

The Association of Pregnancy Weight Gain with Infant Birth Weight and Postpartum Weight Retention: Ethnic Differences in Hawai'i, 1997 & 1998

Gigliola Baruffi¹, Charles Hardy², Carol Waslien¹, Sue Uyehara³, Dmitry Krupitsky¹,
& Jennette Silao²

¹University of Hawai'i

²Private Consultant

³Hawai'i Department of Health

Abstract

Purpose: To investigate weight gain during pregnancy and its association with birth weight and weight retention postpartum (PP) among women of different ethnic backgrounds. **Methods:** Cross-sectional study of 5,863 women participating in the Hawai'i Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in 1997 and 1998. Postpartum weight and height were measured by WIC staff, weight gain during pregnancy and infant birth weight were self-reported. Ethnicity was also self-reported. The Institute of Medicine guidelines for pregnancy weight gain in relation to levels of prepregnancy body mass index (BMI) were followed. The analysis included bivariate tests of association between prepregnancy BMI, pregnancy weight gain, PP weight retention, infant birth weight and ethnicity. Multivariable analysis was conducted to estimate the independent association of the study variables with PP weight retention, birth weight, and ethnicity. SAS was used to analyze the data. **Results:** The largest ethnic groups were Hawaiian (29.9%), Caucasian (27.2%), and Filipino (19.8%). Asians, Blacks, Samoans, and Other represented smaller percentages. Thirty percent of women were overweight or obese before pregnancy. There were significant ethnic differences in prepregnancy BMI. Samoans had the highest mean prepregnancy BMI (29.7). Filipinos had the lowest mean prepregnancy BMI (22.5). There were significant differences in pregnancy weight gain. Samoans had the highest mean weight gain (37.3 lbs). Asians had the lowest mean weight gain (29.1lbs). Almost one half of women (48.1%) gained more than the IOM recommended pregnancy weight. The average weight retention was 9.4 lbs at five to six months postpartum, and 7.4 lbs after eight months postpartum. There were significant ethnic differences in weight retention with Samoans having the largest average weight retention (17.5 lbs) and Asians the lowest (9.6 lbs). Infant birth weight differed significantly by ethnicity. Birth weight was significantly associated with prepregnancy BMI and pregnancy weight gain. **Conclusions:** In spite of large racial/ethnic differences, on the average there was almost a two-thirds pound adjusted PP weight retention for each pound of weight gained during pregnancy. Our study suggests a need for integrated women's health services to include nutritional support during the pre and post conceptual period. Findings of this study will provide guidance in the development of culturally sensitive interventions and counseling.

© 2005 Californian Journal of Health Promotion. All rights reserved.

Keywords: pregnancy weight gain, weight retention, pregravid BMI, birth weight

Introduction

Obesity in the U.S. has become an epidemic. Between 1960 and 2002 mean weight and body mass index (BMI) have increased for both sexes, all race/ethnic groups, and all ages (Ogden, Frayar, Carroll, & Flegal, 2004). Among 20-39 year old women, the prevalence of obesity more

than tripled from 9.3% to 29.1%, and it doubled among women 40-59 years of age from 18.5% to 36.7% (Flegal, Carroll, Ogden, & Johnson, 2002). In 1999-2002 significant differences existed in the prevalence of obesity by race/ethnicity. For example, among women 20-39 years of age, non-Hispanic whites had the

lowest prevalence at 24.9%, non-Hispanic blacks the highest at 46.6%, and Mexican Americans an intermediate prevalence at 31.2% (Hedley, Ogden, Johnson, Carroll, Curtin, & Flegal, 2004).

Weight gain during pregnancy is a major contributor to overweight and obesity for women (Rossner & Ohlin, 1995). Numerous studies have reported that excessive weight gain and retention of weight six months after delivery are predictors of long term obesity (Gunderson, Abrams, & Selvin, 2000; Kac, Benicio, Velasquez-Melendez, Valente, & Struchiner, 2004; Lederman, Alfasi, & Deckelbaum, 2002; Linne & Rossner, 2003; Linne, Dye, Barkeling, & Rossner, 2003; Rooney & Schauburger, 2002; Scholl, Hediger, Schall, Ances, & Smith, 1995).

On the other hand, adequate weight gain during pregnancy is important for optimal pregnancy outcomes (Thorsdottir & Birgisdottir, 1998; Edwards, Hellerstedt, Alton, Story, & Himes, 1996). Inadequate weight gain during pregnancy particularly in the third trimester increases women's risk of delivering pre-term (Schieve, Cogswell, Scanlon, Perry, Ferre, Blackmore-Prince, Yu, & Rosenberg, 2000; Siega-Riz, Adair, & Hobel, 1994). The percentage of infants with fetal growth restriction (FGR) decreases and the mean birth weight increases with the increase of weight gain (Hickey, Cliver, Goldenberg, Kohatsu, & Hoffman, 1993; Pickett, Abrams, & Selvin, 2000).

The Institute of Medicine (IOM, 1990) published recommendations for weight gain in relation to prepregnancy BMI. Evaluations of these recommendations have shown that they are associated with improved infant outcomes (Abrams, Altman, & Pickett, 2000; Schieve et al., 1998). These evaluations have also found that large proportions of women gain weight outside the recommended values (Siega-Riz et al., 1994; Schieve et al., 1998).

Overweight and obesity contribute to the development of several major health risk factors (Must, Spadano, Coakley, Field, Colditz, & Dietz, 1999). Obesity is also associated with pregnancy complications. Transient hyper-

tension, preeclampsia, eclampsia, gestational diabetes, cesarean delivery, and delivery of macrosomic infants are increased in overweight and obese women (Baeten, Bukusi, & Lambe, 2001; Cedergren, 2004; Saftlas, Wang, Risch, Woolson, Hsu, & Bracken, 2000; Shepard, Saftlas, Leo-Summers, & Bracken, 1998). Obesity before pregnancy is associated with increased risk of stillbirth, fetal distress, meconium aspiration, shoulder dystocia, and early neonatal death (Cedergren, 2004; Nohr, Bech, Davies, Frydenberg, Henriksen, Olsen, 2005; Stephansson, Dickman, Johansson, & Cnattingius, 2001). However, it protects against the delivery of a spontaneous preterm birth and a small-for-gestational age infant (Cnattingius, Bergstrom, Lipworth, & Kramer, 1998; Hendler et al., 2005).

It is not completely understood which factors contribute to weight gain during pregnancy and weight retention postpartum. In a 15-year longitudinal study of Swedish women Linne et al. (2003) found that overweight before pregnancy is not a risk factor for postpartum weight retention, but weight gain during pregnancy and weight retention at one year after delivery are predictor of weight retention after the second pregnancy. Age, socioeconomic status, number of children, time interval between pregnancies were not associated with long term overweight or obesity. Similar findings were reported by Gunderson et al. (2000). Gunderson also found that age 24-30 yrs, compared to > 30 yr, young age at menarche, short interval between menarche and first pregnancy in addition to high gestational weight gain were independent risk factors for weight retention postpartum. Weight gain during pregnancy was consistently found to be the strongest factor associated with weight retention postpartum (Kac et al., 2004; Lederman et al., 2002; Rossner & Ohlin, 1995). The parity-weight relationship was not consistently found to be significant. Parity was found to be independently associated with weight retention by Harris, Ellison, Holliday (1997) and Linne & Rossner (2003), but not by Gunderson et al. (2000) and Linne et al. (2003). Lee, Sobal, Frongillo, Olson, Wolfe (2005) found that the association varies by race and place of residence.

Most research has reported differences between non-Hispanic black, non-Hispanic white and Hispanic women. Few have included Asian women (Gunderson et al., 2000). In a study conducted among black and Hispanic women (Lederman et al., 2002), of the 47 women in the study 2/3 had excessive weight gain. At two months postpartum, they were on the average 18 lbs above their prepregnancy weight, and no additional weight was lost at six months. Additional research based on the National Maternal and Infant Health Survey, showed that for women with comparable weight gain during pregnancy, black women were more likely to have higher weight retention postpartum than whites, 7.2 lbs and 1.6 lbs, respectively (Keppel & Taffel, 1993). Gunderson et al. (2000) found that white women were 4.5 times more likely to become overweight than Asian, while blacks and Hispanics did not differ from whites.

The purpose of our study is to investigate the relationship of weight gain during pregnancy with infant birth weight and weight retention postpartum in a Asian/Pacific Islands (API) population of women in Hawai'i.

Methods

Study Sample and Data Source

This is a cross sectional study of 5,863 women attending the post partum clinics of the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) in the state of Hawai'i in 1997-1998. The records of their first clinic visit after giving birth were the source of data. First visits at the WIC clinics ranged from less than one month to more than eight months after delivery. Clinic staff measured weight and height at the time of post partum visits. Prepregnancy weight and weight gain during pregnancy were self-reported. Mothers also reported the infant's birth weight.

During the time period of this study, data were entered on hard-copy forms at the WIC clinics by clerks, sent to a private contractor for data entry, and then sent to the State Information and Communication Services Division of the Department of Administration and General Services for printing of food vouchers. The data were delivered on tape to the Health Information

Systems Office of the State Department of Health, where specific data items were downloaded monthly and translated into dBase 4 format (version 5.0, 1994, Borland International, Inc, Scotts Valley, CA). Records for calendar years 1997 and 1998 were the last before the WIC program initiated electronic data entry at the clinics and adopted the collection of a substantially different set of items.

Variables Definition

Ethnicity was self-defined. In the original dataset, ethnicities were coded into 14 ethnic or racial categories. We grouped them into seven categories as follows: Asian (including Japanese, Chinese, or Korean), black, Caucasian (including non-Hispanic white, Hispanic white or Puerto Rican), Filipino, Hawaiian (including Hawaiian or part-Hawaiian), Samoan, and Other (including mixed ethnicities, Native American, or other).

Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in centimeters. We used the IOM definitions and weight gain recommendations (IOM, 1990) to categorize underweight (BMI <19.8), normal weight (BMI 19.8-26), overweight (BMI 26.1-29), and obesity (BMI >29). Ranges of recommended weight gain in pounds were 28-40 for under weight women, 25-35 for normal weight women, 15-25, and 15 for overweight and obese women respectively. Age was grouped in the following categories: <18 years old, 19-24, 25-34, and > 35 years old. Women's education, marital status, parity, and gestational age at delivery were not reported. Infant birth weight was categorized as low (< 2,500 grams), normal (2,500-4,249 grams), and high (> 4,250 grams).

Analysis

The analysis included bivariate tests of association of weight retention with prepregnancy weight, weight gain during pregnancy, month of post partum visit, age, and ethnicity. F statistics and χ^2 were used when appropriate to test for significant differences among ethnic groups. The bivariate association of birth weight with prepregnancy BMI, weight gain during pregnancy and ethnicity was also

performed. To estimate the independent effect of weight gain during pregnancy on weight retention, controlling for prepregnancy BMI, month of post partum visit, age, and ethnicity, we used multiple linear regression. We also used multiple linear regression to estimate the independent effect of weight gain during pregnancy on birth weight, controlling for prepregnancy BMI, age, and ethnicity. All analyses were performed using the SAS System (version 8.2, 1999–2001, SAS Institute, Inc., Cary, NC).

Table 1 presents characteristics of the study sample. Most women were between the ages of 18 to 34 years. The largest race/ethnic groups were Hawaiian (29.9%), Caucasian (27.2%) and Filipino (19.8%). Asians, blacks, Samoans, and Other represented smaller percentages.

Table 1
Demographic characteristics of women: Hawai`i WIC Program, 1997 & 1998

Characteristics	N (5,863)	Percent*
Age		
< 18	280	4.8
18-24	2,451	41.8
25-34	2,522	43.9
≥ 35	610	10.4
Race Ethnicity		
Asian	405	6.9
Black	254	4.3
Caucasian	1,593	27.2
Filipino	1,162	19.8
Hawaiian	1,751	29.9
Samoan	236	4.0
Other	456	7.8
Month of First WIC Postpartum Visit		
< 1	1,231	21.0
1 to 2	2,638	45.0
3 to 4	1,114	19.0
5 to 6	293	5.0
> 6	587	10.0
Prepregnancy BMI		
<19.8	1,020	17.4
19.8–26	3,031	51.7
26.1–29.0	633	10.8
>29.0	1,179	20.1

*Percent may not add to 100.0 because of rounding

The majority of women attended postpartum clinics for the first time during the period of one to two months (45%), followed by 21% at less than one month, and 19% at three to four months. A considerable number of

women visited the WIC clinics for the first time more than five months after delivery. Most women had a prepregnancy BMI in the normal or lean range. However, over 30 % were overweight or obese.

Table 2 shows mean prepregnancy BMI, weight gain during pregnancy and weight retention postpartum by ethnicity. Filipino women had the lowest prepregnancy BMI and the second lowest prenatal weight gain and postpartum weight retention. Asians had the lowest prenatal weight gain and postpartum weight retention. Before starting

pregnancy, the mean BMI for Hawaiian women was in the overweight range (26.1 ± 6.3 lb) and the mean BMI for Samoans was in the obese range (29.7 ± 6.9 lb) according to the IOM classification. The largest pregnancy weight gain and postpartum weight retention was found among Samoan women.

Table 2
Prepregnancy BMI, pregnancy weight gain, and postpartum weight retention by ethnicity, Hawai'i WIC program, 1997 & 1998

Race/Ethnicity	Prepregnancy BMI	Weight Gain During Pregnancy (lbs)	Weight Retention Postpartum (lbs)
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Asian	22.7 \pm 5.3	29.1 \pm 12.9	9.6 \pm 11.2
Black	25.2 \pm 5.0	32.1 \pm 16.4	11.7 \pm 14.1
Caucasian	24.5 \pm 5.4	33.4 \pm 15.9	11.1 \pm 13.5
Filipino	22.5 \pm 4.4	30.0 \pm 13.3	11.0 \pm 11.3
Hawaiian	26.1 \pm 6.3	34.1 \pm 17.7	12.3 \pm 15.7
Samoan	29.7 \pm 6.9	37.3 \pm 22.0	17.5 \pm 21.7
Other	24.6 \pm 6.1	32.9 \pm 16.7	13.3 \pm 16.3

Overall ethnic differences in pregnancy weight gain: p-value <.0001; in postpartum weight retention: p-value <.0001; in prepregnancy BMI: p-value<.0001

Weight retention varied by month of first postpartum visit. Weight retention decreased with the increase of months after delivery. It was 9.4 lbs at five to six months postpartum, and 7.4 lbs after eight months postpartum (data not shown here).

Mean birth weight and pregnancy weight gain in relation to prepregnancy BMI are

shown in table 3. While mean pregnancy weight gain increases from the lean to the normal prepregnancy categories and decreases for the overweight and obese categories, mean birth weight increases steadily from the lean to the obese prepregnancy BMI categories irrespective of pregnancy weight gain.

Table 3
Mean birth weight by prepregnancy BMI and pregnancy weight gain, Hawai'i WIC program, 1997 & 1998 (N= 5,863)

Prepregnancy BMI	%	Pregnancy weight gain (lbs)	Birth weight (grams)
		Mean \pm SD	Mean \pm SD
<19.8	17.4	33.7 \pm 12.7	3,091 \pm 547.9
19.8-26	51.7	34.6 \pm 15.2	3,264 \pm 571.1
26.1-29	10.8	32.0 \pm 16.6	3,344 \pm 593.5
>29	20.1	27.2 \pm 20.0	3,407 \pm 622.6

Table 4 shows the percentage of low and high birth weights associated with different levels of pregnancy weight gain. Almost 19% of women gained less than the recommended IOM values for their BMI. The percentage of low birth weight infants among them is more than twice the percentage among women who gained the recommended amount, 18.2% and 8.2%, respectively. Almost one half (48.1%) of women gained more than the recommended

weight. Their infants had the lowest percentage of low birth weight (5.3%) and the highest percentage of high birth weight (6.2%).

In order to estimate the independent effect of weight gain during pregnancy and ethnic differences on infant birth weight, we performed a multiple regression analysis including all the study variables. Table 5 presents the results.

Table 4
Percentage of low and high birth weight infants by pregnancy weight gain within and outside the IOM recommendations, Hawai'i WIC program, 1997 & 1998

Pregnancy weight gain	Birth weight (grams)		
	%	% <2,500	% ≥ 4,250
< Recommended	18.8	18.2	0.8
Recommended	33.1	8.2	2.0
> Recommended	48.1	5.3	6.2
Total N	5863	8.7	3.8

Table 5
Multiple regression of infant birth weight on prepregnancy BMI, pregnancy weight gain, age, and ethnicity, Hawai'i WIC program, 1997 & 1998

Characteristics	Infant birth weight (grams)		
	Beta coefficient	(SE)	P value
Intercept	2,619.07	(42.82)	
Age (years)			
< 18	-88.71	(37.69)	0.0186
25-34	72.54	(16.34)	<.0001
>35	-3.97	(26.27)	0.8800
Prepregnant BMI	17.51	(1.36)	<.0001
Weight gain (lb)	8.83	(0.47)	<.0001
Race/Ethnicity			
Asian	-89.35	(31.30)	0.0043
Black	-162.50	(38.09)	<.0001
Filipino	-220.16	(21.86)	<.0001
Hawaiian	-129.99	(19.81)	<.0001
Samoan	66.93	(40.21)	0.0960
Other	-120.64	(29.71)	<.0001

Reference categories: age 19-24 years, Caucasian ethnicity. Birth weight, prepregnancy BMI, and pregnancy weight gain (lb) are continuous variables.

Most variables included in the model were significantly associated with birth weight. Compared with infants of 19-24 year old women, infants of women less than 18 years of age weighed almost 87 grams less, while infants of women 25-34 years of age were heavier by more than 72 grams. No difference was found for women > 35 years old. Infant birth weight increased by more than 17 grams for every maternal prepregnancy BMI unit increase, and by almost nine grams for every pound of pregnancy weight gain. When maternal age, prepregnancy BMI, and pregnancy weight gain were controlled for, women of all ethnicities, with the exception of Samoans, had infants weighing significantly less than Caucasian infants. The smallest were the infants of Filipino mothers who weighed more than 220 grams less than infants of Caucasian mothers. Infants of Samoan women were almost 67 grams heavier than infants of Caucasian women, but the difference was not statistically significant.

Table 6 shows the results of the multiple regression analysis performed to estimate the independent effect of pregnancy weight gain on postpartum weight retention. Prepregnancy BMI, pregnancy weight gain, and month of postpartum visit were found to be independently associated with weight retention. On the average, postpartum weight retention decreased by almost 1/4th pound for each unit increase in prepregnancy BMI, and by .02 pound for each month time after delivery. After controlling for all variables in the model, each pound of weight gained during pregnancy contributed to more than one half-pound weight retention postpartum. Women of all ethnicities, except Asians and blacks, retained significantly more weight than Caucasians. Filipinos retained about one pound, Hawaiians more than 3/4th pounds, women of Other ethnicities more than two pounds, and Samoans almost five pounds more than Caucasians.

Table 6
Multiple regression of postpartum weight retention on prepregnancy BMI, pregnancy weight gain, month of postpartum visit, age, and ethnicity, Hawai'i WIC Program, 1997 & 1998

Characteristics	Postpartum Weight Retention (lbs)		
	Beta coefficient	(SE)	P value
Intercept	-2.13	(0.78)	
Age (years)			
< 18	0.42	(0.67)	0.5307
25-34	0.40	(0.29)	0.1617
≥35	0.55	(0.46)	0.2364
Prepreg BMI	-0.22	(0.02)	<.0001
Weight gain (lb)	0.61	(0.01)	<.0001
PostP month	-0.02	(0.00)	<.0001
Ethnicity			
Asian	0.55	(0.56)	0.3193
Black	1.12	(0.67)	0.0968
Filipino	1.08	(0.39)	0.0055
Hawaiian	0.77	(0.35)	0.0291
Samoan	4.68	(0.71)	<.0001
Other	2.31	(0.53)	<.0001

Reference categories: age 19-24 years, Caucasian ethnicity. Postpartum weight retention, prepregnancy BMI, pregnancy weight gain (lb), and postpartum month are continuous variables.

Discussion

As found across the United States (Flegal et al., 2002; Hedley et al., 2004) our study sample had a high prevalence of overweight or obesity, 10.8% and 20.1% respectively. The results of our analyses also showed significant race/ethnic differences in prepregnancy BMI, infant birth weight, and weight retention. Samoan women had a mean prepregnancy BMI in the obesity range (29.7 ± 6.9), and Hawaiians in the overweight range (26.1 ± 6.3). Filipino women had the lowest mean prepregnancy BMI, 22.5 ± 4.4 . Mean birth weight was highest for infants of Samoan mothers ($3,579 \pm 505.8$ grams) and lowest for infants of Filipino mothers ($3,093 \pm 556.2$ grams). Likewise, mean weight retention was highest in Samoan women (17.5 ± 21.7 lb) and lowest in Asian women (9.6 ± 11.2 lb), while Filipinos retained 11 ± 11.3 lb on the average.

Results of the multiple regression analysis found prepregnancy BMI and pregnancy weight gain to be independently associated with birth weight. Similar results were reported for black and white women by Hickey et al. (1993); for Hispanic women by Siega-Riz et al. (1994); and in a multiethnic California population by Pickett et al. (2000). Women of all race/ethnicities, except Samoans, had infants whose birth weight was significantly lower than infants of Caucasian women. Infants of Samoan mothers had a birth weight higher than infants of Caucasians but only with a borderline statistical significance. Except for the non-significant birth weight difference of Samoan from Caucasian infants, these results confirm previously published ethnic differences in birth weight in Hawai'i (Baruffi et al., 1997; Crowell et al., 1992). The contribution of the current study is the inclusion of prepregnancy BMI and pregnancy weight gain, variables that were not available to Baruffi or Crowell.

In our study, prepregnancy BMI, weight gain during pregnancy, and month of

postpartum period were independently associated with weight retention. Age, whether analyzed as continuous or categorical variable, was not associated with weight retention. Except for Asian and black women, mothers of all other ethnic groups retained significantly more weight than Caucasian mothers. After controlling for all the variables included in the model, Samoans retained almost five pounds more than Caucasians, women of Other ethnicities more than two pounds, Filipinos one pound, and Hawaiians 3/4th pounds more than Caucasians. In other studies, comparison between race/ethnic groups were usually limited to two or three groups. Lederman et al. (2002) studied low SES black women in New York City. Prepregnancy BMI and pregnancy weight gain were found to be independently associated with weight retention after delivery. Gunderson et al. (2000) studied pregnancy weight gain and postpartum weight retention differences between Asian, Hispanic, black and white women in California. Compared to Asians, whites were 4.5 times more likely to become overweight, and blacks and Hispanics did not differ from whites. In our study Asian and black women did not differ from Caucasians, while Filipinos retained one pound more than Caucasians. It is not known if Filipino women were included in the Asian group in Gunderson et al.'s (2000) study. In our study sample, Filipinos formed a category separate from Asians who included Japanese, Chinese, or Korean.

In both longitudinal and cross sectional studies, pregnancy weight gain has been consistently identified as independently associated with weight retention postpartum. (Gunderson et al., 2000; Kac et al., 2004; Lederman et al., 2002; Linne et al., 2003; Linne & Rossner, 2003; Rooney & Schauburger, 2002; Rossner & Ohlin, 1995; Scholl et al., 1995). However, prepregnancy BMI has not always been found to be associated with weight retention. Linne & Rossner, (2003), Rooney & Schauburger (2002) and Rossner & Ohlin (1995) did not

report a significant association, while Lederman et al. (2002), Linne et al. (2003) and Scholl et al. (1995) found a positive association between prepregnancy BMI and postpartum weight retention. Gunderson et al. (2001) found a negative association for the early postpartum period but a positive association in the late (average two yrs) postpartum period. In our study, we found a negative association between prepregnancy BMI and weight retention. For each unit of BMI increase there was a postpartum weight loss of .22 pounds. Kac et al. (2004) also found a reduction in postpartum weight retention equal to about one pound for each unit of BMI increase in Brazilian women.

In our study we found a large proportion of women (48.1%) gaining pregnancy weight above the IOM recommended values, while only one third (33.1%) gained within the recommended range. Schieve et al. (1998) found a similar pattern among WIC women from five states from 1990 to 1996, but a larger proportion of women gaining less than the recommended weight than in our study, 22.0% and 18.8% respectively. Siega-Riz et al. (1994) reported excessive pregnancy weight gain in 52% of overweight and 75% of obese women. Several authors found an increase in postpartum weight gain but a decrease of low birth weight or preterm infants among women gaining above the recommended values (Hickey et al., 1993; Schieve et al., 2000; Siega-Riz et al., 1994; Thorsdottir & Birgisdottir, 1998). They found an indirect strong association between pregnancy weight gain and percentage of low birth weight infants in black women and a lesser association in white women (Hickey et al., 1993).

The relative contribution of several other maternal characteristics to weight retention has been studied. Parity, education, marital status, time interval between pregnancies have not been found to contribute to weight retention. Breastfeeding was reported to have significant value in reducing weight retention by Rooney & Schauburger (2002),

but minimal value by Rossner & Ohlin, (1995). Smoking cessation was identified as a contributing variable by Linne et al. (2003) and Rossner et al. (1995). Physical activity and change in life style were found to be significant contributor to weight retention by Rossner & Ohlin (1995). Parity was found to be independently associated with weight retention by Harris, Ellison, Holliday (1997) and Linne & Rossner (2003) but not by Gunderson et al. (2000) and Linne et al. (2003). Lee et al. (2005) found a significant positive association between parity and body weight only in black women living in metropolitan areas and a negative association in white women living in non-metropolitan areas. We could not examine parity or other sociodemographic variable nor breastfeeding or physical activity as these variables were not included or incompletely reported in our data set.

To the knowledge of the authors, this is the first study reporting on the association of pregnancy weight gain with infant birth weight and postpartum weight retention in a Asian/Pacific Islands (API) population. Although the findings of this study derive from women attending the WIC clinics in the state and cannot be applied to the entire Hawai'i population of postpartum women, the WIC program serves close to half of the mothers and infants in the state and our findings can, therefore, provide a preliminary description of one of the most important risk factors for overweight and obesity in women of different ethnic backgrounds. The importance of our findings also apply to several other states in the U.S. where same racial/ethnic groups reside.

This study has some limitations. In the first place, it is a cross sectional study and cannot describe weight loss and retention over time, but only the status of different women at different points in the postpartum period. In the second place, anthropometric data are self reported and therefore, subject to bias. Several other authors (Gunderson et al., 2000; Lederman et al., 2002; Schieve et al.,

1998; Siega-Riz et al., 1994) have used self-reported pregravid weight and weight gain during pregnancy due to the difficulties of collecting measured anthropometric data repeatedly in a population of pregnant women. The validity of self-reported weights and heights have been assessed (Lederman & Paxton, 1998; Rowland, 1990; Schieve et al., 1999; Stewart et al., 1987; Yu & Nagey, 1992) and found to be acceptable for epidemiologic studies. Weight underreporting is usually found among overweight and obese individual. This bias would only accentuate the findings of this study. The infant birth weight reported by the mother was not found to be significantly different from the birth weight reported by clinical records (Lederman & Paxton, 1998).

Notwithstanding its limitations, this study provides important information on one of the factors influencing weight gain in women, pregnancy weight gain. The study also identifies significant differences in racial/ethnic populations not previously studied. Further research is necessary to better understand the relevance of these differences. There is a need for interventions to help women maintain or achieve a healthy weight status during the preconception to post conception period. Breastfeeding and exercise are recommended for controlling long-term weight gain associated with reproduction (Lederman et al., 2002; Rooney & Schauburger, 2002). Our findings can be used to guide such interventions in a culturally appropriate manner.

References

- Abrams, B., Altman, S. L., Pickett, K., E. (2000). Pregnancy weight gain: still controversial. *American Journal of Clinical Nutrition*, 71 (5 Suppl.), 1233S-1241S.
- Baeten, J. M., Bukusi, E. A., Lambe, M. (2001). Pregnancy complications and outcomes among overweight and obese nulliparous women. *American Journal of Public Health*, 91, 436-440.
- Baruffi, G., Fuddy, L. J., Onaka, A. T., Alexander, G. R., Mor, J. M. (1997). Temporal trends in maternal characteristics and pregnancy outcomes: Their relevance to the provision of health services. Hawaii, 1979-1994. *Hawaii Medical Journal*, 56, 149-153.
- Cedergren, M. I. (2004). Maternal morbid obesity and the risk of adverse pregnancy outcomes. *Obstetrics and Gynecology*, 103, 219-224.
- Cnattingius, S., Bergstrom, R., Lipworth, L., Kramer, M. S. (1998). Prepregnancy weight and the risk of adverse pregnancy outcomes. *New England Journal of Medicine*, 338, 147-152.
- Crowell, D. H., McGee, R. I., Seto, D., Sharma, S. D., Dunn-Rankin, P. (1992). Race, ethnicity and birth-weight: Hawaii 1983 to 1986. *Hawaii Medical Journal*, 51, 242-246, 249, 255.
- Edwards, L. E., Hellerstedt, W. L., Alton, I. R., Story, M., Himes, J. H. (1996). Pregnancy complications and birth outcomes in obese and normal-weight women: effects of gestational weight change. *Obstetrics and Gynecology*, 87, 389-394.
- Flegal, K. M., Carroll, M. D., Ogden, C. L., Johnson, C. L. (2002) Prevalence and trends in obesity among US adults, 1999-2000. *Journal of the American Medical Association*, 288, 1723-1727.
- Gunderson, E.P., Abrams, B., Selvin, S. (2000). The relative importance of gestational gain and maternal characteristics associated with the risk of becoming overweight after pregnancy. *International Journal of Obesity Related Metabolic Disorders*, 24, 1660-1668.
- Gunderson, E. P., Abrams, B., Selvin, S. (2001). Does the pattern of postpartum weight change differ according to pregravid body size? *International Journal of Obesity Related Metabolic Disorders*, 25, 853-862.
- Harris, H. E., Ellison, G. T., Holliday, M. (1997). Is there an independent association between parity and maternal weight gain? *Annals of Human Biology*, 24, 507-519.
- Hedley, A. A., Ogden, C. L., Johnson, C. L., Carroll, M. D., Curtin, L. R., Flegal, K. M. (2004). Prevalence of overweight and obesity among US children, adolescents, and adults. *Journal of the American Medical Association*, 291, 2847-2850.

- Hendler, I., Goldenberg, R. L., Mercer, B. M., Iams, J. D., Meis, P. J., Moawad, A. H., Macpherson, C. A., Caritis, S. N., Miodovnik, M., Mernard, K. M., Thurnau, G. R., Sorokin, Y. (2005). The Pre-term prediction study: Association between maternal body mass index and spontaneous and indicated preterm birth. *American Journal of Obstetrics and Gynecology*, 192, 882-886.
- Hickey, C. A., Kreauter, M., Bronstein, J., Johnson, V., McNeal, S. F., Harshbarger, D. S., Woolbright, L. A. (1999). Low prenatal weight gain among adult WIC participants delivering term singleton infants: Variation by maternal and program participation characteristics. *Maternal and Child Health Journal*, 3, 129-140.
- Hickey, C. A., Cliver, S. P., Goldenberg, R. L., Kohatsu, J., and Hoffman, H. J. (1993). Prenatal weight gain, term birth weight, and fetal growth retardation among high risk multiparous black and white women. *Obstetrics and Gynecology*, 81, 529-535.
- Institute of Medicine. (1990). *Nutrition during pregnancy. Part I. Weight gain*. Washington, DC: National Academy Press.
- Kac, G, Benicio, M. H., Velasquez-Melendez, G, Valente, J. G., Struchiner, C. J. (2004). Gestational weight gain and prepregnancy weight influence postpartum weight retention in a cohort of Brazilian women. *Journal of Nutrition*, 134, 661-666.
- Keppel, K. G., and Taffel, S. M. (1993). Pregnancy-related weight gain and retention: Implications of the 1990 Institute of Medicine Guidelines. *American Journal of Public Health*, 83, 1082-1084.
- Lederman, S. A., Paxton, A. (1998). Maternal reporting of prepregnancy weight and birth outcome: Consistency and completeness compared with the clinical record. *Maternal and Child Health Journal*, 2, 123-126.
- Lederman, S. A., Alfasi, G., & Deckelbaum, R. J. (2002). Pregnancy associated obesity in black women in New York City. *Maternal and Child Health Journal*, 2, 37-42.
- Lee, S. K., Sobal, J., Frongillo, E. A., Olson, C. M., Wolfe, W. S. (2005). Parity and body weight in the United States: differences by race and size of place of residence. *Obesity Research*, 13, 1263-1269.
- Linne, Y., Dye, L., Barkeling, B., Rossner, S. (2003). Weight development over time in parous women — the SPAWN study — 15 years follow-up. *International Journal of Obesity Related Metabolic Disorders*, 27, 1516-1522.
- Linne, Y., Rossner, S. (2003). Interrelationships between weight development and weight retention in subsequent pregnancies: The SPAWN study. *Acta Obstetric and Gynecologic Scandinavian*, 82, 318-325.
- Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., Dietz, W. H. (1999). The disease burden associated with overweight and obesity. *Journal of the American Medical Association*, 282, 1523-1529.
- Nohr, E. A., Bech, B. H., Davies, M. J., Frydenberg, M., Henriksen, T. B., Olsen, J. (2005). Prepregnancy obesity and fetal death: a study within the Danish National Birth Cohort. *Obstetrics and Gynecology*, 106, 250-259.
- Ogden, C. L., Fryar, C. D., Carroll, M. D., Flegal, K. M. (2004). Mean body weight, height, and body mass index, United States 1960-2002. Advance data from vital and health statistics; no. 347. Hyattsville, MD: National Center for Health Statistics.
- Pickett, K. E., Abrams, B., Selvin, S. (2000). Maternal height, pregnancy weight gain, and birth weight. *American Journal of Human Biology*, 12, 682-687.
- Rooney, B. L., Schauburger, C. W. (2002). Excess pregnancy weight gain and long-term obesity: One decade later. *Obstetrics and Gynecology*, 100, 245-252.
- Rossner, S., Ohlin, A. (1995). Pregnancy as a risk factor for obesity: Lessons from the Stockholm pregnancy and weight development study. *Obesity Research*, 3 (Suppl. 2), 267s-275s.
- Rowland, M. L. (1990). Self-reported weight and height. *American Journal of Clinical Nutrition*, 52, 1125-1133.

- Saftlas, A., Wang, W., Risch, H., Woolson, R., Hsu, C., Bracken, M. (2000). Prepregnancy body mass index and gestational weight gain as risk factors for preeclampsia and transient hypertension. *Annals of Epidemiology*, 10, 475.
- Schieve, L. A., Cogswell, M. E., Scanlon, K. S. (1998). Trends in pregnancy weight gain within and outside ranges recommended by the Institute of Medicine in a WIC population. *Maternal and Child Health Journal*, 2, 111-116.
- Schieve, L. A., Perry, G. S., Cogswell, M. E., Scanlon, K. S., Rosenberg, D., Carmichael, S., Ferre, C. (1999). Validity of self-reported pregnancy delivery weight: an analysis of the 1988 National Maternal and Infant Health Survey. NMIHS Collaborative Working Group. *American Journal of Epidemiology*, 150, 947-956.
- Schieve L. A., Coswell, M. E., Scanlon, K. S., Perry, G., Ferre, C., Blackmore-Prince, C., Yu, S. M., Rosenberg, D. (2000). Prepregnancy body mass index and pregnancy weight gain: associations with preterm delivery. The NMIHS Collaborative Study Group. *Obstetrics and Gynecology*, 96, 194-200.
- Scholl, T. O., Hediger, M. L., Schall, J. I., Ances, I. G., Smith, W. K. (1995). Gestational weight gain, pregnancy outcome, and postpartum weight retention. *Obstetrics and Gynecology*, 86, 423-427.
- Shepard, M. J., Saftlas, A. F., Leo-Summers, L., Bracken, M. B. (1998). Maternal anthropometric factors and risk of primary cesarean delivery. *American Journal of Public Health*, 88, 1534-1538.
- Siege-Riz, A. M., Adair, L. S., and Hobel, C. J. (1994). Institute of Medicine maternal weight gain recommendations and pregnancy outcome in predominantly hispanic population. *Obstetrics and Gynecology*, 84, 565-573.
- Stephansson, O., Dickman, P. W., Johansson, A., Cnattingius, S. (2001). Maternal weight, pregnancy weight gain, and the risk of antepartum stillbirth. *American Journal of Obstetrics and Gynecology*, 184, 463-469.
- Stewart, A. W., Jackson, R. T., Ford, M. A., Beaglehole, R. (1987). Underestimation of relative weight by use of self-reported height and weight. *American Journal of Epidemiology*, 125, 122-126.
- Thorsdottir, I., Birgisdottir, B. E. (1998). Different weight gain in women of normal weight before pregnancy: postpartum weight and birth weight. *Obstetrics and Gynecology*, 92, 377-383.
- Yu, S. M., Nagey, D. A. (1992). Validity of self-reported pregravid weight. *Annals of Epidemiology*, 2, 715-721.

Author Information

Gigliola Baruffi, MD, MPH, Professor*
Department of PH Sciences and Epidemiology
UH John A. Burns School of Medicine
1960 East West Road, Biomed C-103
Honolulu, HI 96822-2319
Ph.: 808-956-5756
E-Mail: gigliola@hawaii.edu

Charles Hardy
Private Consultant

Carol Waslien
University of Hawai'i

Sue Uyehara
Hawai'i Department of Health

Dmitry Krupitsky
University of Hawai'i

Jennette Silao
Private Consultant

* corresponding author