Maternal and Child Health Journal (2019) 23:19–29
https://doi.org/10.1007/s10995-018-2587-x

Breastfeeding Discontinuation Not Associated with Maternal Pregravid BMI But Associated with Native Hawaiian or Other Pacific Islander Race in Hawaii and Puerto Rico WIC Participants

Cheryl L. K. Gibby[1] · Cristina Palacios[2] · Maribel Campos[3] · Eunjung Lim[4] · Jinan Banna[1]

Published online: 13 July 2018

Abstract

Objectives This study investigated the association between maternal pregravid body mass index (BMI) and breastfeeding discontinuation at 4–6 months postpartum in Hawaii and Puerto Rico participants from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). *Methods* A secondary data analysis was conducted from a text message-based intervention in WIC participants in Hawaii and Puerto Rico. The analysis included 87 women from the control group who initiated breastfeeding and whose breastfeeding status was known at the end of the study when infants were 4–6 months old. Pregravid BMI and breastfeeding discontinuation were assessed using questionnaires. *Results* The association between pregravid BMI and breastfeeding discontinuation was not significant in the unadjusted model or in the adjusted model. Native Hawaiian or Other Pacific Islander (NHOPI) participants showed significantly increased odds of discontinuing breastfeeding (adjusted odds ratio [AOR] 7.12; 95% CI 1.34, 37.97; p = .02) compared to all the other racial/ethnic participants, as did older women ages 32–39 years versus women who were 25–31 years old (AOR 4.21; 95% CI 1.13, 15.72; p = .03). Women who took vitamins while breastfeeding had decreased odds of discontinuing breastfeeding (AOR 0.15; 95% CI 0.05, 0.46; p = .0009). *Conclusions for Practice* Pregravid BMI was not significantly associated with breastfeeding discontinuation at 4–6 months postpartum in women from Hawaii and Puerto Rico WIC, but NHOPIs and women who were older had higher odds of discontinuing breastfeeding. The results of this study may inform strategies for breastfeeding promotion and childhood obesity prevention but should be further investigated in larger studies. ClinicalTrials.gov Identifier: NCT02903186.

Keywords Pregravid · BMI · Breastfeeding · WIC · Low income

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10995-018-2587-x) contains supplementary material, which is available to authorized users.

✉ Jinan Banna
jcbanna@hawaii.edu

Cheryl L. K. Gibby
clkkoide@hawaii.edu

Cristina Palacios
cristina.palacios@fiu.edu

Maribel Campos
maribel.campos@upr.edu

Eunjung Lim
lime@hawaii.edu

[1] Department of Human Nutrition, Food and Animal Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Agricultural Sciences 216, 1955 East-West Rd, Honolulu, HI 96822, USA

[2] Dietetics and Nutrition Department, Robert Stempel College of Public Health & Social Work, Florida International University, 11200 SW 8th Street, AHC 5 – 313, Miami, FL 33199, USA

[3] Dental and Craniofacial Genomics Unit, Endowed Health Services Research Center, Medical Sciences Campus, University of Puerto Rico, PO Box 365067, San Juan, PR 00936-5067, USA

[4] Department of Complementary and Integrative Medicine, Biostatistics Core Facility, John A. Burns School of Medicine, University of Hawaii at Manoa, Biological Sciences Building 211, 651 Ilalo Street, Honolulu, HI 96813, USA

Significance

What is already known on this subject? High maternal pregravid BMI is a risk factor for childhood obesity. Maternal overweight and obesity are associated with decreased breastfeeding duration, which is problematic since breastfeeding is protective against obesity. Low-income and minority children, such as Hispanics in Puerto Rico and NHOPI in Hawaii, are particularly at risk for childhood obesity.

What this study adds? Pregravid BMI was not significantly associated with breastfeeding discontinuation at 4–6 months postpartum in women from Hawaii and Puerto Rico WIC. Modifying overweight or obese pregravid BMI may not significantly affect breastfeeding duration before 6 months. However, NHOPI showed increased odds of early breastfeeding discontinuation.

Introduction

Although breastfeeding rates are rising in the US, where the breastfeeding rate at 6 months increased from 51.8% of infants in 2013 to 55.3% in 2014 (Centers for Disease Control and Prevention 2017), the US has not yet met the Office of Disease Prevention and Health Promotion's Healthy People 2020 goal of 60.6% of infants breastfeeding at 6 months (US Department of Health and Human Services, Office of Disease Prevention and Health Promotion 2010). In Puerto Rico, the breastfeeding rate at 6 months is low at 38.1%, which is about 17% lower than the national average (Centers for Disease Control and Prevention 2017). In Hawaii, although the rate of breastfeeding at 6 months was 62.9% in 2014 (Centers for Disease Control and Prevention 2017), it was previously reported that Native Hawaiian participants in Hawaii's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) had much lower rates of breastfeeding at 6 months postpartum, at 52% among initiators (Dodgson et al. 2007).

Overweight and obese women may have an increased risk for failure to initiate breastfeeding and decreased duration of breastfeeding, as indicated by a 2010 literature review (Wojcicki 2011). Previous studies have reported negative associations between pregravid overweight/obesity body mass index (BMI) and breastfeeding duration in Hispanic (Kugyelka et al. 2004) and White (Liu et al. 2010) women. According to the 2010 Hawaii Pregnancy Risk Assessment Monitoring System (PRAMS) Breastfeeding Fact Sheet, obese maternal pregravid BMI is associated with less breastfeeding initiation and breastfeeding for less than 8 weeks in Hawaii's ethnically diverse population (Hawaii State Department of Health 2010).

One biological factor that likely causes overweight and obese women to stop breastfeeding is a lower prolactin response to suckling (Rasmussen and Kjolhede 2004). This diminished response may lead to compromised milk production and, subsequently, to premature cessation of breastfeeding (Rasmussen and Kjolhede 2004). Delayed lactogenesis II, or a delay in the onset of copious milk production after birth, is associated with overweight or obese BMI (Nommsen-Rivers et al. 2010) and exhibited a significant effect on cessation of breastfeeding at 4 weeks postpartum in a study with almost 2500 US women (Brownell et al. 2012).

Breastfeeding is moderately yet consistently protective against obesity later in life (Li et al. 2005). According to the Centers for Disease Control and Prevention (CDC), 9 months of breastfeeding reduces an infant's risk of becoming overweight by more than 30% (Centers for Disease Control and Prevention 2011). Moreover, more protection from overweight and obesity is conferred by increasing the exclusivity and duration of breastfeeding (Spatz 2014). In contrast, high maternal pregravid BMI has been shown to be a significant risk factor for childhood obesity (Catalano et al. 2009), and pregravid obesity is associated with increased fat mass in newborn offspring (Sewell et al. 2006).

Low-income and minority children are particularly at risk for childhood obesity (Pan et al. 2012). Among infants, Hispanic and Black children have increased odds of rapid infancy weight gain compared with White infants (Taveras et al. 2010). Minority groups in Hawaii, such as Native Hawaiian or Other Pacific Islander (NHOPI), have higher BMI between 2 and 4 months of age compared to other races (Oshiro et al. 2015). In one study, low-income NHOPI and Filipino pre-kindergarten children in Hawaii had a high prevalence of obesity, with more than 42% being overweight or obese (Okihiro et al. 2012). Nationally, in 2014, overweight or obesity occurred in 40% of US 1-year-olds and 30% of 2 to 5-year-olds participating in WIC (Thorn et al. 2015), a federally funded program for low-income women and children. A systematic review of risk factors for childhood obesity that are present from conception to 2 years old indicated that excessive gestational weight gain, higher pregravid BMI, high infant birth weight, prenatal tobacco exposure, and rapid infancy weight gain were consistently associated with childhood obesity (Woo Baidal et al. 2016). Lower socioeconomic status was found to be a risk factor, but the review authors suggested that more research is needed in low-income and minority populations to determine underlying mechanisms (Woo Baidal et al. 2016). Factors contributing to the development of childhood obesity may involve environmental and behavioral aspects such as parental and child feeding practices, such as restriction and pressure (Birch and Davison 2001).

For obesity prevention, the association between pregravid BMI and breastfeeding duration is worthy of attention. To

our knowledge, no studies have investigated the association between pregravid BMI and breastfeeding discontinuation in low-income groups in Hawaii or Puerto Rico. Examination of this association may inform childhood obesity prevention strategies in these groups. Therefore, the objective of this study is to investigate the association between maternal pregravid BMI and breastfeeding discontinuation at 4–6 months postpartum in Hawaii and Puerto Rico WIC participants. We hypothesized that low-income women in Hawaii and Puerto Rico with pregravid BMI ≥ 25 kg/m^2 would have greater odds of discontinuing breastfeeding before 4–6 months postpartum than women with pregravid BMI < 25 kg/m^2.

Methods

Participants

A secondary data analysis was conducted from participants in a 4-month text message-based intervention aimed at preventing excessive weight gain in at-risk infants from WIC clinics in Hawaii and Puerto Rico [blinded]. Eligible mothers/caregivers were at least 18 years old, owned a mobile phone with unrestricted texting capabilities, were responsible for caring for the infant, and were willing to complete the entire study. Inclusion criteria required the infant to have been born after 37 weeks of gestation, to be on a normal diet and free from disabilities that hinder movement, and to have had birthweight at or between the 10th and 90th percentiles as indicated by the World Health Organization (WHO) growth charts (World Health Organization 2006). In addition, infants were required to have been no more than 2 months old at baseline to ensure that they were, at most, 6 months old at the end of the intervention, which is the recommended age at which complementary foods should be introduced. Text messages regarding breastfeeding were introduced first, followed by messages about complementary foods that, ideally, would be used at the age of 6 months.

A convenience sample of infants (n = 202) and their mother/caregiver were recruited from four WIC clinics in Hawaii and two WIC clinics in Puerto Rico from January to April, 2016. Participants were assigned to control or intervention groups by block randomization. Detailed methods used in the trial have been published elsewhere (Banna et al. 2017). Study procedures were approved by the institutional review boards at the University of Hawaii and the University of Puerto Rico, and informed consent was obtained prior to data collection.

Measures

Mothers/caregivers (n = 202) completed the baseline assessment which included questionnaires and infant anthropometric measurements. Data collected from the questionnaires included the following: socio-demographic information such as race, mother's age, and infant's gender; pregnancy- and health-related information such as maternal pregravid weight and height, weeks of gestation at delivery, weight gained during pregnancy, and infant vaccinations; food frequency information; and infant feeding practices information such as breastfeeding initiation and duration, reasons for discontinuing breastfeeding, and complementary foods used.

Analyses for the current study included the control group only (n = 100). Pregravid BMI (exposure) was calculated using self-reported weight before pregnancy and height. The National Institutes of Health classifications for BMI (kg/m^2) was used to determine weight status: underweight (< 18.5), normal (18.5–24.9), overweight (25–29.9), and obese (≥ 30) ("Losing Weight, Body Mass Index," n.d.). Breastfeeding initiation was defined as breastfeeding at least once and was assessed using the questionnaire item, "Did you breastfeed your baby, even once?" Discontinuation of breastfeeding (main outcome of interest) was assessed with the questionnaire item, "Are you still breastfeeding your baby?" Duration of breastfeeding was self-reported with the questionnaire item, "If you are no longer breastfeeding your baby, how old was your baby when you stopped nursing?" Exclusively pumping milk was considered continued breastfeeding.

Figure 1 describes inclusion in the analysis group. Ninety-eight participants from the control group initiated breastfeeding. Eighty-seven mothers/caregivers completed the 4-month follow-up assessment. Of those who initiated breastfeeding, 11 were lost to follow-up and their breastfeeding duration could not be determined. Of those who were lost, seven had normal pregravid BMI, three were overweight, one was obese, nine were from Hawaii, and two were from Puerto Rico.

Variables

Dependent variable

Breastfeeding discontinuation status at 4–6 months postpartum was defined as a binary outcome in women from the control group who initiated breastfeeding (n = 98) and whose breastfeeding status was known at the end of the study (n = 87). Breastfeeding continuation was coded as "yes", and breastfeeding discontinuation was coded as "no".

Independent variable

Due to the similar trend in the distribution in breastfeeding status between pregravid BMI categories, pregravid BMI categories were combined as underweight/normal (UN) or overweight/obese (OWOB) for the analysis.

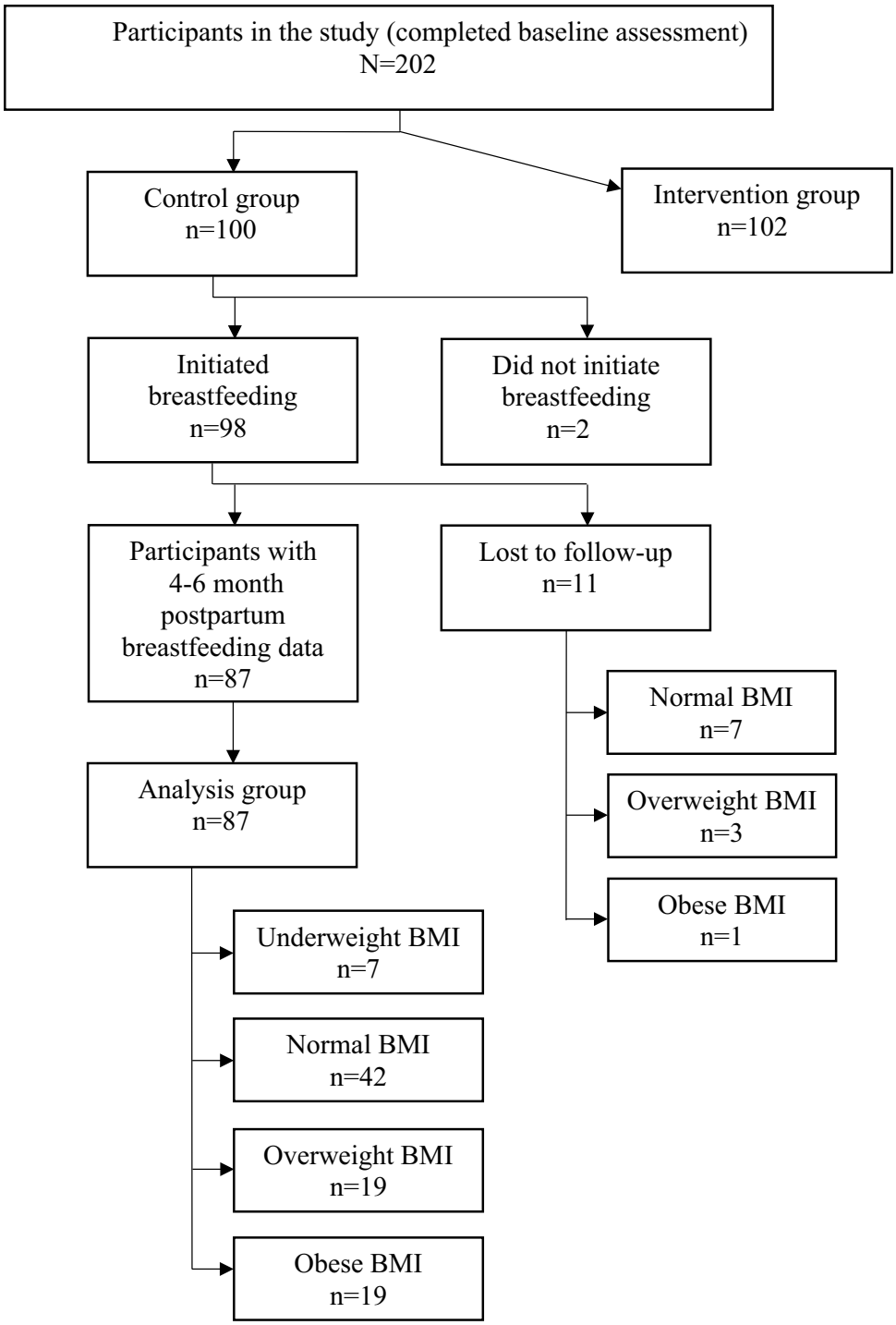

Fig. 1 Final analysis group and participants lost to follow-up for a secondary data analysis of pregravid BMI and breastfeeding discontinuation

Possible covariates

Variables tested as possible covariates included site (Hawaii or Puerto Rico), mother's race/ethnicity, mother's age (divided into three strata by years: 18–24, 25–31, and 32–39), mother's education level, parity, use of prenatal vitamins during pregnancy, pregnancy complications, use of vitamins while breastfeeding, weeks of gestation at delivery, gestational weight gain, infant gender, and being up-to-date with infant vaccinations. Based upon the US Office of Management and Budget (OMB) standards (US Census Bureau, n.d.), race/ethnicity categories were divided into the following groups: Hispanic, Native Hawaiian or Other Pacific Islander (NHOPI), American Indian or Alaska Native, Asian, Black or African American, and White. Each racial/ethnic group was treated as a binary variable.

Statistical analyses

For baseline characteristics, descriptive statistics were presented using frequencies and percentages, or using means and standard deviations. Chi-squares tests, Fisher's exact tests, and two-sample t-tests were conducted to investigate the bivariate associations between baseline characteristics and breastfeeding discontinuation status, depending on variable type. Chi square tests were used to examine the bivariate association between breastfeeding status (discontinuation or continuation) and pregravid BMI (OWOB or UN).

To determine the association between pregravid BMI and breastfeeding discontinuation, a multivariable logistic regression was conducted adjusting for the demographic variables that were statistically significant in the bivariate analyses. The covariates in the final logistic models were NHOPI race, mother's age, and use of vitamins while breastfeeding. Goodness-of-fit for the multivariable logistic regression model was assessed using Hosmer and Lemeshow test, and c-statistics were used to measure the accuracy of the model. For all analyses, a p-value of $< .05$ was considered statistically significant. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Forty participants (46%) from Hawaii and 47 participants (54.0%) from Puerto Rico were included in the final analysis. Characteristics of the final analysis group, presented by pregravid BMI, are shown in Table 1. Characteristics of the control group and group that was lost to follow-up are shown in Online Resource 1. Comparing participants in the final analysis group (n = 87) with those who did not complete the study (n = 11), we found no statistically significant differences in age, gestational age at birth, gestational weight gain, pregravid BMI, race other than Asian and non-White, level of education, parity, use of prenatal vitamins during

Table 1 Distribution of select maternal and infant characteristics by pregravid BMI, n (%), for the final analysis group from a secondary data analysis of pregravid BMI and breastfeeding discontinuation

	Total (n = 87)	UN[a] (n = 49)	OWOB[b] (n = 38)
Maternal factors			
Age (mean [SD])	27.0 [5.0]	27.6 [4.9]	26.4 [5.1]
18–24 years	29 (33.3)	13 (26.5)	16 (42.1)
25–31 years	40 (50.0)	25 (51.0)	15 (39.5)
32–39 years	18 (20.7)	11 (22.4)	7 (18.4)
Race[c]/ethnicity			
Hispanic	53 (61.6)	28 (57.1)	25 (65.8)
Native Hawaiian or other Pacific Islander	15 (14.9)	6 (8.2)	9 (23.7)
Asian	15 (17.2)	10 (20.4)	5 (13.2)
American Indian or Alaska Native	3 (3.5)	1 (2.0)	2 (5.3)
Black or African American	11 (12.6)	6 (12.2)	5 (13.2)
White	43 (49.4)	26 (53.1)	17 (44.7)
Education			
Less than college	34 (39.1)	19 (38.8)	15 (39.5)
Some college	21 (24.1)	11 (22.4)	10 (26.3)
College degree or higher	32 (36.8)	19 (38.8)	13 (34.2)
Parity (mean [SD])	1.8 [0.8]	1.8 [0.9]	1.8 [0.6]
Use of prenatal vitamins	85 (97.7)	47 (95.9)	38 (100.0)
Pregnancy complications	33 (37.9)	13 (26.5)	20 (52.6)
Took vitamins while breastfeeding	43 (49.4)	21 (42.9)	22 (57.9)
Gestational age (weeks; mean [SD])	38.8 [1.0]	38.8 [1.2]	38.8 [0.6]
Gestational weight gain (lb; mean [SD])	27.8 [12.1]	29.2 [10.6]	26.1 [13.8]
Infant factors			
Male	44 (50.6)	26 (53.1)	18 (47.4)
Female	43 (49.4)	23 (46.9)	20 (52.6)
Up-to-date with vaccinations	70 (80.5)	38 (77.6)	32 (84.2)

Column percentages

[a]Underweight or normal BMI

[b]Overweight or obese BMI

[c]Participants can choose multiple races

pregnancy, pregnancy complications, infant gender, and being up-to-date with infant vaccines. Women who were in Hawaii (p = .05), Asian (p = .04), non-White (p = .02), or who took vitamins while breastfeeding (p = .04) were more likely to have been lost to follow-up.

Half of the women in the final analysis group were in the 25–31 years old age group, half (49.4%) were White, 14.9% were NHOPI, and more than half (61.6%) were Hispanic. In the final group, almost all women (97.7%) used prenatal vitamins and about half (49.4%) used vitamins while breastfeeding. Sixty percent of NHOPI participants were overweight or obese prior to pregnancy, and 66.7% of Asian women had UN pregravid weight. More than half (52.6%) of OWOB women had pregnancy complications in contrast to about a quarter (26.5%) of UN women having complications.

The mean pregravid BMI for the final analysis group was 26.2 (SD = 7.1). Participants who discontinued breastfeeding (n = 43) or continued breastfeeding (n = 44) had mean pregravid BMI of 27.6 (SD = 8.5) or 24.8 (SD = 5.1), respectively, which was not significantly different (p = .07). Bivariate analysis, results shown in Table 2, revealed that the associations between breastfeeding status and the following variables were not statistically significant: site (Hawaii vs. Puerto Rico), pregravid BMI, age (as a continuous variable), race/ethnicity (NHOPI vs. other), level of education, parity, use of prenatal vitamins, pregnancy complications, gestational age at birth, gestational weight gain, infant gender, and being up-to-date with infant vaccines (Table 2). Variables that were statistically significant were used in the final adjusted multiple logistic regression model: age by category (p = .046), NHOPI (p = .011), and took vitamins while breastfeeding (p < .0001). As shown in Table 2, slightly more than half (53.5%) of the women who discontinued breastfeeding had normal or underweight pregravid BMI, and a little more than half (52.6%) of OWOB women discontinued breastfeeding.

As shown in Table 3, the association between breastfeeding discontinuation and pregravid BMI was not significant in the unadjusted model (crude odds ratio [COR] 0.8; 95% confidence interval [CI] 0.34, 1.86; p = .60) or in the adjusted model (adjusted odds ratio [AOR] 1.34; 95% CI 0.44, 4.02; p = .61). [Table 3] However, as presented in Table 3, participants of NHOPI race showed significantly increased odds of discontinuing breastfeeding (AOR 7.12; 95% CI 1.34, 37.97; p = .02). Also, older women in age group 32–39 years, versus women who were 25–31 years old, showed increased odds of discontinuing breastfeeding (AOR 4.21; 95% CI 1.13, 15.72; p = .03). Finally, women who took vitamins while breastfeeding had decreased odds of discontinuing breastfeeding (AOR 0.15; 95% CI 0.05, 0.46; p = .0009).

The multivariable logistic regression showed good fit (p = .58), and the c-statistic was 0.84 (95% CI 0.76, 0.92), indicating a good model.

Discussion

Several previous studies reported associations between maternal pregravid BMI and breastfeeding duration at 6 months in minority populations in the US (Kugyelka et al. 2004; Liu et al. 2010; Wojcicki 2011), but none investigated these associations in low-income groups in Hawaii or Puerto Rico. Therefore, more research is needed in these at-risk populations, and the current study contributes new knowledge in this area.

Contrary to our hypothesis, in comparison to women with pregravid BMI < 25 kg/m^2, overweight or obese women from Hawaii and Puerto Rico WIC did not show increased odds of discontinuing breastfeeding at 4–6 months postpartum. Larger studies have reported that overweight or obese women are more likely to breastfeed for shorter duration than normal or underweight women (Hawaii State Department of Health 2010; Wojcicki 2011). In upstate New York, pregravid obesity in Hispanic women, most of whom were Puerto Rican, was significantly associated with shorter duration of breastfeeding during the first 6 months (Kugyelka et al. 2004). Although pregravid BMI was not investigated, a study in Western Massachusetts of predominately Puerto Rican women reported that second or third generation Hispanic women who were born in the US were less likely to report intent to breastfeed in comparison to first generation women (Barcelona de Mendoza et al. 2016). Therefore, acculturation may play an important role in the association between pregravid BMI and breastfeeding discontinuation. In the current study involving Puerto Rican women in Puerto Rico, lack of acculturation may partly explain why overweight or obese pregravid BMI was not associated with greater breastfeeding discontinuation. Future studies investigating the role of acculturation in breastfeeding rates across pregravid BMI categories for Puerto Rican and NHOPI women could shed light on these associations.

Physiological mechanisms that support the association between OWOB pregravid BMI and early cessation of breastfeeding include lower prolactin response to suckling (Rasmussen and Kjolhede 2004) and delayed lactogenesis II (Brownell et al. 2012; Nommsen-Rivers et al. 2010). Therefore, in order to better understand the impact of pregravid BMI on breastfeeding practices of low-income women in Hawaii and Puerto Rico, future studies with larger samples are needed.

Several statistically significant associations occurred in the final analysis group. Although older maternal age has been associated with longer duration of breastfeeding (McKechnie et al. 2009), the current study found that older women (32 years and older) had more than four times the odds of discontinuing breastfeeding than women

Table 2 Results of bivariate analysis by breastfeeding status from a secondary data analysis of the association between pregravid BMI and breastfeeding discontinuation

Variable	Breastfeeding status at 4–6 months, n (%)		p Value
	Discontinued 43 (49.3)	Continued 44 (50.6)	
Site			.165[a]
Hawaii	23 (57.5)	17 (42.5)	
Puerto Rico	20 (42.6)	27 (57.5)	
Pregravid BMI			.569[a]
Underweight (U)	3 (42.9)	4 (57.1)	
Normal (N)	20 (47.6)	22 (52.4)	
Overweight (OW)	8 (42.1)	11 (57.9)	
Obese (OB)	12 (63.2)	7 (36.8)	
Pregravid BMI (combined)			.598[a]
Underweight or normal (UN)	23 (46.9)	26 (53.1)	
Overweight or obese (OWOB)	20 (52.6)	18 (47.4)	
Pregravid BMI (continuous)	27.6 (8.5)	24.8 (5.1)	.066[d]
Age (categorical)			.046[a]*
18–24 years	18 (62.1)	11 (37.9)	
25–31 years	14 (35.0)	26 (65.0)	
32–39 years	11 (61.1)	7 (38.9)	
Age (continuous)			.580[c]
Race[e]/ethnicity			
Hispanic	23 (43.4)	30 (56.6)	.201[a]
Native Hawaiian or other Pacific Islander	12 (80.0)	3 (20.0)	.011[b]*
Asian	9 (60.0)	6 (40.0)	.368[a]
American Indian or Alaska Native	1 (33.3)	2 (66.7)	1.0[b]
Black or African American	5 (45.5)	6 (54.6)	.778[a]
White	18 (41.9)	25 (58.1)	.163[a]
Education			.870[a]
Less than college	18 (52.9)	16 (47.1)	
Some college	10 (47.6)	11 (52.4)	
College degree or higher	15 (46.9)	17 (53.1)	
Parity			.547[b]
1	17 (50.0)	17 (50)	
2	19 (50.0)	19 (50.0)	
3	5 (38.5)	8 (61.5)	
4	2 (100.0)	0 (0)	
Use of prenatal vitamins			.241[b]
No	2 (100.0)	0 (0)	
Yes	41 (48.2)	44 (51.8)	
Pregnancy complications			.761[a]
No	26 (48.2)	28 (51.9)	
Yes	17 (51.1)	16 (48.5)	
Took vitamins while breastfeeding			< .0001[b]*
No	24 (64.9)	13 (35.1)	
Yes	12 (27.9)	31 (72.1)	
No response given	7 (100.0)	0 (0)	
Gestational age (weeks)			.326[c]
Gestational weight gain (lb)			.951[c]
Infant gender			.163[a]
Male	25 (56.8)	19 (43.2)	
Female	18 (41.9)	25 (58.1)	
Up-to-date with vaccinations			.747[a]

Table 2 (continued)

Variable	Breastfeeding status at 4–6 months, n (%)		p Value
	Discontinued 43 (49.3)	Continued 44 (50.6)	
No	9 (52.9)	8 (47.1)	
Yes	34 (48.6)	36 (51.4)	

Row percentages

*p < .05

[a]Analysis by Chi square test

[b]Analysis by Fisher's exact test

[c]Analysis by t-test, pooled

[d]Analysis by t-test, satterthwaite

[e]Participants can choose multiple races

Table 3 Association of pregravid BMI and covariates with breastfeeding discontinuation at 4–6 months postpartum

Variable	COR[a] (95% CI[b])	p Value	AOR[c] (95% CI)	p Value
Pregravid BMI (OWOB vs. UN)	0.80 (0.34, 1.86)	.5984	1.34 (0.44, 4.02)[a]	.607
NHOPI versus all other race/ethnicity	–	–	7.12 (1.34, 37.97)[b]	.022*
Age (years)				
18–24 versus 25–31	–	–	3.10 (0.91, 10.63)[c]	.072
32–39 versus 18–24	–	–	1.36 (0.34, 5.47)[c]	.668
32–39 versus 25–31	–	–	4.21 (1.13, 15.72)[c]	.032*
Took vitamins while breastfeeding (yes vs. No)	–	–	0.15 (0.05, 0.46)[d]	.0009*

OWOB overweight or obese, *UN* underweight or normal weight, *COR* crude odds ratio, *CI* confidence interval, *AOR* adjusted odds ratio

*p < .05

[a]Adjusted, controlling for Native Hawaiian or Other Pacific Islander (NHOPI), age, took vitamins while breastfeeding

[b]Adjusted, controlling for age, pregravid BMI, took vitamins while breastfeeding

[c]Adjusted, controlling for pregravid BMI, NHOPI, took vitamins while breastfeeding

[d]Adjusted, controlling for pregravid BMI, NHOPI, age

aged 25–31 years. One explanation for this association may be due to physiological factors related to milk production or career responsibilities that may be increased with older age. For example, it was reported that risk factors for early weaning in Hawaii women included problems starting breastfeeding, problems with breasts, full-time employment outside of the home, and insufficient milk (Novotny et al. 2000). Factors such as these variables that lead to early breastfeeding discontinuation may intensify as maternal age increases. For example, in a breastfeeding study of blue-collar Taiwanese women, breastfeeding discontinuation rate increased as the number of employed years increased (Chen et al. 2006). Another study of women receiving care through the University of California Davis Medical Center reported that maternal age ≥ 30 years in first-time mothers was an independent risk factor for delayed onset of lactogenesis (Nommsen-Rivers et al. 2010).

According to the 2010 PRAMS fact sheet, women in Hawaii who initiated breastfeeding but discontinued before 8 weeks postpartum were more likely to be Hawaiian, Samoan, Filipino, or Black (Hawaii State Department of Health 2010). The current study found that 80% of NHOPI women discontinued breastfeeding before 4–6 months postpartum. In comparison to the other races/ethnicities, NHOPI women had more than seven times the odds of discontinuing breastfeeding (AOR 7.12; 95% CI 1.34, 37.97; p = .022). However, the number of NHOPI women was very small (n = 15) and the wide confidence interval suggests that a larger sample size may be needed to produce a more precise estimate of effect. Other studies have reported lower rates for breastfeeding discontinuation in NHOPI women in Hawaii (Dodgson et al. 2007), although, in comparison to other races, the percentages of NHOPI women who discontinued breastfeeding were higher. A small study of postpartum Native Hawaiian women in Hawaii enrolled in WIC during

2003–2005 reported that 48% of the women discontinued breastfeeding before 6 months postpartum (Dodgson et al. 2007). According to the 2014 PRAMS, 28% of low-income NHOPI women in Hawaii who initiated breastfeeding discontinued breastfeeding before 8 weeks postpartum ("Hawaii IBIS Query Builder Hawaii's Pregnancy Risk Assessment Monitoring System Data," n.d.). Outside of the US, earlier studies prior to 1985 demonstrated that breastfeeding discontinuation rates for some Pacific Islander women are much lower at 4–6 months postpartum, ranging from just 7–14% (Franks and Jurgensen 1985; Jansen 1979). More recently, in 2007, it was reported that 47% of Pacific Islanders in the Commonwealth of the Northern Mariana Islands discontinued breastfeeding before 6 months (Novotny et al. 2007). However, Pacific Islanders who reside in Hawaii may have different breastfeeding practices in comparison to those who live in the Pacific Islands, and a better understanding of these disparities and the risk factors for poor breastfeeding outcomes in US NHOPI women is needed.

In addition to mother's age and NHOPI race, the use of vitamins while breastfeeding was significantly associated with breastfeeding status at 4–6 months postpartum. Similar factors, such as race/ethnicity and maternal age, have been covariates in other studies (Wojcicki 2011). But, to our knowledge, the association between vitamin use while breastfeeding and breastfeeding discontinuation has not been widely reported. Women who took vitamins while breastfeeding had 85% decreased odds of discontinuing breastfeeding (AOR 0.15; 95% CI 0.05, 0.46; p = .0009). One possible explanation for this association is that women who are taking vitamins while breastfeeding are getting appropriate postnatal care and are, therefore, receiving more education and support for breastfeeding. These women may also be more inclined to seek out infant care education and to be proactive in implementing preventative measures.

Limitations of the study

Several limitations were present in this study. First, a small sample size may have impeded our ability to detect statistically significant associations. Additional studies are needed to further investigate the associations described in this study. Second, our results are not generalizable to women beyond those who participated in the study due to the inherent bias of convenience sampling. Furthermore, based upon these results, findings cannot be generalized regarding when mothers introduced solid foods to their infants' diets. Third, the current BMI cut-off points may not be accurate in some populations such as Pacific Islanders (Swinburn et al. 1999) due to differences in body composition. However, the WHO expert consultation has recommended that the current WHO BMI cut-off points be retained as the international standard (WHO expert consultation 2004). Finally, pregravid BMI was calculated using self-reported weight and height, which could have introduced measurement error.

Implications for future research and clinical practice

Early discontinuation of breastfeeding and introduction of solid foods is associated with excessive weight gain (Taveras et al. 2010). Promoting and supporting appropriate breastfeeding practices contribute to achieving optimal infant health. The results of this study may inform strategies for childhood obesity prevention and breastfeeding promotion, such as increasing outreach, education, and support efforts that are tailored to women who are older or NHOPI.

Conclusion

Pregravid BMI was not significantly associated with breastfeeding discontinuation at 4–6 months postpartum in women from Hawaii and Puerto Rico WIC. However, women of NHOPI race, in comparison to other races, and women aged 32 years and older, in comparison to women aged 25–31 years, had higher odds of discontinuing breastfeeding at 4–6 months. Compared to women who did not take vitamins while breastfeeding, women who did had lower odds of discontinuing breastfeeding at 4–6 months postpartum.

Acknowledgements This study was supported by the National Institute on Minority Health and Health Disparities (NIMHD) of the National Institutes of Health under award number U54MD008149 and in part by grant U54MD007584 (RMATRIX). Infrastructure support was also provided in part by the NIMHD RCMI Grant: 8G12MD007600. The authors acknowledge Linda Chock (Branch Chief), Iris Takahashi (Clinic Operations Section Chief), Laura Morihara (Wahiawa WIC Coordinator), Wendy Baker (Wahiawa WIC Office Assistant), Jean Kanda (Leeward WIC Coordinator), Dawn Fujimoto-Redoble (Leeward WIC Nutritionist), and Christina Mariano (Pearl City WIC Coordinator) from the Hawaii Department of Health WIC Services Branch. They also acknowledge the Puerto Rico WIC Program, including Dana Miró (Executive Director), Blanca Sastre (Interim supervisor of Nutrition and Lactation Division), Alexandra Reyes (Nutrition Education Coordinator), Iris Roldan (Breastfeeding Coordinator), Ivelisse Bruno (Breastfeeding Peer Support Coordinator), Sherley M. Panell (Nutrition Supervisor in Plaza las Americas WIC Clinic) and her team, and Marta Meaux (Nutrition Supervisor in Trujillo Alto WIC Clinic) and her team. They also thank the WIC participants and undergraduate and graduate research assistants.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Banna, J., Campos, M., Gibby, C., Graulau, R. E., Meléndez, M., Reyes, A., … Palacios, C. (2017). Multi-site trial using short mobile messages (SMS) to improve infant weight in low-income

minorities: Development, implementation, lessons learned and future applications. *Contemporary Clinical Trials, 62*, 56–60.
Barcelona de Mendoza, V., Harville, E., Theall, K., Buekens, P., & Chasan-Taber, L. (2016). Acculturation and intention to breastfeed among a population of predominantly Puerto Rican women. *Birth, 43*(1), 78–85. https://doi.org/10.1111/birt.12199.
Birch, L. L., & Davison, K. K. (2001). Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatric Clinics of North America, 48*(4), 893–907.
Brownell, E., Howard, C. R., Lawrence, R. A., & Dozier, A. M. (2012). Delayed onset lactogenesis II predicts the cessation of any or exclusive breastfeeding. *The Journal of Pediatrics, 161*(4), 608–614. https://doi.org/10.1016/j.jpeds.2012.03.035.
Catalano, P. M., Farrell, K., Thomas, A., Huston-Presley, L., Mencin, P., de Mouzon, S. H., & Amini, S. B. (2009). Perinatal risk factors for childhood obesity and metabolic dysregulation. *The American Journal of Clinical Nutrition, 90*(5), 1303–1313. https://doi.org/10.3945/ajcn.2008.27416.
Centers for Disease Control and Prevention. (2011). Hospital support for breastfeeding: Preventing obesity begins in hospitals. *Vital Signs*. Retrieved August 2011, from https://www.cdc.gov/VitalSigns/pdf/2011-08-vitalsigns.pdf.
Centers for Disease Control and Prevention. (2017, August 1). National Immunization Survey. Retrieved August 29, 2017, from https://www.cdc.gov/breastfeeding/data/nis_data/index.htm.
Chen, Y. C., Wu, Y.-C., & Chie, W.-C. (2006). Effects of work-related factors on the breastfeeding behavior of working mothers in a Taiwanese semiconductor manufacturer: A cross-sectional survey. *BMC Public Health, 6*, 160. https://doi.org/10.1186/1471-2458-6-160.
Dodgson, J. E., Codier, E., Kaiwi, P., Oneha, M. F. M., & Pagano, I. (2007). Breastfeeding patterns in a community of Native Hawaiian mothers participating in WIC. *Family & Community Health, 30*(2 Suppl), 46–58. https://doi.org/10.1097/01.FCH.0000264880.96310.9a.
Franks, A. J., & Jurgensen, C. (1985). Nutrition and health in the first year of life on a Pacific atoll. Observations on Abemama Atoll, Central Pacific. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 79*(5), 681–684.
Hawaii IBIS Query Builder Hawaii's Pregnancy Risk Assessment Monitoring System Data. (n.d.). Retrieved September 19, 2017, from http://ibis.hhdw.org/ibisph-view/query/builder/prams/BFAnyGE8WksInit/BFAnyGE8WksInit_ST.html.
Hawaii State Department of Health. (2010). *PRAMS breastfeeding fact sheet*. Retrieved from http://health.hawaii.gov/mchb/files/2013/05/breastfeeding2010.pdf.
Jansen, A. A. (1979). Malnutrition and child-feeding practices among Solomon Islanders in Honiara and Nggela-Sandfly. *The Journal of Tropical Pediatrics and Environmental Child Health, 25*(1), 15–22.
Kugyelka, J. G., Rasmussen, K. M., & Frongillo, E. A. (2004). Maternal obesity is negatively associated with breastfeeding success among Hispanic but not black women. *The Journal of Nutrition, 134*(7), 1746–1753.
Li, C., Kaur, H., Choi, W. S., Huang, T. T.-K., Lee, R. E., & Ahluwalia, J. S. (2005). Additive interactions of maternal prepregnancy BMI and breastfeeding on childhood overweight. *Obesity Research, 13*(2), 362–371. https://doi.org/10.1038/oby.2005.48.
Liu, J., Smith, M. G., Dobre, M. A., & Ferguson, J. E. (2010). Maternal obesity and breast-feeding practices among white and black women. *Obesity, 18*(1), 175–182. https://doi.org/10.1038/oby.2009.182.
Losing Weight, Body Mass Index. (n.d.). Retrieved October 26, 2016, from http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_dis.htm.
McKechnie, A. C., Tluczek, A., & Henriques, J. B. (2009). Maternal variables influencing duration of breastfeeding among low-income mothers. *Infant, Child & Adolescent Nutrition, 1*(3), 126–132. https://doi.org/10.1177/1941406409334379.
Nommsen-Rivers, L. A., Chantry, C. J., Peerson, J. M., Cohen, R. J., & Dewey, K. G. (2010). Delayed onset of lactogenesis among first-time mothers is related to maternal obesity and factors associated with ineffective breastfeeding. *The American Journal of Clinical Nutrition, 92*(3), 574–584. https://doi.org/10.3945/ajcn.2010.29192.
Novotny, R., Coleman, P., Tenorio, L., Davison, N., Camacho, T., Ramirez, V., … Tudela, M. D. (2007). Breastfeeding is associated with lower body mass index among children of the Commonwealth of the Northern Mariana Islands. *Journal of the American Dietetic Association, 107*(10), 1743–1746. https://doi.org/10.1016/j.jada.2007.07.018.
Novotny, R., Hla, M. M., Kieffer, E. C., Park, C.-B., Mor, J., & Thiele, M. (2000). Breastfeeding duration in a multiethnic population in Hawaii. *Birth, 27*(2), 91–96. https://doi.org/10.1046/j.1523-536x.2000.00091.x.
Okihiro, M., Davis, J., White, L., & Derauf, C. (2012). Rapid growth from 12 to 23 months of life predicts obesity in a population of Pacific Island children. *Ethnicity & Disease, 22*(4), 439–444.
Oshiro, C., Novotny, R., Grove, J., & Hurwitz, E. (2015). Race/ethnic differences in birth size, infant growth, and body mass index at age five years in children in Hawaii. *Childhood Obesity, 11*(6), 683–690. https://doi.org/10.1089/chi.2015.0027.
Pan, L., Blanck, H. M., Sherry, B., Dalenius, K., & Grummer-Strawn, L. M. (2012). Trends in the prevalence of extreme obesity among US preschool-aged children living in low-income families, 1998–2010. *JAMA, 308*(24), 2563–2565. https://doi.org/10.1001/jama.2012.108099.
Rasmussen, K. M., & Kjolhede, C. L. (2004). Prepregnant overweight and obesity diminish the prolactin response to suckling in the first week postpartum. *Pediatrics, 113*(5), e465–e471.
Sewell, M. F., Huston-Presley, L., Super, D. M., & Catalano, P. (2006). Increased neonatal fat mass, not lean body mass, is associated with maternal obesity. *American Journal of Obstetrics and Gynecology, 195*(4), 1100–1103. https://doi.org/10.1016/j.ajog.2006.06.014.
Spatz, D. (2014). Preventing obesity starts with breastfeeding. *The Journal of Perinatal & Neonatal Nursing, 28*(1), 41–50. https://doi.org/10.1097/JPN.0000000000000009.
Swinburn, B. A., Ley, S. J., Carmichael, H. E., & Plank, L. D. (1999). Body size and composition in Polynesians. *International Journal of Obesity and Related Metabolic Disorders, 23*(11), 1178–1183.
Taveras, E., Gillman, M., Kleinman, K., Rich-Edwards, J., & Rifas-Shiman, S. (2010). Racial/ethnic differences in early-life risk factors for childhood obesity. *Pediatrics, 125*(4), 686–695. https://doi.org/10.1542/peds.2009-2100.
Thorn, B., Tadler, C., Huret, N., Ayo, E., & Trippe, C. (2015, November). *WIC participant and program characteristics final report*. Retrieved October 23, 2016, from http://www.fns.usda.gov/sites/default/files/ops/WICPC2014.pdf.
US Census Bureau. (n.d.). Race. Retrieved August 1, 2017, from https://www.census.gov/topics/population/race/about.html.
US Department of Health and Human Services, Office of Disease Prevention and Health Promotion. (2010). *Healthy People 2020*. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/maternal-infant-and-child-health/objectives.
WHO expert consultation. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *The Lancet, 363*(9403), 157–163. https://doi.org/10.1016/S0140-6736(03)15268-3.
Wojcicki, J. M. (2011). Maternal prepregnancy body mass index and initiation and duration of breastfeeding: A review of the

literature. *Journal of Women's Health, 20*(3), 341–347. https://doi.org/10.1089/jwh.2010.2248.

Woo Baidal, J. A., Locks, L. M., Cheng, E. R., Blake-Lamb, T. L., Perkins, M. E., & Taveras, E. M. (2016). Risk factors for childhood obesity in the first 1,000 days: A systematic review. *American Journal of Preventive Medicine, 50*(6), 761–779. https://doi.org/10.1016/j.amepre.2015.11.012.

World Health Organization. (2006). *WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and development*. Geneva, Switzerland. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5909a1.htm.