfeeding using the Ten-Steps through the Baby-Friendly Hawai'i Project. This project improves maternity care practices in the critical early postpartum period by supporting health systems through staff training and on-going technical assistance to all birthing hospitals in the State.<sup>12</sup> In 2011 the US Surgeon General Call to Action outlined many barriers to breastfeeding. The report included a lack of maternal knowledge on the benefits of breastfeeding, social norms favorable toward formula feeding, embarrassment, lactation problems, poor family and social support, lack of supportive environments at work, and health services-related barriers.<sup>1</sup> Health services related barriers included the early hospital experience of breastfeeding. The Call to Action included the Ten-Steps to Successful Breastfeeding (Ten-Steps) in the final recommendations.<sup>1</sup>

There are about 18 000 births annually amongst a population of nearly 1.4 million people in Hawai'i. Hawai'i is composed of a diverse population that may have differences in early infant feeding. Analysis of data collected in the state of Hawai'i of-

fers an opportunity to understand differences in breastfeeding initiation or early experience of feeding among a wide variety of racial and ethnic subgroups including Asian and Native Hawaiian or Other Pacific Islander (NHOPI) subgroups. Asians and NHOPI are a diverse population consisting of several distinct subgroups with different characteristics that include language, occupations, culture, and length of residence in the United States.<sup>13-14</sup>

A Hawai'i Pregnancy Risk Assessment Monitoring System (PRAMS) study based on 2004-2008 data, prior to implementation of the Baby-Friendly Hawai'i Project, highlighted that Asian and NHOPI subgroups were less likely to exclusively breastfeed at least 8 weeks compared to white mothers.<sup>15</sup> The study highlighted differences among the Asian and NHOPI subgroups at 8 weeks. However, it is unknown whether there are differences in early infant feeding experience in the hospital at the population level among the diverse race groups in Hawai'i.

An overall increase occurred statewide in early exclusive breastfeeding, indicated by Newborn Metabolic Screening data in Hawai'i between 2009 and 2014, covering the time since the Baby-Friendly Hawai'i Project started.<sup>12</sup> However, it is unclear if these improvements were seen across various maternal race and other characteristic subgroups. The aims of this paper are to report the trends in early infant feeding practices by maternal race and other characteristics in Hawai'i and to explore further some differences in early infant feeding practices in maternal race compared with white mothers accounting for the other characteristics.

## Methods

This is a retrospective, cross-sectional descriptive secondary analysis of de-identified linked data provided to the researcher after the linkage was completed. The analysis was considered as exempt from Institutional Review Board approval by the Hawai'i State Department of Health.

The Hawai'i Newborn Metabolic Screening Program collects information and a blood spot specimen to identify 33 rare metabolic conditions early for appropriate counseling and referral to treatment among families with affected newborns. The Hawai'i State Department of Health Office of Health Status and Monitoring (OHSM) collects vital statistics for the state on all births. Linkage of birth certificate and metabolic screening data based on patient identifiers (eg, names, dates, weight, times, institution) using a combination of 3-4 variables per each of 15 iterations was done by staff at OHSM. For the time period included in this manuscript, the linkage rate between the two sources was 99.4% (n=963 not linked). A de-identified analytic file covering data collected for births from 2008-2015 was provided to the researchers for analysis. A total of 150 589 births were identified in the linked data set. Information on early infant feeding was obtained from the Newborn Metabolic Screening program data while maternal race, other socio-demographic, and some

clinical based information such as gestational age, birthweight, delivery method, and maternal factors complicating delivery were included in the linked OHSM birth certificate file. Analysis was limited to term singleton deliveries (gestational age  $\geq 37$  weeks) to minimize concerns about a multiple gestation or preterm infants having medical concerns that could influence early infant feeding. The potential samples of 132 867 were available for analysis.

The protocol for the Newborn Metabolic Screening test is to collect the blood spot specimen and other information between 24 and 48 hours post-delivery for both hospital and out of hospital births. Infant feeding information is based on an assessment of the last 24 hours at time of newborn metabolic testing. If an infant is discharged less than 24 hours after delivery, the specimen and other information is collected at time of discharge. Infant feeding practices were based on reporting at discharge. The information on infant feeding was categorized into three mutually exclusive categories used for analysis in this paper: Early exclusive breastfeeding (ie, received only human milk in the last 24 hours), early mixed feeding (ie received both human milk and formula, though not necessarily at the same time, during the last 24 hours), and early formula feeding (ie, received only infant formula in the last 24 hours). There were 4468 excluded records with a feeding status of "Other," Nil per Os ("NPO") or nothing by mouth, "Tube Feeding," or missing, resulting in the final study sample of 128 399 observations.

The Hawai'i birth certificate collects information on all reported race groups at delivery for both parents. This information is converted to 1 of 22 single race groups by an algorithm implemented by OHSM.<sup>16</sup> The algorithm prioritizes Hawaiian for those that list multiple race groups, followed by the first non-Caucasian race reported. Thus, those that report being Hawaiian in combination with another race group would be considered part-Hawaiian. All other multiple race groups without Hawaiian listed are coded to a single race group in the algorithm. For consistency with race reporting in Hawai'i, this analysis combines part-Hawaiian and Hawaiian single race groups together, referred to as Native Hawaiian. The 22 maternal single race groups provided by OHSM were categorized into 9 total race groups for this analysis which reflected those commonly reported in Hawai'i, and to ensure sufficient sample size for reliable estimates: white (Caucasian), black, Native Hawaiian (Hawaiian and part-Hawaiian), Samoan, Filipino, Japanese, Chinese, Korean, and all others (including Vietnamese, Asian Indian, Other Asian, Guamanian/Chamorro, other Pacific Islander, Puerto Rican, Portuguese, Cuban, Mexican, American Indian/Alaskan Native, all others). Maternal race was used for this analysis to be consistent with general reporting of birth outcomes by race.

Maternal age, calculated by mother's age upon birth of the infant, was categorized into the following 5 year age groups other than at tails which included commonly used categories and ensured at least 10% in the youngest group: Under 20, 20-24, 25-29,

30–34, and 35 or more years. Marital status was considered married or unmarried as reported at time of delivery on the birth certificate. Birth attendant was categorized as physician, midwife, or other. The other group may include out of hospital deliveries attended by bystanders, non-licensed providers, or where the attendant is unknown, but that specific level of detail was not available in analytic data set. Resident zip code, as collected in the birth certificate data, was used to categorize into the four counties of residence in the State.

Annual estimates for the prevalence of each feeding type and bivariate associations with maternal race, maternal age, marital status, type of birth attendant, and county of residence were calculated. Relative changes from 2008 to 2015 were calculated for each feeding type overall and among all maternal race and other subgroups. The Cochran-Armitage Trend test assesses unadjusted trends in prevalence over time for each outcome (ie, early exclusive breastfeeding, early mixed feeding, and early formula feeding) overall and among all subgroups.

To assess trends over time in each maternal race subgroup while accounting for other factors, individual generalized logit modeling determined crude and adjusted odd ratios for early exclusive breastfeeding and early mixed feeding compared with the reference group of early formula feeding for each maternal race subgroup. The models for each maternal race subgroup were performed with birth year as a primary predictor (categorical with comparison from 2015 to 2008) with adjustment for maternal age, marital status, birth attendant, and county of residence. The factors were selected based on their availability in the database and review of the general literature as possible predictors of infant feeding. For simplicity, only the results of the birth year odds ratios stratified by maternal race for early exclusive breastfeeding compared with formula feeding are shown in the manuscript.

To assess differences among maternal race subgroups for the entire time period of the study while accounting for the influence of these other factors, a generalized logit model was developed with maternal race subgroup as the primary predictor and adjustment for the other factors noted previously for the trend model along with using birth year as a categorical variable. SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina) was used for analysis with a two-tailed *P*-value of <.05 considered statistically significant.

## Results

Within the final analytic sample (N=128,399), nearly two-thirds of births were to mothers who identified within the three following race groups: Native Hawaiian (26.8%), white (23.7%), and Filipino (16.9%; Table 1). Over half the births were to mothers who were 25–29 (28.1%) or 30–34 (25.3%) years of age. Nearly two-thirds of the births were to married (62.7%) mothers and nearly all births were delivered by a physician

(89.6%). Nearly three-quarters of the births in the sample were to mothers residing in Honolulu County (71.9%).

Statewide, the prevalence of early exclusive breastfeeding increased from 58.8% in 2008 to 79.1% in 2015 (a relative increase of +35%; Table 2). Early exclusive breastfeeding increased among all maternal race groups with Samoan mothers having the largest relative increase (+71%), followed by all

Table 1. Maternal Race and Other Characteristics, 2008–2015 (N=128 399)

Characteristic	n	%
<b>Maternal Race</b>		
white	30 370	23.7
black	3 503	2.7
Native Hawaiian	34 326	26.8
Samoan	3 325	2.6
Filipino	21 683	16.9
Japanese	12 031	9.4
Chinese	5 486	4.3
Korean	2 377	1.9
All others <sup>a</sup>	15 048	11.7
Missing	250	
<b>Maternal Age</b>		
<20 years	12 810	10.0
20–24 years	24 607	19.2
25–29 years	36 046	28.1
30–34 years	32 499	25.3
35 years and older	22 330	17.4
Missing	107	
<b>Marital Status</b>		
Married	80 518	62.7
Unmarried	47 878	37.3
Missing	3	
<b>Birth Attendant</b>		
Physician	114 936	89.6
Midwife	12 516	9.8
Other	894	0.7
Missing	53	
<b>County of Residence</b>		
Hawai'i	16 281	12.9
Honolulu	90 605	71.9
Kaua'i	5 634	4.5
Maui	13 528	10.7
Missing	2 351	

Notes: Data source is the Newborn Metabolic Screening-Linked Birth Certificate File. Individual subgroup column totals may not sum to overall total due to missing/unknown data and row percentages may not sum to 100% due to rounding.

<sup>a</sup>All others include Vietnamese, Asian Indian, other Asian, Guamanian/Chamorro, other Pacific Islander, Puerto Rican, Portuguese, Cuban, Mexican, American Indian/Alaskan Native, and all others.

Table 2. Relative Changes in Early Infant Feeding <sup>a</sup> by Maternal Race and Other Characteristics, 2008–2015												
Characteristic	Early Exclusive Breastfeeding				Early Mixed Feeding				Early Formula Feeding			
	2008 %	2015 %	Relative Change <sup>b</sup>	Trend P-value <sup>c</sup>	2008 %	2015 %	Relative Change	Trend P-value	2008 %	2015 %	Relative Change	Trend P-value
<b>Maternal Race</b>												
white	75.9	87.7	16%	<.001	16.1	8.8	-45%	<.001	7.9	3.5	-56%	<.001
black	59.6	72.9	22%	<.001	25.5	19.4	-24%	.019	15.0	7.7	-49%	<.001
Native Hawaiian	52.6	76.0	44%	<.001	33.9	17.5	-48%	<.001	13.5	6.6	-51%	<.001
Samoan	37.1	63.4	71%	<.001	41.1	26.2	-36%	<.001	21.8	10.4	-52%	<.001
Filipino	52.0	77.4	49%	<.001	38.3	18.0	-53%	<.001	9.7	4.6	-53%	<.001
Japanese	67.1	87.4	30%	<.001	28.3	11.0	-61%	<.001	4.6	1.6	-65%	<.001
Chinese	63.1	74.5	18%	<.001	28.8	20.7	-28%	<.001	8.1	4.9	-40%	<.001
Korean	66.1	83.9	27%	<.001	29.6	14.2	-52%	<.001	4.3	1.8	-58%	.128
All others <sup>d</sup>	45.8	70.7	54%	<.001	45.2	24.2	-46%	<.001	9.1	5.1	-44%	<.001
<b>Maternal Age</b>												
<20 years	51.1	77.2	51%	<.001	37.5	16.2	-57%	<.001	11.3	6.7	-41%	<.001
20–24 years	55.4	77.4	40%	<.001	32.4	17.0	-48%	<.001	12.2	5.6	-54%	<.001
25–29 years	59.9	78.7	31%	<.001	29.8	16.5	-45%	<.001	10.3	4.8	-53%	<.001
30–34 years	62.7	81.3	30%	<.001	28.2	14.6	-48%	<.001	9.1	4.1	-55%	<.001
35 years and older	61.4	79.2	29%	<.001	31.0	16.3	-47%	<.001	7.7	4.5	-42%	<.001
<b>Marital Status</b>												
Married	64.2	81.6	27%	<.001	27.6	14.6	-47%	<.001	8.2	3.8	-54%	<.001
Unmarried	49.7	74.9	51%	<.001	37.0	18.4	-50%	<.001	13.3	6.7	-50%	<.001
<b>Birth Attendant</b>												
Physician	57.7	77.5	34%	<.001	32.0	17.4	-46%	<.001	10.3	5.2	-50%	<.001
Midwife	70.6	90.5	28%	<.001	21.8	6.7	-69%	<.001	7.6	2.8	-63%	<.001
Other	69.7	88.2	27%	.008	15.2	8.8	-42%	.440	15.2	2.9	-81%	.002
<b>County of Residence</b>												
Hawai'i	59.1	71.5	21%	<.001	30.0	21.5	-28%	<.001	10.8	7.1	-34%	<.001
Honolulu	58.2	79.4	36%	<.001	31.5	15.6	-50%	<.001	10.3	5.0	-51%	<.001
Kauai	80.3	92.5	15%	<.001	12.5	4.0	-68%	<.001	7.2	3.5	-51%	<.001
Maui	52.7	81.1	54%	<.001	38.3	17.2	-55%	<.001	9.0	1.8	-80%	<.001
Overall	58.8	79.1	35%	<.001	31.1	16.0	-49%	<.001	10.1	4.9	-51%	<.001

Notes: Data source is the Newborn Metabolic Screening-Linked Birth Certificate File. Individual subgroup column totals may not sum to overall total due to missing/unknown data and row percentages may not sum to 100% due to rounding.

<sup>a</sup>Early is based on time of newborn metabolic screening test, less than 48 hours from discharge.

<sup>b</sup>Relative Change is defined by: (Prevalence in 2015 – Prevalence in 2008) / (Prevalence in 2008)

<sup>c</sup>Trend p-value based on Cochran-Armitage Trend Test

<sup>d</sup>All others include Vietnamese, Asian Indian, other Asian, Guamanian/Chamorro, other Pacific Islander, Puerto Rican, Portuguese, Cuban, Mexican, American Indian/Alaskan Native, and all others.

others (+54%), Filipino (+49%), and Native Hawaiian (+44%) mothers (Table 2 and Figure 1). Increases in early exclusive breastfeeding were also seen across all characteristic subgroups categorized by maternal age, marital status, birth attendant, and county of residence (Table 2).

Conversely, the prevalence of early mixed feeding decreased from 31.1% in 2008 to 16.0% in 2015 (a relative decrease of -49%; Table 2). Early mixed feeding declined among all maternal race groups with Japanese mothers having the largest relative

decrease (-61%), followed by Filipino (-53%), Korean (-52%), and Native Hawaiian (-48%) mothers (Table 2 and Figure 2). Declines in early mixed feeding were also seen across all characteristic subgroups categorized by maternal age, marital status, birth attendant (except other birth attendant), and county of residence (Table 2).

Statewide, the prevalence of early formula feeding decreased from 10.1% in 2008 to 4.9% in 2015 (a relative decrease of -51%; Table 2). Early formula feeding declined among all maternal



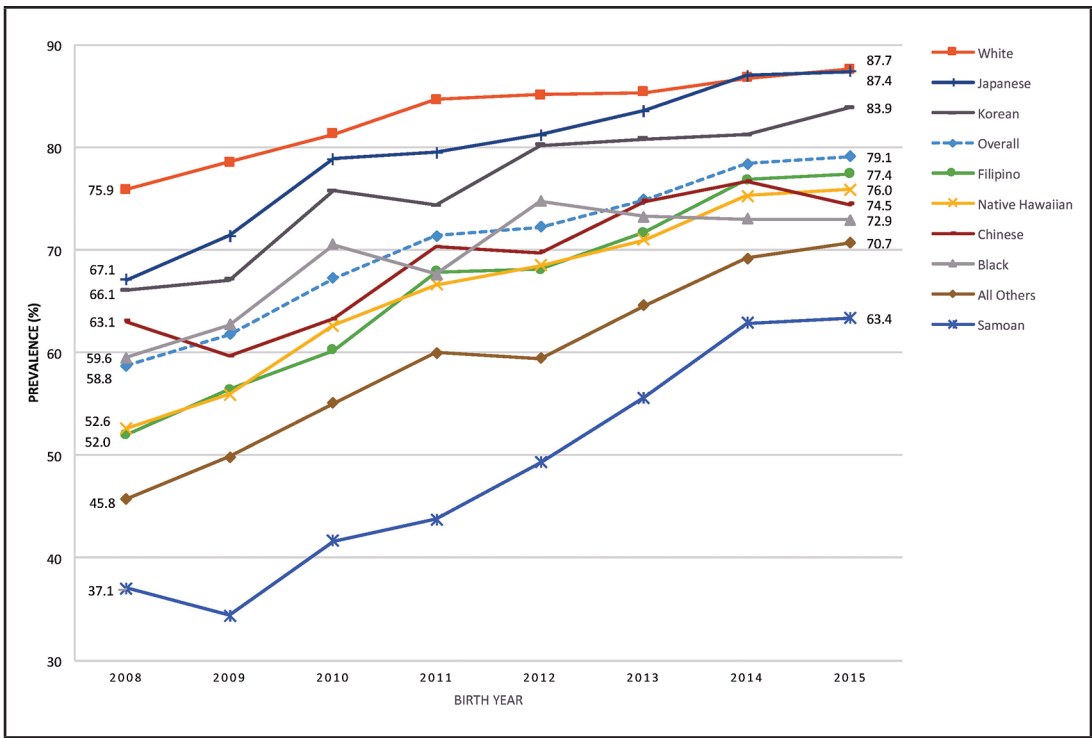


Figure 1. Early Exclusive Breastfeeding by Maternal Race, Hawai'i Newborn Metabolic Screening-Linked Birth Certificate, File, 2008-2015

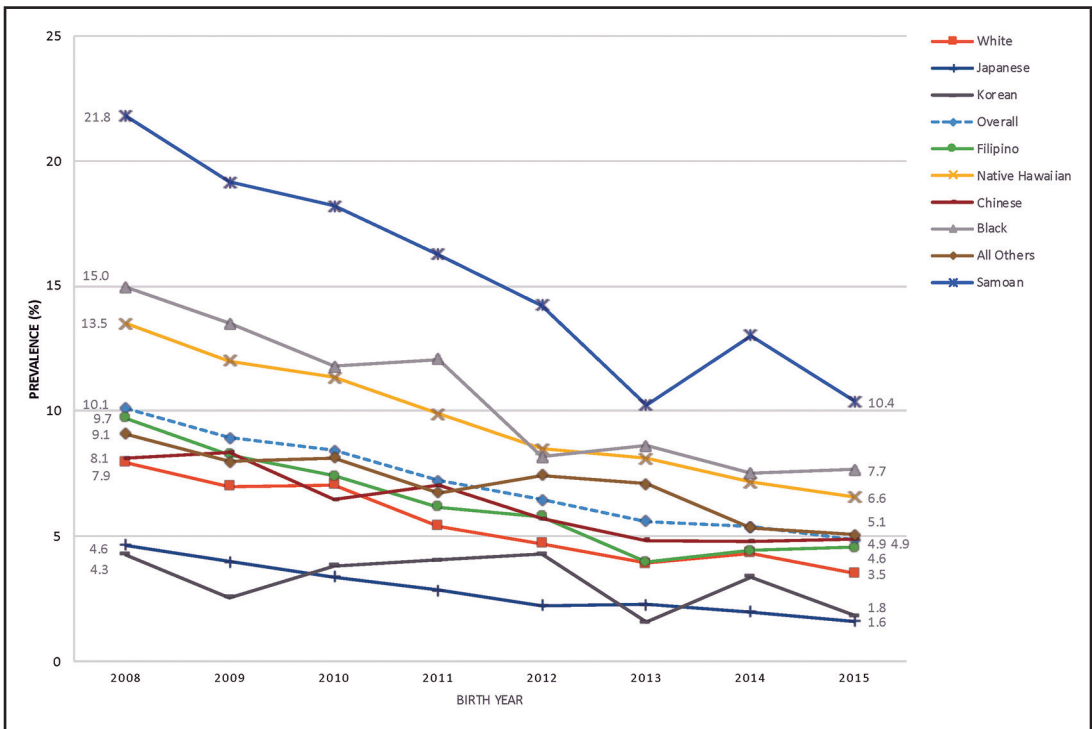


Figure 2. Early Formula Feeding by Maternal Race, Hawai'i Newborn Metabolic Screening-Linked Birth Certificate File, 2008-2015

race groups (except Korean mothers) with Japanese mothers having the largest relative decrease (-65%; Table 2 and Figure 3). Declines in early formula feeding were also seen across all characteristic subgroups categorized by maternal age, marital status, birth attendant, and county of residence (Table 2).

Overall, there was a 2.78 times greater odds of early exclusive breastfeeding versus early formula feeding in 2015 compared to 2008 after adjustment for maternal race, maternal age, marital status, birth attendant, and county of residence (Table 3). Additionally, within each maternal race subgroup, adjusted odds ratios indicated women who delivered in 2015 were more likely to practice early exclusive breastfeeding than early formula feeding compared with women who delivered in 2008 (Table 3).

In the generalized logit model to compare differences by maternal race subgroups, Japanese and Korean mothers were more likely to practice early exclusive breastfeeding (reference=early formula feeding) compared with white mothers after adjusting for maternal age, marital status, birth attendant, county of residence, and birth year (Table 4). However, Samoan, Black, Native Hawaiian, Filipino, Chinese, and all others were all less likely to practice early exclusive breastfeeding compared with white mothers. In the adjusted analysis for early mixed feeding (reference=early formula feeding), Japanese, Korean, Filipino, Chinese, Native Hawaiian, Samoan, and all others were more likely to practice early mixed feeding compared with white mothers.

Maternal Race	Crude OR (95% CI) <sup>a</sup>	Adjusted OR <sup>b</sup> (95% CI)
white	2.60 (2.11 - 3.21)	2.41 (1.95 - 2.99)
black	2.40 (1.54 - 3.72)	2.11 (1.35 - 3.32)
Native Hawaiian	2.97 (2.55 - 3.46)	3.05 (2.60 - 3.56)
Samoan	3.59 (2.35 - 5.49)	3.48 (2.23 - 5.44)
Filipino	3.17 (2.53 - 3.97)	3.29 (2.62 - 4.13)
Japanese	3.79 (2.34 - 6.13)	3.80 (2.29 - 6.31)
Chinese	1.97 (1.26 - 3.10)	2.20 (1.39 - 3.46)
Korean	2.98 (1.04 - 8.49)	2.68 (0.93 - 7.74)
All others <sup>c</sup>	2.77 (2.12 - 3.62)	2.97 (2.26 - 3.89)
Overall	2.80 (2.56 - 3.06)	2.78 (2.54 - 3.05)

Note: Data source is the Newborn Metabolic Screening-Linked Birth Certificate File. Individual models for each Maternal Race group and overall were used to assess trend difference between 2015 and 2008.  
<sup>a</sup>CI denotes Confidence interval around the odds ratio estimate  
<sup>b</sup>Individual models were adjusted for maternal age, marital status, birth attendant, and county of residence  
<sup>c</sup>All others include Vietnamese, Asian Indian, other Asian, Guamanian/Chamorro, other Pacific Islander, Puerto Rican, Portuguese, Cuban, Mexican, American Indian/Alaskan Native, and all others.

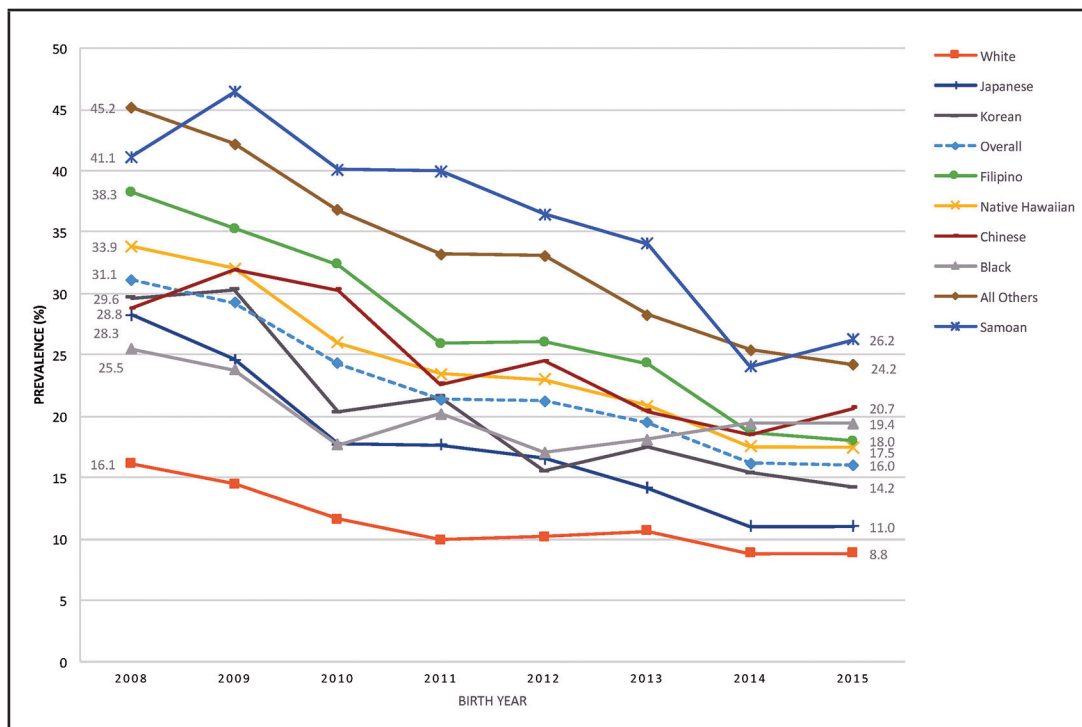


Figure 3. Early Mixed Feeding by Maternal Race, Hawai'i Newborn Metabolic Screening-Linked Birth Certificate File, 2008-2015

Maternal Race	Early Exclusive Breastfeeding		Early Mixed Feeding	
	Crude OR (95% CI) <sup>b</sup>	Adjusted OR <sup>c</sup> (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
white	ref ref	ref ref	ref ref	ref ref
black	0.44 (0.39–0.50)	0.48 (0.42–0.54)	0.94 (0.82–1.08)	1.00 (0.87–1.15)
Native Hawaiian	0.44 (0.42–0.47)	0.57 (0.53–0.61)	1.22 (1.14–1.31)	1.33 (1.23–1.43)
Samoan	0.20 (0.18–0.23)	0.25 (0.23–0.28)	1.13 (1.01–1.28)	1.26 (1.11–1.42)
Filipino	0.68 (0.63–0.73)	0.80 (0.74–0.86)	2.10 (1.93–2.28)	2.22 (2.03–2.41)
Japanese	1.77 (1.58–1.99)	2.15 (1.90–2.42)	2.98 (2.62–3.38)	3.10 (2.72–3.54)
Chinese	0.74 (0.66–0.84)	0.83 (0.73–0.94)	1.93 (1.69–2.20)	2.03 (1.77–2.32)
Korean	1.54 (1.22–1.94)	1.73 (1.37–2.18)	3.07 (2.40–3.93)	3.07 (2.39–3.94)
All others <sup>d</sup>	0.55 (0.51–0.59)	0.65 (0.60–0.71)	2.28 (2.09–2.49)	2.43 (2.22–2.67)

Note: Data source is the Newborn Metabolic Screening-Linked Birth Certificate File.

Formula Feeding is the referent comparison group for each outcome.

<sup>a</sup>Early is based on time of newborn metabolic screening test.

<sup>b</sup>CI denotes Confidence interval around the odds ratio estimate.

<sup>c</sup>Adjusted for maternal age, marital status, birth attendant, county of residence, and birth year.

<sup>d</sup>All others include Vietnamese, Asian Indian, other Asian, Guamanian/Chamorro, other Pacific Islander, Puerto Rican, Portuguese, Cuban, Mexican, American Indian/Alaskan Native, and all others.

## Discussion

These findings highlight early infant feeding patterns among a diverse subgroup of maternal races not previously described in the general literature. There was an overall improvement in early exclusive breastfeeding and declines in early mixed feeding and in early formula feeding among almost all maternal race subgroups in Hawai‘i from 2008–2015. Further evaluation identified some persistent differences in maternal race subgroups. Additionally, there were improvements in early exclusive breastfeeding for other socio-demographic characteristics in the unadjusted analysis.

There are likely several factors contributing to the noted improvements in early infant feeding patterns seen among maternal race subgroups. In 2010, the Baby Friendly Hawai‘i Project started promoting breastfeeding support in hospitals, through maternity care practices without giving specific attention to high-risk populations.<sup>12</sup> The study results, showing improvement in all maternal race and other subgroups, support the premise that this system level change helped improve early infant feeding rates for all women. Additionally, other system level factors including the establishment of Joint Commission measures in 2010 for breastfeeding at hospitals or other smaller scale interventions may have contributed to this large-scale improvement.<sup>14,17</sup> The increasing awareness of the benefits of breastfeeding in society over time also likely contributed to the improvement. The descriptive nature of this study does not allow further exploration but are briefly mentioned here. For example, breastfeeding is promoted through legislative laws to protect the ability of women to breastfeed in the workplace and in public. The Hawai‘i Special Supplemental Nutrition Program for Women Infants and Children (WIC) provides

education on infant feeding to nearly half the mothers in the state on breastfeeding and supports policy and workplace efforts across the state.<sup>18</sup>

Despite the overall significant improvement noted, some notable differences remain in early infant feeding patterns, among maternal race subgroups. Understanding the reasons for these differences could help inform the development of programs to address disparities. Rates of breastfeeding change as immigrant populations become acculturated to living in the United States.<sup>19-26</sup> Other key factors including employment where breastfeeding is not supported and general societal expectations are also important for breastfeeding.<sup>19,20</sup> Finally, other factors including health literacy may also be related to early infant feeding as it has been associated with other perinatal outcomes in Hawai‘i including low birth weight, cesarean delivery, obstetric trauma, medical decision making, and vaginal birth after cesarean<sup>27-32</sup> and in other settings for breastfeeding.<sup>33,34</sup> Understanding and learning from differences within the diverse race groups in Hawai‘i is challenging but clarifying the influence due to immigration, acculturation, health literacy, employment, and cultural factors through both quantitative and qualitative approaches could be helpful in developing targeted interventions among these particular subgroups.

The accuracy of the feeding pattern reported on the Newborn Metabolic Screening data and the quality of the data collection may vary from hospital to hospital and for births outside a hospital potentially influencing our results. Additionally, the analysis is based on the feeding pattern noted within the first 24–48 hours of life only, but this is a critical time period that is predictive of future breastfeeding patterns.<sup>35-38</sup> This analysis was limited to term newborns to minimize concerns about

medical conditions associated with prematurity that could influence early breastfeeding, but overall results without this exclusion demonstrated very similar patterns and rates (data not shown). Moreover, race was based on the maternal single race provided by OHSM, which limits the ability to generalize these results to all Asian and NHOPI subgroups particularly due to the inability to separate out those women who were of more than 1 race. Additionally, the number of births among some of the other smaller Asian or NHOPI subgroups were too small (ie, Vietnamese, Micronesian) to be analyzed and may result in different patterns. Moreover, race is a social construct that is not even homogenous within a population and thus there are limitations on its use to characterize populations. Further, the ability to look at the combination of mother and father race or of proportions of various race groups for those that were multi-race were not possible with the data provided. Other limitations include the lack of ability to look at other social determinants (ie, income, household federal poverty level, and insurance status) and cultural practices that likely influence infant feeding patterns. The data did not include a woman's past experience with breastfeeding or familial support of breastfeeding, which are both important predictors for breastfeeding experience and continuation.<sup>20,39,40</sup> Finally, this study was based on a diverse population in Hawai'i and although many of these same populations live in communities across the country, these results may not be generalizable to those populations due to acculturation and cultural differences from those found outside Hawai'i. However, these results may provide insight into early infant feeding patterns in these subgroups, and it will be important to validate these results in other states.

## Conclusions

There was substantial improvement in early exclusive breastfeeding in the state of Hawai'i, coinciding with systemic changes implemented by hospitals. However, some persistent disparities exist among maternal race groups. Further understanding of reasons why certain maternal race subgroups continue to have lower while others have high estimates of early exclusive breastfeeding may help in the development of culturally appropriate hospital practices to address disparities in early infant feeding in Hawai'i.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the Hawai'i State Department of Health.

## Conflict of Interest

None of the authors identify a conflict of interest.

## Disclosure

Donald Hayes initiated his work on the reported research while affiliated with the Hawai'i State Department of Health. Currently, he is affiliated with the Centers for Disease Control and Prevention's Division for Heart Disease and Stroke Prevention. The research in this manuscript was completed and submitted outside of the official duties of his current position.

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### Authors' Affiliations:

- Centers for Disease Control and Prevention, Division of Reproductive Health, Atlanta, GA (DKH)
- Hawai'i State Department of Health, Family Health Services Division, Honolulu, HI (DKH)
- Centers for Disease Control and Prevention, Epidemic Intelligence Service, Atlanta, GA (EOB)
- Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity, and Obesity, Atlanta, GA (EOB)
- Hawai'i State Department of Health, Chronic Disease Prevention and Health Promotion Division, Honolulu, HI (HHS, CLM)

### Correspondence to:

Donald K Hayes MD, MPH; Division for Heart Disease and Stroke Prevention, Centers for Disease Control & Prevention, 4770 Buford Hwy, MS S107-1, Atlanta, GA 30341; Email: Bkn0@cdc.gov



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