Maternal and Child Health Journal (2019) 23:1525–1535
https://doi.org/10.1007/s10995-019-02775-8

Adverse Pregnancy and Neonatal Outcomes Among Marshallese Women Living in the United States

Wendy N. Nembhard[1,2] · Britni L. Ayers[3] · R. Thomas Collins[6] · Xiaoyi Shan[2,4] · Nader Z. Rabie[7] · Di Chang[5] · James M. Robbins[2,4] · Pearl A. McElfish[3]

Published online: 21 June 2019

Abstract

Objective Despite heterogeneity among Pacific Islanders, most studies aggregate them regardless of origin. Thus, limited information is available about perinatal outcomes among various subgroups of Pacific Islanders in the United States, including immigrants from the Republic of the Marshall Islands. We sought to evaluate perinatal outcomes among Marshallese women. *Methods* We conducted a cross-sectional study of women with at least one singleton live birth between 1997 and 2013 in two Arkansas counties using birth certificate data from the Arkansas Department of Health. Unadjusted and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) were calculated from modified Poisson regression models. *Results* Of the 91,662 singleton births in both counties during the study period, 2488 were to Marshallese women. In adjusted analyses, Marshallese women had higher prevalence of "other medical risk factors" (PR = 1.47; 95% CI 1.30, 1.65) than NH White women. Marshallese women had higher rates of precipitous labor and fetal distress during labor compared to NH White women (PR = 2.65; 95% CI 2.22, 3.17 and 1.89; 95% CI 1.62, 2.21, respectively). Marshallese were also more likely to have tocolysis (PR = 1.43; 95% CI 1.16, 1.76), forceps (PR = 1.68; 95% CI 1.16, 2.43) or vacuum (PR = 1.89; 95% CI 1.60, 2.22) used in delivery and cesarean section (PR = 1.13; 95% CI 1.01, 1.27). Marshallese infants had higher rates of anemia (PR = 3.10; 95% CI 2.01, 4.77), birth injury (PR = 2.13; 95% CI 1.50, 3.03), assisted ventilation < 30 min (PR = 2.11; 95% CI 1.64, 2.71), preterm birth (PR = 1.67; 95% CI 1.50, 1.83), and small-for-gestational age (PR = 1.25; 95% CI 1.12, 1.39) than NH White infants. *Conclusions* Marshallese women and infants had higher rates of adverse perinatal outcomes compared to their NH White counterparts. Additional studies are needed to determine if perinatal outcomes among the Marshallese differed from other Pacific Islander subgroups.

Keywords Infant · Low birth weight · Marshall Islands · Marshallese · Pacific Islander · Pregnancy · Preterm birth

✉ Wendy N. Nembhard
wnnembhard@uams.edu

Britni L. Ayers
blayers@uams.edu

R. Thomas Collins
tomcollins@stanford.edu

Xiaoyi Shan
xshan@uams.edu

Nader Z. Rabie
nader.z.rabie.mil@mail.mil

Di Chang
dchang@uams.edu

James M. Robbins
robbinsjames@uams.edu

Pearl A. McElfish
pamcelfish@uams.edu

[1] Department of Epidemiology, Fay W. Boozman College of Public Health, University of Arkansas for Medical Sciences, 4301 West Markham Street, Slot #820, Little Rock, AR 72205-7199, USA

[2] Arkansas Children's Research Institute, Little Rock, AR, USA

[3] College of Medicine, University of Arkansas for Medical Science, Fayetteville, AR, USA

[4] Department of Pediatrics, College of Medicine, University of Arkansas for Medical Sciences, Little Rock, AR, USA

[5] Arkansas Center for Health Improvement, University of Arkansas for Medical Sciences, Little Rock, AR, USA

[6] Department of Pediatrics, Stanford University School of Medicine, Palo Alto, CA, USA

[7] Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, Tripler Army Medical Center, Honolulu, HI, USA

Significance

Despite heterogeneity among Pacific Islanders, most clinical and epidemiologic studies aggregate them regardless of origin. Therefore, little is known about perinatal outcomes among subgroups of Pacific Islanders in the United States, especially people from the Marshall Islands. We found that Marshallese women and infants have higher rates of adverse perinatal outcomes that differ from adverse outcomes reported for other Pacific Islander subgroup populations.

Introduction

Pacific Islanders are one of the fastest growing populations in the United States (US), growing three times faster between 2000 and 2010 than the total US population (Hixson et al. 2012). The most rapid growth is occurring in the Southern US (66% increase), particularly in the state of Arkansas (252% increase) (Hixson et al. 2012). The vast majority of Pacific Islanders in Arkansas are immigrants from the Republic of the Marshall Islands (RMI) (Central Intelligence Agency. World Factbook:Marshall Islands 2014). Arkansas has the largest population of Marshallese in the continental US (Hixson et al. 2012). Between 1947 and 1986, the RMI were administratively controlled by the US as a United Nations Trust Territory of the Pacific Islands (McElfish et al. 2015). The RMI became an independent country in 1986 under the Compact of Free Association (COFA). The COFA allows people in these territories to freely enter, lawfully reside, and work in the US without visas; thus, the precise number of COFA immigrants is difficult to ascertain (McElfish et al. 2015). Based on US Census estimates, migration from the RMI to Arkansas and other US states tripled between 2000 and 2010 from 6700 to 22,434. However, the true number of Marshallese living in the US is estimated to be much higher. Based on school enrollment data, we estimated that about 40,000 COFA migrants live in the US and approximately 10,000 to 12,000 live in Arkansas (McElfish et al. 2015). With increasing changes in climate and declining employment opportunities in the RMI, the Marshallese population is likely to increase in the US (Yamada 2004).

Based on the projected increase in the Marshallese population in the US, obstetric providers throughout the US will encounter increasing numbers of Marshallese women in their practice; however, a paucity of published literature exists on perinatal outcomes among Marshallese immigrants. Most research aggregate data on Pacific Islanders and Asian Americans, which obscures the substantial differences between ethnic subgroups (The American Community—Pacific Islanders: 2004 2007 ; Park et al. 2009; Ro and Yee 2010; Roehr 2010; Srinivasan and Guillermo 2000; Working Group of the Applied Research Center, 2013). As a result, most information available about perinatal outcomes are reported for "Asians/Pacific Islanders" or for all Pacific Islanders in aggregate. The few studies that report perinatal outcomes for subgroups among Pacific Islanders report outcomes for Hawaiians, Samoans, Guamanian and Micronesian populations and show heterogeneity in perinatal outcomes between the subgroups (Chang et al. 2015; Rao et al. 2006; Schempf et al. 2010; Tsitas et al. 2015; Wong et al. 2008); thus extrapolating findings from these populations to Marshallese women may not be appropriate. Therefore, the intent of this investigation was to compare obstetric and newborn outcomes between immigrant Marshallese women and non-Hispanic (NH) White, NH Black, and Hispanic women.

Methods

A cross-sectional study was conducted using vital records data from the Arkansas Department of Health, Health Statistics Branch. The study population consisted of all resident women from two counties in Arkansas (Benton and Washington), who had one or more singleton, live births between January 1, 1997, and December 31, 2013. Benton and Washington counties were selected because more than 95% of the Marshallese population in Arkansas resides in these counties.

Maternal information obtained from birth records included maternal age (<20, 20–29, 30–39, ≥ 40 years); education [(elementary (1–8 years of schooling), secondary (9–12 years), some college or higher (≥ 13 years)]; marital status (married/unmarried); parity (1, 2, or ≥ 3 children); prenatal care; medical risk factors; obstetric procedures; complications of labor; and method of delivery. Maternal ethnicity (NH White, NH Black, Hispanic, and Marshallese) was also obtained from birth records. Women were categorized as Marshallese if the birth certificate indicated that the woman was born in the Marshall Islands. Women who were not NH White, NH Black, Hispanic or Marshallese were excluded from the study.

Infant information obtained from birth certificate records included sex, birthweight (<1500, 1500–2499, 2500–4000, and >4000 g), gestational age (<20, 20–36, ≥ 37 completed weeks of gestation), and abnormal conditions of newborns. Infant weight was further categorized as small-for-gestational-age (SGA; birthweights <10th percentile), appropriate-for-gestational-age (AGA; birthweights from 10th to 90th percentiles), and large-for-gestational-age (LGA;

birthweights > 90th percentile) based on gestational age using nationally representative growth curves (Alexander et al. 1999).

Statistical Analyses

Summary statistics were computed for all study variables and expressed as means (standard deviation) for continuous variables and counts (percentage) for categorical variables. Chi square and ANOVA tests were used for the comparison across racial groups (Tables 1, 2). Crude prevalence ratios (PR) and 95% confidence intervals (CI) were also calculated using NH White women as the reference group. Adjusted PRs and 95% CIs were calculated adjusting for maternal age, education, marital status, and parity in multivariable modified Poisson regression analyses. Statistical significance was set at $P < 0.05$ or if the confidence interval excluded the null value. All statistical analyses were performed using SAS 9.4 software (SAS Inc., Cary, NC).

The research was conducted in accordance with the prevailing ethical principles and was deemed exempt by the Institutional Review Board at the University of Arkansas for Medical Sciences. The manuscript is not based upon clinical study. The research was approved by the Arkansas Department of Health, Science Advisory Committee.

Results

During the study period, 649,957 infants were born to resident women in Arkansas (68.5% non-Hispanic White, 19.7% non-Hispanic Black, 9.1% Hispanic), of which 2567 (0.4%) were to immigrant Marshallese women. Of those births, 99,045 (15.3%) occurred to resident women in Benton and Washington Counties. Of the 99,045 births, 7423 live births

Table 1 Number and percentages for sociodemographic characteristics of Marshallese mothers, benton and Washington counties, Arkansas, 1997–2013 (n = 91,622)

	NH White (n = 65,800)		NH Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)		*p*
	n	%	n	%	n	%	n	%	
Maternal age									
Mean and SD	26.6	5.7	26.2	5.8	26.4	6.1	25.8	5.2	< 0.01
< 20 years	7081	10.8	220	13.1	2946	13.6	220	8.9	
20–29 years	38,335	58.3	981	58.4	12,209	56.4	1675	67.4	
30–39 years	19,368	29.4	454	27.0	6032	27.9	581	23.4	
≥ 40 years	1000	1.5	25	1.5	461	2.1	11	0.4	
Missing	16	0.0	0	0.0	6	0.0	1	0.0	
Maternal education									
Mean and SD	13.5	2.3	13.8	2.3	9.8	3.3	11.3	1.5	< 0.01
Elementary (1–8 years)	697	1.1	6	0.4	6591	31.5	149	6.5	
Secondary (9–12 years)	31,111	47.6	672	40.8	11,763	56.2	1978	85.7	
Some college or higher (≥ 13 years)	33,594	51.4	969	58.8	2572	12.3	180	7.8	
Missing	398	0.6	33	2.0	728	3.4	181	7.3	
Marital status									
Married	48,689	74.0	788	46.9	12,517	57.8	781	31.4	< 0.01
Unmarried	17,068	26.0	892	53.1	9133	42.2	1706	68.6	
Missing	43	0.1	4	0.0	1	0.0	48	0.1	
Parity									
Mean and SD	25.8	5.2	25.8	5.2	25.8	5.2	25.8	5.2	< 0.01
1 Child	28,524	43.4	745	44.4	7215	33.4	562	22.7	
2 Children	20,161	30.7	467	27.9	6007	27.8	503	20.3	
≥ 3 Children	16,997	25.9	465	27.7	8382	38.8	1414	57.0	
Missing	118	0.2	3	0.0	50	0.2	9	0.4	
Prenatal care[a]									
Prenatal care in the 1st trimester	58,522	87.4	1433	83.4	15,835	73.2	1262	52.2	< 0.01
No prenatal care	840	1.3	57	3.4	524	2.4	480	19.3	< 0.01

NH non-Hispanic, SD standard deviation

[a]Based on two variables: number of prenatal care visits and month prenatal care began. Does not add up to 100

Table 2 Prevalence of medical risk factors and obstetric procedures by maternal ethnicity, Benton and Washington Counties, Arkansas, 1997–2013

	NH White (n = 65,800)		NH Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)		*p*
	n	%	n	%	n	%	n	%	
Medical risk factors									
No medical risk factors	53,303	81.0	1316	78.3	17,958	82.9	1940	78.0	< 0.01
Anemia (Hct. < 30/Hgb < 10)	969	1.5	52	3.1	266	1.2	48	1.9	< 0.01
Cardiac disease	259	0.4	6	0.4	32	0.2	6	0.2	< 0.01
Acute or chronic lung disease	794	1.2	18	1.1	108	0.5	3	0.1	< 0.01
Diabetes	1561	2.4	51	3.0	1006	4.7	81	3.3	< 0.01
Genital herpes	765	1.2	37	2.2	86	0.4	8	0.3	< 0.01
Polyhydramnios/oligohydramnios	527	0.8	14	0.8	279	1.3	35	1.4	< 0.01
Hemoglobinopathy	6	0.0	2	0.1	1	0.0	0	0.0	< 0.01
Hypertension, chronic	527	0.8	28	1.7	91	0.4	9	0.4	< 0.01
Hypertension, pregnancy associated	2435	3.7	54	3.2	575	2.7	26	1.1	< 0.01
Eclampsia	101	0.2	2	0.1	34	0.2	0	0	0.25
Incompetent cervix	82	0.1	6	0.4	30	0.1	0	0	< 0.05
Previous infant ≥ 4000 g	837	1.3	14	0.8	255	1.2	25	1.0	0.20
Previous preterm or small infant	975	1.5	32	1.9	323	1.5	58	2.3	< 0.01
Renal disease	129	0.2	2	0.1	22	0.1	8	0.3	< 0.05
Rh sensitization	220	0.3	2	0.1	23	0.1	0	0	< 0.01
Uterine bleeding	356	0.5	6	0.4	94	0.4	5	0.2	< 0.05
Other medical risk factors	4513	6.9	163	9.7	1153	5.3	320	12.9	< 0.01
Alcohol use during pregnancy	442	0.7	13	0.8	61	0.3	8	0.3	< 0.01
Tobacco use during pregnancy	9147	13.9	135	8.0	293	1.4	58	2.3	< 0.01
Obstetric procedures									
No obstetric procedure	2633	4.0	76	4.5	687	3.2	67	2.7	< 0.01
Amniocentesis	1008	1.5	24	1.4	153	0.7	12	0.5	< 0.01
Electronic fetal monitoring	50,176	76.3	1260	75.0	17,822	82.3	2143	86.1	< 0.01
Induction of labor	15,476	23.5	260	15.5	3582	16.5	108	4.3	< 0.01
Stimulation of labor	9249	14.1	196	11.7	3501	16.2	342	13.8	< 0.01
Tocolysis	1487	2.3	41	2.4	576	2.7	101	4.1	< 0.01
Ultrasound	42,835	65.1	1179	70.2	12,763	58.9	1836	73.8	< 0.01
Other obstetric procedures	2631	4.0	79	4.7	777	3.6	91	3.7	< 0.05
Complications of labor									
No complications of labor or delivery	47,002	71.4	1161	69.1	15,334	70.8	1493	60.0	< 0.01
Febrile (> 100 °F or 38 °C)	784	1.2	14	0.8	339	1.6	18	0.7	< 0.01
Meconium, moderate/heavy	2059	3.1	52	3.1	1012	4.7	104	4.2	< 0.01
Premature rupture of membrane > 12 h	989	1.5	15	0.9	306	1.4	25	1.0	< 0.05
Abruptio placenta	280	0.4	8	0.5	77	0.4	12	0.5	0.49
Placenta previa	160	0.2	2	0.1	59	0.3	5	0.2	0.59
Other excessive bleeding	191	0.3	2	0.1	102	0.5	7	0.3	<0.01
Seizures during labor	16	0	4	0.2	10	0.1	1	0	< 0.01
Precipitate labor	1138	1.7	29	1.7	723	3.3	175	7.0	< 0.01
Prolonged labor (> 20 h)	337	0.5	5	0.3	82	0.4	3	0.1	< 0.01
Dysfunctional labor	2107	3.2	48	2.9	600	2.8	42	1.7	< 0.01
Breech/malpresentation	2283	3.5	42	2.5	743	3.4	101	4.1	0.06
Cephalopelvic disproportion	961	1.5	18	1.1	313	1.5	7	0.3	< 0.01
Cord prolapse	141	0.2	1	0.1	35	0.2	6	0.2	0.24
Anesthetic complications	41	0.1	0	0	4	0	1	0	0.07
Fetal distress	3052	4.6	90	5.4	848	3.9	189	7.6	< 0.01

Table 2 (continued)

	NH White (n = 65,800)		NH Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)		*p*
	n	%	n	%	n	%	n	%	
Other complications of labor and delivery	8280	12.6	278	17	2517	11.6	513	20.6	< 0.01
Method of delivery									
Vaginal delivery	49,641	75.4	1191	71	16,299	75.3	1852	74.4	< 0.01
Vaginal birth after prior C-section	724	1.1	13	0.8	341	1.6	36	1.5	< 0.01
Primary C-section	8826	13.4	271	16	2230	10.3	280	11.3	< 0.01
Repeat C-section	6557	10.0	203	12	2778	12.8	319	12.8	< 0.01
Forceps	1038	1.6	20	1.2	185	0.9	32	1.3	< 0.01
Vacuum	3204	4.9	64	3.8	938	4.3	155	6.2	< 0.01

NH non-Hispanic, *Hct* hematocrit, *Hgb* hemoglobin

were excluded because they did not meet the study criteria (2741 were not singletons, and maternal ethnicity of 4682 births did not fit the study categories or were missing), leaving a total of 91,622 singleton infants in our study (Table 1). In both counties combined, 2488 (2.6%) singleton births were to Marshallese women. As seen in Tables 1 and 2, Marshallese women tended to have only 9–12 years of education, be unmarried, and have three or more children. Only 52% of Marshallese women received prenatal care in the first trimester, whereas 73% of Hispanic women and more than 80% of NH Black and NH White women received prenatal care in the first trimester. Fifteen percent of Marshallese women received no prenatal care.

Maternal Outcomes

Medical Risk Factors and Obstetric Outcomes

Prevalence rates of medical risk factors and obstetric outcomes by maternal ethnicity are presented in Table 2. About 80% of pregnant women (78% Marshallese, 78.3% NH Black, 81% NH White, and 82.8% Hispanic) had no known medical risk factors for an adverse pregnancy outcome. The frequency of alcohol and tobacco use during pregnancy was relatively low among Marshallese women (0.3% and 2.3%). The highest rates of alcohol use during pregnancy were among NH Black and NH White women (0.8% and 0.7%, respectively). NH White women had the highest rates of prenatal tobacco use (13.9%) followed by NH Black women (8.0%). Although only 52% of Marshallese women received prenatal care in the first trimester of pregnancy, 74% had an ultrasound during pregnancy which was the highest of all racial/ethnic groups (70.2% for NH Blacks, 65.1% for NH Whites and 58.9% for Hispanics). Similarly, electronic fetal monitoring was used more often in Marshallese.

In multivariable analyses (Table 3), compared to NH-White women, Marshallese women tended toward a higher prevalence of renal disease, but the increase was not statistically significant (PR = 1.45; 95% CI 0.70, 2.98). With the exception of "other medical risk factors," which were more prevalent in Marshallese compared to NH White (PR = 1.47; 95% CI 1.30, 1.65), the prevalence of all other conditions of all other conditions were similar between the groups. During pregnancy, Marshallese women were more likely to have polyhydramnios or oligohydramnios (PR = 1.4, 95% CI 1.0, 2.0), tocolysis (PR = 1.43; 95% CI 1.16, 1.76), and ultrasound (PR = 1.16; 95% CI 1.13, 1.19) than NH White women.

Complications of Labor

The prevalence of complications of labor for each ethnic group are displayed in Table 2. Approximately 30% of NH White, NH Black, and Hispanic women experienced complications during labor or delivery; whereas, 40% of Marshallese women experienced complications. Seven percent of Marshallese women had precipitous labor (a labor lasting less than two hours) while only 1.7% of NH White and NH Black women and 3.3% of Hispanic had precipitous labor. Eight percent of Marshallese women experienced fetal distress during labor, compared to 5% of NH White and NH Black women and 4% of Hispanic women. Twenty-one percent of Marshallese women had "other complications of labor and delivery," which was more frequent than the other racial/ethnic groups (12.6% for NH White, 17% for NH Black, and 11.6% for Hispanic women).

After adjusting for potential confounders, Marshallese women were more likely to have several complications of labor (Table 3). They were more likely to have moderate/heavy meconium in their amniotic fluid (PR = 1.34; 95% CI 1.08, 1.65), precipitous labor (PR = 2.65; 95% CI 2.22, 3.17), fetal distress (PR = 1.89; 95% CI 1.62, 2.21), and other complications of labor or delivery (PR = 1.67; 95% CI 1.53, 1.82).

Table 3 Prevalence rates (PR) and 95% confidence intervals (CI) for medical risk factors and obstetric procedures by maternal race/ethnicity, Benton and Washington Counties, Arkansas, 1997–2013

	NH-Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)	
	PR (95% CI)	PR[a] (95% CI)	PR (95% CI)	PR[a] (95% CI)	PR (95% CI)	PR[a] (95% CI)
Medical risk factors						
No medical risk factors	0.96 (0.94–0.98)	0.97 (0.94–0.99)	1.02 (1.01–1.03)	1.04 (1.04–1.05)	0.96 (0.94–0.98)	1.01 (0.99–1.03)
Anemia (Hct < 30/ Hgb < 10)	1.94 (1.47–2.55)	1.90 (1.44–2.51)	0.82 (0.72–0.94)	0.80 (0.68–0.93)	1.25 (0.94–1.67)	0.84 (0.60–1.17)
Cardiac disease	0.88 (0.39–1.97)	0.91 (0.40–2.06)	0.40 (0.28–0.57)	0.49 (0.32–0.74)	0.82 (0.41–1.66)	1.01 (0.49–2.09)
Acute or chronic lung disease	1.02 (0.67–1.55)	0.98 (0.64–1.52)	0.42 (0.35–0.51)	0.43 (0.34–0.54)	0.10 (0.03–0.31)	0.06 (0.02–0.25)
Diabetes	1.38 (1.07–1.78)	1.47 (1.13–1.91)	1.93 (1.79–2.08)	1.45 (1.30–1.61)	1.36 (1.09–1.69)	1.11 (0.88–1.41)
Genital herpes	1.80 (1.30–2.49)	1.68 (1.20–2.36)	0.34 (0.27–0.42)	0.34 (0.26–0.45)	0.27 (0.13–0.54)	0.19 (0.08–0.45)
Polyhydramnios/oligo-hydramnios	0.97 (0.57–1.65)	1.00 (0.58–1.7)	1.58 (1.37–1.82)	1.37 (1.14–1.65)	1.69 (1.20–2.37)	1.38 (0.95–2.01)
Hemoglobinopathy	10.96 (2.28–52.72)	11.59 (2.59–51.97)	0.44 (0.05–3.58)	0.37 (0.01–10.06)	–	–
Hypertension, chronic	2.08 (1.44–2.99)	2.35 (1.63–3.38)	0.53 (0.43–0.66)	0.43 (0.32–0.57)	0.44 (0.23–0.85)	0.53 (0.27–1.04)
Hypertension, pg associated	0.97 (0.76–1.23)	1.01 (0.79–1.29)	0.72 (0.66–0.79)	0.72 (0.65–0.80)	0.27 (0.18–0.40)	0.34 (0.23–0.51)
Eclampsia	1.30 (0.48–3.52)	1.55 (0.55–4.35)	0.88 (0.60–1.29)	0.91 (0.55–1.51)	–	–
Incompetent cervix	2.47 (1.08–5.63)	2.39 (1.03–5.57)	0.99 (0.66–1.49)	1.25 (0.75–2.11)	–	–
Previous infant ≥ 4000 g	0.63 (0.37–1.07)	0.65 (0.39–1.11)	0.94 (0.82–1.08)	0.84 (0.71–0.99)	0.78 (0.53–1.16)	0.57 (0.37–0.89)
Previous preterm or small infant	1.27 (0.91–1.78)	1.16 (0.82–1.65)	1.01 (0.89–1.14)	0.91 (0.78–1.07)	1.62 (1.26–2.09)	0.87 (0.65–1.15)
Renal disease	0.57 (0.14–2.30)	0.56 (0.14–2.24)	0.50 (0.32–0.78)	0.43 (0.26–0.74)	1.59 (0.78–3.24)	1.45 (0.70–2.98)
Rh sensitization	0.35 (0.09–1.41)	0.39 (0.10–1.56)	0.32 (0.21–0.49)	0.39 (0.23–0.66)	–	–
Uterine bleeding	0.61 (0.27–1.36)	0.66 (0.30–1.48)	0.76 (0.61–0.95)	0.69 (0.52–0.92)	0.36 (0.15–0.87)	0.34 (0.14–0.83)
Other medical risk factors	1.42 (1.23–1.64)	1.32 (1.13–1.53)	0.77 (0.72–0.82)	0.70 (0.65–0.76)	1.85 (1.67–2.05)	1.47 (1.30–1.65)
Alcohol use during pregnancy	1.29 (0.77–2.15)	1.18 (0.71–1.96)	0.42 (0.32–0.55)	0.34 (0.24–0.48)	0.48 (0.24–0.96)	0.36 (0.18–0.74)
Tobacco use during pregnancy	0.59 (0.50–0.69)	0.52 (0.44–0.60)	0.10 (0.09–0.11)	0.02 (0.02–0.03)	0.17 (0.13–0.22)	0.06 (0.05–0.08)
Obstetric procedures						
No obstetric procedure performed	1.14 (0.92–1.42)	1.19 (0.95–1.49)	0.79 (0.73–0.86)	0.64 (0.58–0.71)	0.69 (0.55–0.87)	0.60 (0.46–0.77)
Amniocentesis	0.94 (0.64–1.38)	1.02 (0.70–1.50)	0.46 (0.39–0.54)	0.49 (0.40–0.60)	0.31 (0.18–0.55)	0.51 (0.28–0.90)
Electronic fetal monitoring	0.99 (0.96–1.02)	0.97 (0.94–0.99)	1.08 (1.07–1.09)	1.11 (1.10–1.12)	1.13 (1.11–1.15)	1.09 (1.07–1.11)
Induction of labor	0.65 (0.58–0.73)	0.67 (0.59–0.74)	0.71 (0.69–0.73)	0.77 (0.74–0.80)	0.19 (0.16–0.23)	0.20 (0.17–0.25)
Stimulation of labor	0.83 (0.73–0.95)	0.83 (0.73–0.95)	1.15 (1.11–1.19)	1.15 (1.10–1.20)	0.99 (0.90–1.09)	1.04 (0.93–1.15)
Tocolysis	1.46 (1.14–1.87)	1.43 (1.11–1.84)	1.13 (1.03–1.24)	1.08 (0.96–1.21)	1.70 (1.40–2.06)	1.43 (1.16–1.76)
Ultrasound	1.08 (1.05–1.11)	1.09 (1.06–1.12)	0.90 (0.89–0.91)	0.88 (0.87–0.89)	1.13 (1.10–1.16)	1.16 (1.13–1.19)
Other obstetric procedures	1.30 (1.07–1.58)	1.31 (1.08–1.6)	0.89 (0.83–0.96)	0.90 (0.82–0.99)	0.89 (0.73–1.09)	0.90 (0.72–1.12)
Complications of labor						
No complications of labor/delivery	0.96 (0.93–0.99)	0.97 (0.93–1.00)	0.99 (0.98–1.00)	0.99 (0.98–1.00)	0.84 (0.81–0.87)	0.82 (0.79–0.85)
Febrile (> 100 °F or 38 °C)	0.87 (0.55–1.38)	0.70 (0.42–1.17)	1.30 (1.15–1.47)	1.59 (1.37–1.84)	0.61 (0.38–0.97)	0.80 (0.48–1.34)
Meconium, moderate/ heavy	0.97 (0.74–1.27)	0.95 (0.72–1.25)	1.50 (1.39–1.61)	1.35 (1.23–1.48)	1.35 (1.11–1.64)	1.34 (1.08–1.65)
Premature rupture of membrane > 12 h	1.14 (0.80–1.62)	1.05 (0.72–1.53)	0.90 (0.79–1.02)	0.90 (0.77–1.05)	0.62 (0.42–0.92)	0.79 (0.52–1.20)

Table 3 (continued)

	NH-Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)	
	PR (95% CI)	PR[a] (95% CI)	PR (95% CI)	PR[a] (95% CI)	PR (95% CI)	PR[a] (95% CI)
Abruptio placenta	1.05 (0.52–2.12)	0.99 (0.49–2.02)	0.83 (0.65–1.06)	0.60 (0.43–0.84)	1.10 (0.62–1.96)	0.69 (0.38–1.26)
Placenta previa	0.47 (0.12–1.89)	0.52 (0.13–2.11)	1.15 (0.86–1.54)	1.03 (0.69–1.55)	0.82 (0.34–1.99)	0.71 (0.27–1.84)
Other excessive bleeding	0.38 (0.09–1.53)	0.41 (0.10–1.65)	1.56 (1.23–1.98)	1.50 (1.12–2.02)	0.94 (0.44–2.00)	1.00 (0.45–2.21)
Seizures during labor	9.59 (3.21–28.66)	9.53 (2.76–32.88)	1.92 (0.87–4.23)	2.37 (0.87–6.41)	1.68 (0.22–12.66)	1.14 (0.16–7.92)
Precipitate labor	1.12 (0.80–1.57)	0.95 (0.66–1.37)	1.93 (1.76–2.11)	1.51 (1.35–1.69)	4.17 (3.58–4.85)	2.65 (2.22–3.17)
Prolonged labor (> 20 h)	0.57 (0.24–1.38)	0.64 (0.26–1.55)	0.74 (0.58–0.94)	0.94 (0.70–1.25)	0.24 (0.08–0.75)	0.44 (0.14–1.38)
Dysfunctional labor	0.90 (0.68–1.19)	0.91 (0.69–1.20)	0.86 (0.79–0.94)	0.99 (0.89–1.10)	0.53 (0.39–0.72)	0.89 (0.65–1.21)
Breech/malpresentation	0.83 (0.65–1.07)	0.84 (0.65–1.08)	0.96 (0.89–1.03)	0.93 (0.85–1.02)	1.08 (0.90–1.30)	1.05 (0.85–1.28)
Cephalopelvic disproportion	0.71 (0.45–1.13)	0.77 (0.48–1.22)	1.00 (0.88–1.13)	1.23 (1.05–1.43)	0.19 (0.09–0.40)	0.33 (0.15–0.74)
Cord prolapse	1.05 (0.39–2.83)	1.10 (0.40–3.04)	0.74 (0.51–1.07)	0.53 (0.34–0.82)	1.10 (0.49–2.49)	0.98 (0.41–2.36)
Anesthetic complications	–	–	0.43 (0.18–1.01)	0.54 (0.19–1.54)	0.63 (0.09–4.57)	0.70 (0.09–5.41)
Fetal distress	1.12 (0.91–1.37)	1.13 (0.92–1.39)	0.84 (0.78–0.90)	0.82 (0.75–0.90)	1.62 (1.41–1.87)	1.89 (1.62–2.21)
Other complications of labor and delivery	1.33 (1.20–1.48)	1.27 (1.14–1.41)	0.92 (0.88–0.96)	1.00 (0.95–1.05)	1.63 (1.51–1.76)	1.67 (1.53–1.82)
Method of delivery						
Vaginal delivery	0.93 (0.90–0.96)	0.94 (0.91–0.96)	1.00 (0.99–1.01)	0.99 (0.98–1.00)	1.00 (0.98–1.02)	1.00 (0.97–1.02)
Vaginal birth after prior C-section	0.69 (0.40–1.19)	0.64 (0.35–1.17)	1.45 (1.28–1.65)	1.32 (1.12–1.55)	1.33 (0.95–1.85)	0.93 (0.65–1.34)
Primary C-section	1.24 (1.12–1.37)	1.22 (1.11–1.35)	0.77 (0.74–0.80)	0.88 (0.84–0.92)	0.80 (0.72–0.89)	1.13 (1.01–1.27)
Repeat C-section	1.16 (1.02–1.32)	1.19 (1.04–1.35)	1.29 (1.24–1.34)	1.23 (1.17–1.30)	1.28 (1.15–1.42)	0.91 (0.81–1.03)
Forceps	0.87 (0.58–1.30)	0.93 (0.62–1.39)	0.54 (0.46–0.63)	0.73 (0.62–0.87)	0.81 (0.57–1.15)	1.68 (1.16–2.43)
Vacuum	0.80 (0.63–1.01)	0.84 (0.66–1.07)	0.89 (0.83–0.96)	0.95 (0.87–1.03)	1.32 (1.13–1.54)	1.89 (1.60–2.22)

NH White is the reference group

NH non-Hispanic, *PR* prevalence ratio, *Hct* hematocrit, *Hgb* hemoglobin

[a]Adjusted by maternal age, education, parity, and marital status

Method of Delivery

As seen in Table 2, Marshallese women had similar frequency of vaginal delivery and vaginal births after cesarean delivery to the other ethnic groups. After adjusting for potential confounders, Marshallese women were more likely to have a primary cesarean delivery (PR = 1.13; 95% CI 1.01, 1.27), forceps (PR = 1.68; 95% CI 1.16, 2.43), and a vacuum-assisted delivery (PR = 1.89; 95% CI 1.60, 2.22) compared to NH White women.

Infant Outcomes

The prevalence of infant outcomes is displayed in Tables 3 and 4 by maternal ethnicity. Eight percent of Marshallese and NH Black infants were born low birthweight (1500–2499 g); mean birthweights of Marshallese and NH Black infants were 3110 and 3134 g, respectively. Only 3.7% of Marshallese infants were born macrosomic (> 4000 g. Nineteen percent of Marshallese infants were born moderately preterm (32–36 weeks). Fifteen percent of Marshallese and 15.9% of NH Black infants were born small-for-gestational age. Of the ethnic groups, Marshallese infants had the highest prevalence of anemia, birth injury, meconium aspiration, assisted ventilation less than 30 min, and "other abnormal conditions of the infant."

After adjusting for covariates in multivariable regression analyses, infants born to Marshallese women experienced greater adverse outcomes compared to NH Whites (Table 5). Marshallese infants had a slightly higher prevalence of low birthweight (PR = 1.12; 95% CI 0.96, 1.29), preterm birth (PR = 1.66; 95% CI 1.50, 1.83), and small-for-gestational age (PR = 1.25; 95% CI 1.12, 1.39) compared to NH White infants. Marshallese infants were less likely to be macrosomic or large-for-gestational age (OR = 0.43; 95% CI 0.35, 0.53 and OR = 0.59: 95% CI 0.50, 0.70, respectively). Marshallese infants were more likely to have anemia (PR = 3.10; 95% CI 2.01, 4.77), birth injury (PR = 2.13; 95% CI 1.50, 3.03), and

Table 4 Prevalence of infant outcomes by maternal race/ethnicity, Benton and Washington Counties, Arkansas, 1997–2013

	NH White (n = 65,800)		NH Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)		*p*
	n	%	n	%	n	%	n	%	
Infant sex									
Boys	33,746	51.3	846	50.4	10,916	50.4	1255	50.4	0.13
Girls	32,053	48.7	834	49.6	10,738	49.6	1233	49.6	
Infant birthweight									
< 1500 g	520	0.8	49	2.9	179	0.8	33	1.3	
1500–2499 g	2933	4.5	135	8.1	994	4.6	189	7.6	
2500–4000 g	55,552	84.5	1401	83.6	18,691	86.4	2173	87.4	
> 4000 g	6750	10.3	91	5.4	1767	8.2	92	3.7	
Mean and SD	3373	554	3134	637.8	3329	538.8	3110	528.6	< 0.01
Infant gestational age									
< 32 weeks	725	1.2	50	3.2	281	1.4	59	2.7	
32–36 weeks	5263	8.3	162	10.2	1953	9.4	427	19.3	
≥ 37 weeks	57,150	90.5	1372	86.6	18,482	89.2	1732	78.1	
Mean and SD	38.9	2.3	38.4	2.7	38.8	2.4	38.1	2.9	< 0.01
Fetal growth									
Small for gestational age	5596	8.9	252	15.9	1914	9.3	335	15.1	< 0.01
Appropriate for gestational age	50,107	79.4	1213	76.7	16,659	80.5	1746	78.8	
Large for gestational age	7404	11.7	116	7.3	2130	10.3	136	6.1	
Abnormal conditions of newborn									
Anemia (Hct < 39/Hgb < 13)	257	0.4	11	0.7	123	0.6	24	1.0	< 0.01
Birth injury	629	1.0	12	0.7	168	0.8	38	1.5	< 0.01
Hyaline membrane disease/RDS	1123	1.7	39	2.3	333	1.5	75	3.0	< 0.01
Meconium aspiration syndrome	124	0.2	5	0.3	60	0.3	9	0.4	< 0.05
Assisted ventilation < 30 min	978	1.5	30	1.8	310	1.4	85	3.4	< 0.01
Assisted ventilation ≥ 30 min	651	1.0	17	1.0	200	0.9	28	1.1	0.72
Seizures	42	0.1	1	0.1	8	0	2	0.1	0.51
Other abnormal conditions of infant	1564	2.4	45	2.7	457	2.1	114	4.6	< 0.01
Baby transferred to ICU	1744	2.7	75	4.5	461	2.1	74	3.0	< 0.01
Apgar scores	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1 min apgar score	7.8	1.2	7.7	1.4	7.8	1.2	7.6	1.4	< 0.01
5 min apgar score	8.9	0.7	8.8	0.9	8.9	0.7	8.8	0.9	< 0.01

NH non-Hispanic, *SD* standard deviation, *Hct* hematocrit, *Hgb* hemoglobin

hyaline membrane disease or respiratory distress syndrome (PR = 1.26; 95% CI 0.99, 1.60) compared to NH White infants. Marshallese infants were also more likely to have meconium aspiration syndrome (PR = 2.09; 95% CI 0.97, 4.53), require assisted ventilation for < 30 min (PR = 2.11; 95% CI 1.64, 2.71), and have "other abnormal conditions of the infant" (PR = 1.73; 95% CI 1.42, 2.12).

Discussion

Information about pregnancy and infant outcomes among Marshallese women in the US is scarce. The intent of our study was to provide data to aid clinicians in caring for and counseling Marshallese women on perinatal risks

Table 5 Prevalence rates (PR) and 95% confidence intervals (CI) for infant outcomes by maternal race/ethnicity, Benton and Washington Counties, Arkansas, 1997–2013

	NH-Black (n = 1680)		Hispanic (n = 21,654)		Marshallese (n = 2488)	
	PR (95% CI)	PR[a] (95% CI)	PR (95% CI)	PR[a] (95% CI)	PR (95% CI)	PR[a] (95% CI)
Infant sex						
Boys	0.98 (0.94–1.03)	0.99 (0.94–1.04)	0.98 (1.03–0.97)	0.98 (0.97–1.00)	0.99 (0.97–0.99)	1.00 (0.96–1.04)
Girls	1.02 (0.97–1.07)	1.01 (0.97–1.06)	1.02 (1.07–1.00)	1.02 (1.00–1.04)	1.02 (1.00–1.04)	1.00 (0.96–1.05)
Infant birthweight						
< 1500 g	3.59 (2.82–4.57)	3.18 (2.46–4.12)	0.89 (4.57–0.77)	0.67 (0.55–0.82)	1.46 (0.77–1.04)	1.03 (0.72–1.46)
1500–2499 g	1.75 (1.52–2.02)	1.69 (1.46–1.96)	0.96 (2.02–0.90)	0.85 (0.78–0.92)	1.42 (0.90–1.02)	1.12 (0.96–1.29)
2500–4000 g	0.97 (0.95–0.99)	0.97 (0.95–0.99)	1.03 (1.02–1.04)	1.03 (1.03–1.04)	1.04 (1.02–1.06)	1.05 (1.03–1.07)
> 4000 g	0.52 (0.43–0.64)	0.57 (0.46–0.69)	0.80 (0.76–0.84)	0.84 (0.79–0.89)	0.37 (0.30–0.45)	0.43 (0.35–0.53)
Infant gestational age						
< 32 weeks	2.94 (2.34–3.70)	2.60 (2.04–3.32)	0.99 (3.70–0.87)	0.77 (0.66–0.91)	1.82 (0.87–1.12)	1.25 (0.94–1.65)
32–36 weeks	1.23 (1.08–1.41)	1.19 (1.04–1.37)	1.07 (1.41–1.02)	0.97 (0.92–1.03)	1.91 (1.02–1.12)	1.66 (1.50–1.83)
≥ 37 weeks	0.92 (0.90–0.94)	0.95 (0.93–0.97)	0.99 (0.94–0.98)	1.01 (1.00–1.01)	0.81 (0.98–1.00)	0.90 (0.88–0.92)
Fetal growth						
Small for gestational age	1.73 (1.55–1.93)	1.72 (1.54–1.92)	1.02 (1.93–0.97)	0.84 (0.79–0.90)	1.48 (0.97–1.07)	1.25 (1.12–1.39)
Appropriate for gestational age	0.94 (0.91–0.97)	0.96 (0.93–0.98)	1.01 (0.97–1.00)	1.04 (1.03–1.05)	0.93 (1.00–1.02)	1.02 (1.00–1.05)
Large for gestational age	0.60 (0.50–0.72)	0.65 (0.55–0.78)	0.88 (0.72–0.84)	0.89 (0.84–0.93)	0.50 (0.84–0.92)	0.59 (0.50–0.70)
Abnormal conditions of newborn						
Anemia (Hct < 39/Hgb < 13)	1.85 (1.06–3.22)	1.89 (1.08–3.29)	1.44 (1.17–1.78)	1.18 (0.92–1.52)	2.60 (1.74–3.88)	3.10 (2.01–4.77)
Birth injury	0.72 (0.41–1.27)	0.69 (0.38–1.24)	0.81 (0.68–0.96)	0.83 (0.68–1.02)	1.64 (1.19–2.26)	2.13 (1.50–3.03)
Hyaline membrane disease/ RDS	1.37 (1.04–1.81)	1.27 (0.96–1.68)	0.86 (0.77–0.96)	0.79 (0.69–0.91)	1.55 (1.24–1.93)	1.26 (0.99–1.60)
Meconium aspiration syndrome	1.55 (0.63–3.78)	1.57 (0.64–3.85)	1.48 (1.09–2.01)	1.35 (0.93–1.96)	1.95 (0.99–3.83)	2.09 (0.97–4.53)
Assisted ventilation < 30 min	1.39 (1.01–1.91)	1.43 (1.04–1.98)	0.96 (0.85–1.09)	0.92 (0.79–1.07)	2.23 (1.80–2.76)	2.11 (1.64–2.71)
Assisted ventilation ≥ 30 min	1.06 (0.70–1.61)	0.97 (0.61–1.52)	0.87 (0.75–1.01)	0.72 (0.60–0.87)	1.08 (0.76–1.53)	0.92 (0.63–1.35)
Seizures	0.83 (0.11–6.02)	0.86 (0.12–6.43)	0.67 (0.34–1.33)	0.68 (0.31–1.50)	1.17 (0.28–4.82)	1.39 (0.33–5.75)
Other abnormal conditions of infant	1.27 (0.98–1.65)	1.13 (0.86–1.50)	0.86 (0.78–0.95)	0.76 (0.67–0.86)	1.87 (1.56–2.24)	1.73 (1.42–2.12)
Baby transferred to ICU	1.07 (0.93–1.24)	1.65 (1.34–2.02)	0.62 (0.58–0.66)	0.68 (0.60–0.76)	0.53 (0.44–0.63)	0.85 (0.67–1.07)

NH non-Hispanic, *PR* prevalence ratio, *Hct* hematocrit, *Hgb* hemoglobin

[a]Adjusted by maternal age, education, parity, and marital status

and to determine if Marshallese women and infants have increased risk of specific adverse perinatal outcomes. In this study, Marshallese women did not have a higher prevalence of identified medical risk factors included on the birth certificate, but had higher prevalence of the category "other medical risk factors" that complicated their pregnancies. Their use of tobacco and alcohol during pregnancy was much lower than NH White women. In general, lower percentages of Pacific Islander women access first trimester prenatal care and Marshallese women had a similar pattern of low prenatal care usage. Although Marshallese immigrants are legally able to live and work in the US, they are not eligible for Medicaid or Medicaid expansion benefits (McElfish et al. 2015). Lack of health insurance may explain low first trimester prenatal care rates for Marshallese women. In addition, sociodemographic barriers (e.g. not speaking or understanding English), socioecological constraints, and low trust of Western medicine may inhibit use of healthcare by immigrant Marshallese women (Ayers et al. 2018). We found higher rates of cesarean deliveries and other obstetric interventions including the use of forceps and vacuum-assisted delivery. Our study also showed that Marshallese infants were more likely be low birthweight, preterm, and small-for-gestational age compared to NH White infants.

The only study to date that examined obstetric outcomes among the Marshallese population separate from other Pacific Islander populations found similar results (Schempf et al. 2010). Schempf et al. (2010) used California data from 2003 to 2005 on several subgroups of Pacific Islanders including 938 Marshallese women; 18.8% of Marshallese infants were preterm and 8.4% were low birthweight.

Marshallese infants were two times more likely to be preterm and 1.38 times more likely to be low birthweight. They also found low first trimester prenatal care rates and low rates of prenatal cigarette smoking.

A few studies have investigated obstetric outcomes among all Pacific Islanders combined and among Pacific Islander subgroups. Rao et al. (2006) found that Pacific Islander women (Tongan, Samoan, Guamanian, and Polynesian combined) did not have statistically significantly higher rates of preterm birth or low birthweight but did have statistically significantly higher rates of gestational diabetes, gestational hypertension, cesarean deliveries, and macrosomia (Rao et al. 2006). Native Hawaiian women are reported to have higher rates of low birthweight (Chang et al. 2015; Todd and Peabody 2004), preterm birth (Schempf et al. 2010), gestational diabetes (Chang et al. 2015), and cesarean deliveries (Wong et al. 2008). Samoan women have higher rates of macrosomia (Chang et al. 2015; Tsitas et al. 2015; Wong et al. 2008), preterm birth (Schempf et al. 2010; Wong et al. 2008), very preterm birth (< 32 weeks) (Wong et al. 2008), gestational diabetes (Chang et al. 2015), pregnancy-associated hypertension (Chang et al. 2015), cesarean section (Wong et al. 2008), and eclampsia (Wong et al. 2008). The three studies which investigated obstetric outcomes among Guamanian women report higher rates of low birthweight (Wong et al. 2008), preterm birth (Schempf et al. 2010; Wong et al. 2008), very preterm birth (Wong et al. 2008), gestational diabetes (Schempf et al. 2010), pregnancy-associated hypertension (Chang et al. 2015), cesarean section (Wong et al. 2008), and eclampsia (Wong et al. 2008). Only one study reported obstetric outcomes for women from Micronesia and showed higher rates of pregnancy-associated hypertension and cesarean section compared to Caucasian women (Schempf et al. 2010).

Taken together, the literature reveals that each Pacific Islander subgroup has different perinatal risk profiles and that Marshallese women may have distinct perinatal outcomes from other Pacific Islander subgroups. Unlike findings for Native Hawaiian, Samoan, and Guamanian women and all Pacific Islander women combined, Marshallese women in our population did not have higher rates of gestational diabetes, pregnancy-associated hypertension or eclampsia. In contrast to Samoans, all Pacific Islanders combined and "other Pacific Islanders," we found no evidence of higher rates of macrosomia or large-for-gestational age for Marshallese infants. Thus, extrapolating perinatal findings from studies which combine all Pacific Islanders in aggregate or from other Pacific Islander populations seems to be inappropriate.

A few potential limitations should be considered when evaluating the results of our study. First, although our study population consisted of the largest Marshallese study population to date and the largest population in the continental US, fewer than 3000 live births occurred to Marshallese women during the study period. Second, to ensure the data set included Marshallese, records where selected if they included both Pacific Islander as their race and the women reported being born in the Marshall Islands. Therefore, we may have under-ascertained live births to Marshallese women and underestimation of the true prevalence of their outcomes. Third, we relied on information about maternal risk factors, pregnancy complications, and infant outcomes from the birth certificates instead of medical records. Studies indicate that the accuracy of reporting of these conditions on birth certificates varies greatly, and these conditions are often underreported or inaccurately reported on birth certificates in comparison to medical records (Schempf et al. 2010). Fourth, we were unable to control for the amount of time women have lived in the US, acculturation, immigration status, obesity, and other factors that may affect care. Despite these limitations, our study has several strengths. Our study population included almost 2500 singleton Marshallese births, which is the largest study of Marshallese births to date. Unlike other studies, which aggregate all Pacific Islander populations, our study focused solely on Marshallese women and compared birth outcomes to those of NH Black and Hispanics within the same counties. Our study also provided a broader examination of perinatal outcomes by including all conditions reported on the standard US birth certificate, as opposed to the few selected conditions reported in other studies. Our results highlight the heterogeneity in perinatal outcomes among expatriate women from the Pacific Islands and can assist clinicians who care for and counsel Marshallese women.

Acknowledgements The authors would like to thank Robin Richardson and Lindsey Overman for assisting with the preparation of this manuscript.

Funding This study was supported by the CDC National Center for Birth Defects and Developmental Disabilities (#5U01DD000491-05), the Arkansas Biosciences Institute (#037062), and the Translational Research Institute Grant (1U54TR001629-01A1) through the National Center for Advancing Translational Sciences of the National Institutes of Health (NIH). "The content is solely the responsibility of the authors and does not necessarily represent the official views of the Centers for Disease Control and Prevention or the National Institutes of Health."

References

Alexander, G. R., Tompkins, M. E., Allen, M. C., & Hulsey, T. C. (1999). Trends and racial differences in birth weight and related survival. *Maternal and Child Health Journal, 3*(2), 71–79.

Ayers, B. L., Purvis, R. S., Bing, W. I., Rubon-Chutaro, J., Hawley, N. L., Delafield, R., … McElfish, P. A. (2018). Structural and Sociocultural barriers to prenatal care in a US Marshallese community. *Maternal and Child Health Journal*. https://doi.org/10.1007/s10995-018-2490-5.

Central Intelligence Agency. World Factbook:Marshall Islands. (2014). Retrieved December 12, 2017 from https://www.cia.gov/library/publications/the-world-factbook/geos/rm.html.

Chang, A. L., Hurwitz, E., Miyamura, J., Kaneshiro, B., & Sentell, T. (2015). Maternal risk factors and perinatal outcomes among Pacific Islander groups in Hawaii: A retrospective cohort study using statewide hospital data. *BMC Pregnancy and Childbirth, 15,* 239. https://doi.org/10.1186/s12884-015-0671-4.

Hixson, L., Hepler, B. B., & Kim, M. O. (2012). The Native Hawaiian and Other Pacific Islander Population: 2010. Report Number C2010BR-12. 2010 Census Briefs https://www.census.gov/library/publications/2012/dec/c2010br-12.html.

McElfish, P. A., Hallgren, E., & Yamada, S. (2015). Effect of US health policies on health care access for Marshallese migrants. *American Journal of Public Health, 105*(4), 637–643. https://doi.org/10.2105/ajph.2014.302452.

Park, C. B., Braun, K. L., Horiuchi, B. Y., Tottori, C., & Onaka, A. T. (2009). Longevity disparities in multiethnic Hawaii: An analysis of 2000 life tables. *Public Health Reports, 124*(4), 579–584.

Rao, A. K., Daniels, K., El-Sayed, Y. Y., Moshesh, M. K., & Caughey, A. B. (2006). Perinatal outcomes among Asian American and Pacific Islander women. *American Journal of Obstetrics and Gynecology, 195*(3), 834–838. https://doi.org/10.1016/j.ajog.2006.06.079.

Ro, M. J., & Yee, A. K. (2010). Out of the shadows: Asian Americans, Native Hawaiians, and Pacific Islanders. *American Journal of Public Health, 100*(5), 776–778. https://doi.org/10.2105/AJPH.2010.192229.

Roehr, B. (2010). Asians and Pacific islanders in US need greater prominence in research. *BMJ, 340*. https://doi.org/10.1136/bmj.c2495.

Schempf, A. H., Mendola, P., Hamilton, B. E., Hayes, D. K., & Makuc, D. M. (2010). Perinatal outcomes for Asian, Native Hawaiian, and other Pacific Islander mothers of single and multiple race/ethnicity: California and Hawaii, 2003–2005. *American Journal of Public Health, 100*(5), 877–887. https://doi.org/10.2105/AJPH.2009.177345.

Srinivasan, S., & Guillermo, T. (2000). Toward improved health: Disaggregating Asian American and Native Hawaiian/Pacific Islander data. *American Journal of Public Health, 90*(11), 1731–1734.

The American Community—Pacific Islanders: 2004. (2007). Washington, DC. Retrieved December 12, 2017 from http://www.census.gov/prod/2007pubs/acs-06.pdf.

Todd, W. A., & Peabody, J. W. (2004). Maternal predictors of infant health outcomes among Hawaiians. *Hawaii Medical Journal, 63*(2), 40–44.

Tsitas, M., Schmid, B. C., Oehler, M. K., & Tempfer, C. B. (2015). Macrosomic and low birth weight neonates in Pacific Islanders from Samoa: A cas–-control study. *Archives of Gynecology and Obstetrics, 292*(6), 1261–1266. https://doi.org/10.1007/s00404-015-3773-3.

Wong, L. F., Caughey, A. B., Nakagawa, S., Kaimal, A. J., Tran, S. H., & Cheng, Y. W. (2008). Perinatal outcomes among different Asian-American subgroups. *American Journal of Obstetrics and Gynecology, 199*(4), 382.e381–386. https://doi.org/10.1016/j.ajog.2008.06.073.

Working Group of the Applied Research Center, N. C. O. A. P. A. (2013). Best practices: Researching Asian Americans, Native Hawaiians and Pacific Islanders.

Yamada, S. (2004). Cancer, reproductive abnormalities, and diabetes in Micronesia: The effect of nuclear testing. *Pacific Health Dialog, 11*(2), 216–221.