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Parental characteristics can explain why Japanese women give birth to the smallest infants in the United States

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Abstract

Background—Whether birthweight differences observed between races are due to modifiable factors remains controversial. In the United States, Asian infants weigh less than white infants and Japanese infants weigh the least.

Methods—Using US natality data, we evaluated 4,132,319 singleton term live births to parents of non-Hispanic white or Japanese race/ethnicity from 2009 to 2012. Infants were categorized by parental race/ethnicity (both white, n=4,116,637; Japanese father/white mother, n=2,377; white father/Japanese mother, n=7,478; both Japanese, n=5,827). We used multivariable regression to sequentially adjust for maternal characteristics to determine to what extent they explained differences in fetal growth due to maternal race/ethnicity.

Results—Infants born to Japanese mothers were smaller by 132 (95% CI 101, 122) grams, with higher risk of small-for-gestational-age (relative risk ratio (RRR) 1.56 (95% CI 1.47, 1.65) and lower risk of large-for-gestational-age RRR 0.49, 95% CI 0.44, 0.54), compared to infants of white mothers. Differences in social factors and in maternal age, parity, and gestational age only minimally explained this difference. However, additionally adjusting for maternal height, body mass index and gestational weight gain substantially attenuated this difference to 20 (95%CI 12, 29) grams in birthweight, 0.91 (95% CI 0.86, 0.97) times risk of small-for-gestational-age, and 1.06 (95% CI 0.96, 1.17) times risk of large-for-gestational-age, with the effect similar across strata of paternal race/ethnicity.

Conclusion—Differences in fetal growth between infants from Japanese and white mothers could be explained by differences in maternal height, pre-pregnancy weight, and gestational weight gain. Fetal growth potential appears to be similar across racial/ethnic groups when parental sizes are similar.

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INTRODUCTION

Numerous studies report that black and Asian infants are born smaller than white infants in the United States (US),[1-3] but have failed to explain this apparently persistent difference. A recent longitudinal study on low-risk pregnant women also showed black and Asian infants to be 235 to 245 grams smaller than white infants proposing race specific fetal growth charts.[4] However, the high proportion of socially disadvantaged mothers in the minority groups in this study leaves room for discussion as to whether the observed differences in birthweight was truly physiological or whether environmental factors also contributed.

On the other hand, a recent international collaboration to create a universal fetal growth standard found that the country difference in infant size was relatively small among women with no socioeconomic or nutritional constraints,[5, 6] suggesting fetal growth potential may be universal if maternal background characteristics are similar. Unfortunately, their strict inclusion criteria limited the generalizability of the findings to populations that exhibit a high prevalence of low birthweight.

Currently, among all race and ethnic groups categorized in the US birth certificate, Japanese mothers give birth to the smallest infants, despite fairly high socio-economic status.[7] Therefore, we aimed to evaluate whether maternal characteristics could explain the large differences in birthweight between white and Japanese mothers, using a large nationally representative sample.

MATERIAL AND METHODS

Study population

This study used data from all singleton live births delivered at 37 to 41 weeks of gestation from mothers residing in the US and recorded in the National Natality Files 2009–2012.[8]

We limited our analysis to births using the 2003 revision of birth certificates, as the older 1989 version does not allow multiple-race category reporting, nor does it include data on maternal height, pre-pregnancy weight, and delivery weight. The number of states using the 2003 version increased from 28 in 2009 to 38 in 2012. [8]

We limited the analysis to 4,439,762 live born term singletons born to parents of either Japanese or non-Hispanic white race/ethnicity. We excluded infants with unreliable gestational age estimations (n=312),[9] with any congenital anomaly suspected at birth (n=14,904), or missing any maternal demographics of interest (n=292,227, 7%), thus, 4,132,319 births (white parents, n=4,116,637; Japanese father/white mother, n=2,377; white father/Japanese mother, n=7,478; Japanese parents n= 5,827) were included in the analysis.

Definition of variables

We classified both maternal and paternal race/ethnicity as non-Hispanic Japanese or non-Hispanic white, and created four categories: both parents white, Japanese father/white mother, white father/Japanese mother, and both parents Japanese.

Fetal growth was our primary outcome, measured as both a continuous outcome birthweight (adjusted for gestational age), and as divided into three categories: small for gestational age (SGA), appropriate for gestational age (AGA), and large for gestational age (LGA). Using the obstetric estimate of gestational age, we defined SGA as being below the 10th percentile, and LGA as being above the 90th percentile of US birthweight references.[10] Covariables for multivariable analyses included maternal age, number of previous live births, pre-pregnancy BMI, height, gestational age, gestational weight gain, maternal education, timing of initiation of antenatal care, and smoking status.

Statistical analysis

We first compared maternal and infant characteristicsacross the four categories of parental race/ethnicity. Then, we used multivariable regression to evaluate how much of the birthweight difference between infants of white and Japanese mothers could be explained by racial differences in maternal characteristics. We did so both overall and after stratification by paternal race/ethnicity. We included maternal characteristics in the following order, with risk factors which are modifiable coming first and characteristics that are less modifiable later: gestational age, societal risk factors (maternal age, maternal education, marital status, parity, smoking status, initiation of antenatal care), gestational weight gain, maternal pre-pregnancy BMI, maternal height, and lastly, paternal race/ethnicity.

Linear regression was used for birthweight, and multinomial logistic regression was used for categorized fetal growth. Additional analysis restricting the population to primiparous women or including indicators of gestational hypertension and gestational diabetes were conducted as sensitivity analyses.

Statistical analyses were performed using STATA version 13 (STATA Corp, College Station, TX). The protocol for this study was approved by the Institutional Review Board at the National Center for Child Health and Development, Tokyo, Japan (Project # 2014-09)

RESULTS

All measured maternal characteristics were significantly different between Japanese and white mothers (Table 1). Japanese mothers were older, more educated, shorter, thinner, less likely to smoke, and had fewer previous deliveries and gained less weight during pregnancy. For both Japanese and white mothers, maternal height did not differ by paternal race/ethnicity. On the other hand, while gestational weight gain for white mothers did not differ by paternal race/ethnicity, for Japanese mothers, gestational weight gain was significantly lower in those with a Japanese partner ($p<0.001$). This association was consistent across BMI categories (**Figure 1**).

Figure 2 shows how the association of maternal race/ethnicity with fetal growth is explained by maternal characteristics, both overall and stratified by paternal race/ethnicity. Infants born to Japanese mothers were substantially smaller compared to those born from white mothers, regardless of paternal race/ethnicity (132 grams among all infants, 111 grams for those with white fathers, and 248 grams for those with Japanese fathers). This difference was not explained by variation in societal risk factors or gestational age; however, was substantially

reduced after adjusting for maternal height, BMI and gestational weight gain [SGA risk: Relative risk ratio (RRR) 0.91 (95% CI 0.86, 0.97); LGA risk: RRR 1.06 (95% CI 0.96, 1.17); birthweight difference 30 (95% CI 10, 49) grams], with the effect similar across strata by paternal race/ethnicity. Sensitivity analyses restricted to primiparous women or including indicators of gestational hypertension and gestational diabetes minimally altered the effect estimates.

COMMENTS

This study took advantage of a large dataset that enabled us to disentangle reasons for substantial birthweight differences between two racial/ethnic groups by directly comparing birthweight outcomes among women giving birth in the same societal context separating the contributions of maternal and paternal factors by studying mixed-race parents. The study focused on infants of Japanese parents, who have the lowest birthweight for a single racial category in the United States. The combination of maternal pre-pregnancy anthropometrics and gestational weight gain explained the majority of the observed differences in fetal growth between infants born to Japanese and white women, with differences of 111 to 248 grams attenuated to 20 to 36 grams, which, albeit still being statistically significant (because of our large sample sizes), may not be clinically significant.

Previous attempts to explain racial variability in birthweight between Asian and white infants in the US were not able to account for the differences.[1, 11, 12] However, none of these studies took into account the effect of paternal race/ethnicity or size, and some did not consider differences in maternal size. On the other hand, a Dutch study showed that differences in maternal and paternal height in addition to gestational age mostly explained the lower birthweight between several ethnic minorities and the Dutch [13]. In our study, the effect of paternal race/ethnicity -- most likely the effect of paternal height, which is not recorded on birth certificates -- on birthweight (124 grams) was prominent as well. Our results corroborate the Dutch findings, in that while both paternal and maternal height are significant determinants of fetal growth, inter-racial difference in fetal growth from parents of similar size that is not modifiable by pre-pregnant or antenatal management may be small.

Our findings also suggest a universal growth chart can be appropriately used across races, and any customization to improve identification of pathological (as opposed to physiological) growth restriction should be based on parental height, rather than on race and ethnicity.

In the US, African-American infants have second to lowest birthweights after Japanese infants, and most studies of racial birthweight variability in the United States have focused on this group. The low birthweight outcomes of African-American mothers have been ascribed to socioeconomic disadvantage and racial discrimination, however as a birthweight difference persists even among college-educated mothers, it has been argued that some of this difference is non-modifiable [14]. It is also possible that the residual black/white birthweight gap which is barely explained at all by parental anthropometrics reflects growth restriction stemming from environmental factors such as the cumulative life-course adversity in black mothers[1].

The study has several limitations. First, as race was self-reported, misclassification may have occurred. However, the option to report a mixed race may minimize such misclassification. Second, we did not have detailed information on paternal anthropometrics. This limitation most likely resulted in the reversal in birthweight of infants born to Japanese mothers with white partners after adjustment, and can be explained if Japanese mothers had chosen taller and/or heavier partners compared to white mothers.

In conclusion, in this nationally representative study we found that birthweight differences between infants born to Japanese and white mothers in the United States appear primarily attributable to maternal size and gestational weight gain. These findings confirm the importance of parental size for fetal growth, and suggest that infants of all races have similar growth potential.

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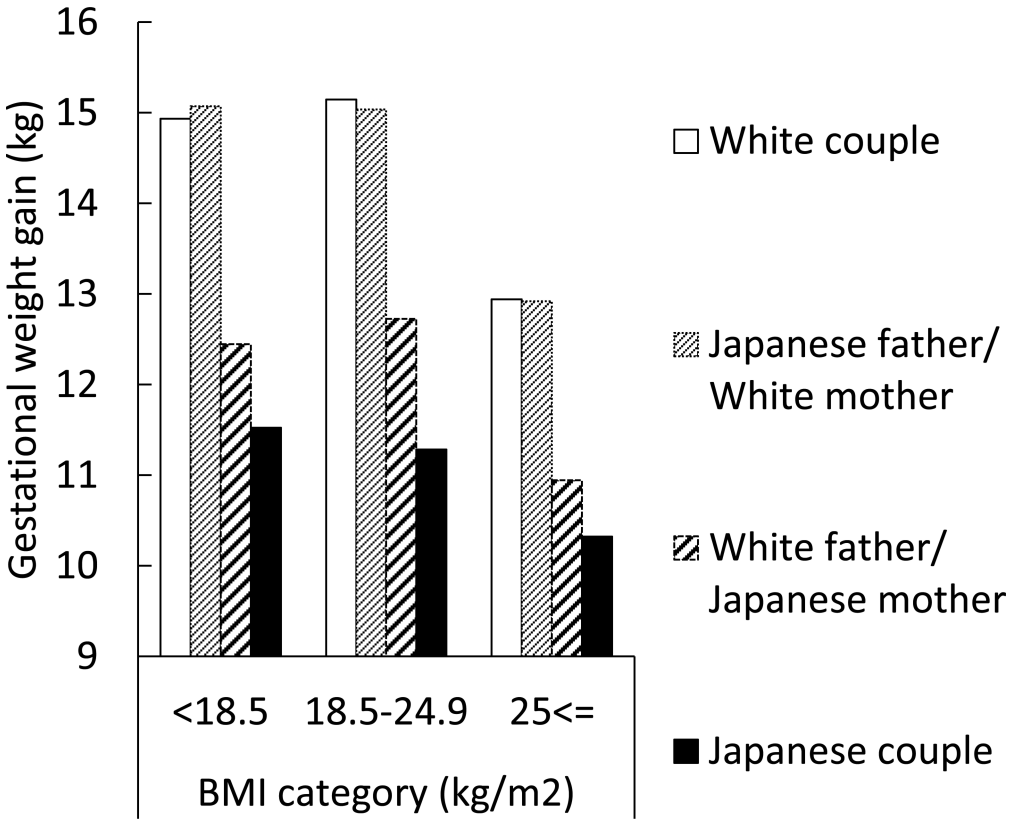

Figure 1.

Average Gestational Weight Gain by Body Mass Index (BMI) among Japanese and White Parents

Footnote: Analysis of 4,132,319 Singleton Term Births of Japanese and Non-Hispanic White Parents in the United States, 2009–2012.

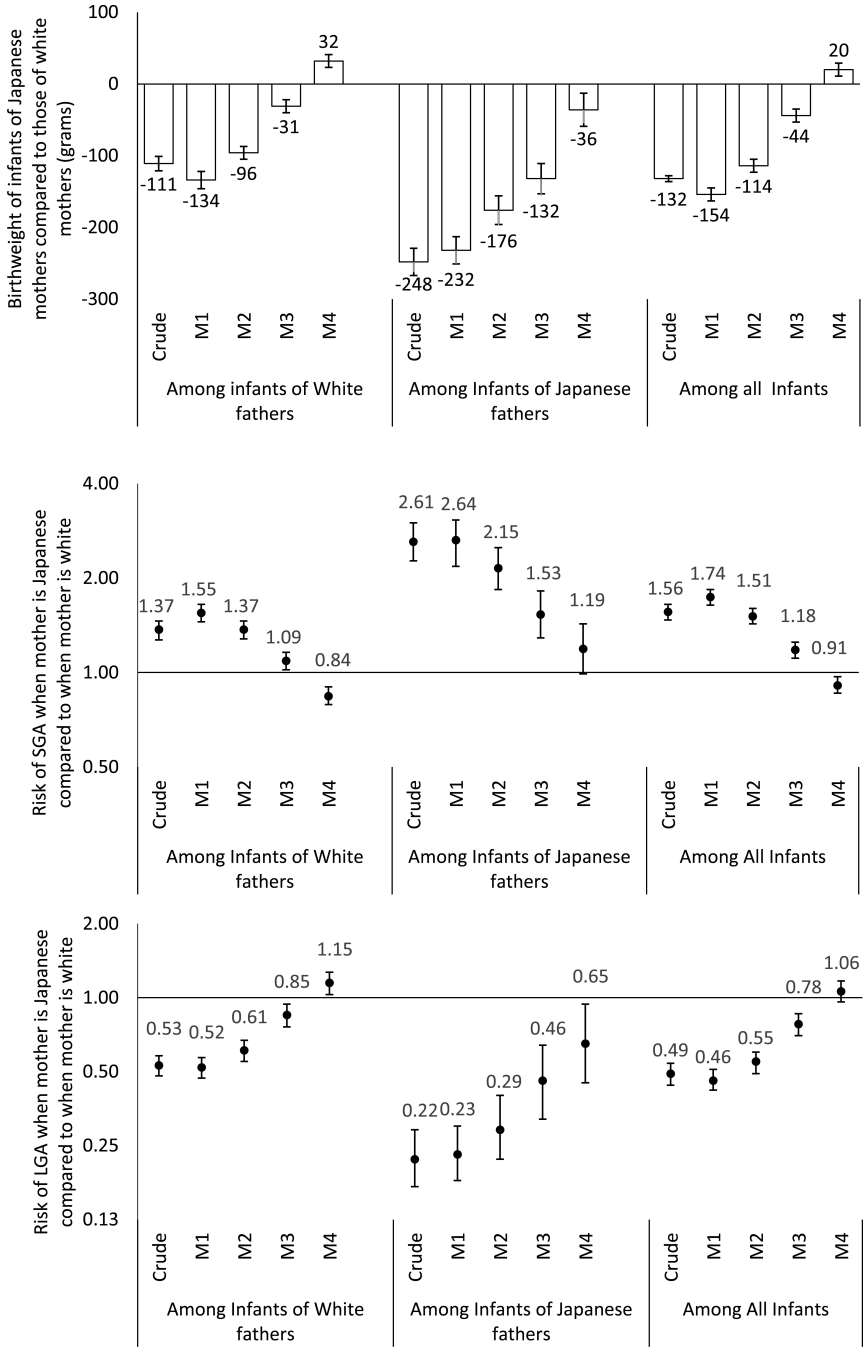

Figure 2.

Estimated Effect of Mother Being Japanese Compared to Being White on Birthweight and Fetal Growth, After Sequential Adjustment by Maternal Characteristics.

Footnote: Top panel: Estimated effects on Birth weight; Middle panel: Estimated relative risk ratios of small for gestational age; Lower panel: Estimated relative risk ratios of large for gestational age. Analysis of 4,132,319 Singleton Term Births of Japanese and Non-Hispanic White Parents in the United States, 2009–2012. M1: Adjusted for gestational age, infant sex, parity, maternal age, education, smoking status, and initiation of antenatal care.

M2 Additionally adjusted for gestational weight gain. M3: Additionally adjusted for pre-pregnancy body mass index. M4: Additionally adjusted for maternal height.

Table 1

Maternal and Infant Characteristics. Analysis of 4,132,319 Singleton Term Births of Japanese and Non-Hispanic White Parents in the United States, 2009-2012.

	Non-Hispanic White father		Japanese father	
	Non-Hispanic White mother	Japanese mother	Non-Hispanic White mother	Japanese mother
	n=4,116,637	n=5,827	n=2,377	n=5,827
Maternal characteristics				
Age (years) [mean (SD)]	28.9 (5.5)	34.0 (4.9)	31.8 (5.4)	34.0 (4.0)
Number of previous deliveries (%)				
0	41.3	51.3	44.6	48.7
1	34.1	35.6	35.1	38.8
≥2	24.7	13.1	20.2	12.5
Height (cm) [mean (SD)]	165.0 (6.8)	159.9 (5.8)	165.0 (6.8)	159.4 (5.7)
Body mass index (kg/m^2) (%)				
<18.5	3.7	11.0	3.5	19.5
18.5-24.9	52.4	73.2	57.2	72.7
≥25 kg/m^2	43.9	15.8	39.3	7.8
Gestational weight gain (kg) [mean (SD)]	14.3 (5.7)	12.5 (4.5)	14.3 (5.3)	11.3 (4.1)
Unmarried (%)	19.6	4.8	12.0	1.8
Maternal education (%)				
College degree	52.6	81.3	70.6	80.9
College credit	21.0	10.6	16.5	10.1
High school	27.4	8.1	12.9	9.0
Smoking (%)				
Yes	9.3	1.6	3.7	0.3
No	80.8	92.8	90.1	92.0
Unknown	9.9	5.6	6.1	7.7
Initiation of prenatal care (%)				
1-3 months	82.2	86.8	85.4	85.2
4-6 months	14.6	10.6	11.9	11.6
7-9 months	2.7	2.2	2.3	3.1

	Non-Hispanic White father		Japanese father	
	Non-Hispanic White mother	Japanese mother	Non-Hispanic White mother	Japanese mother
	n=4,116,637	n=5,827	n=2,377	n=5,827
No prenatal care	0.5	0.5	0.4	0.1
Infant characteristics				
Birthweight (g) [mean (SD)]	3444 (457)	3331 (426)	3373 (439)	3125 (376)
Small for gestational age (%)	10.2	14.1	11.8	27.1
Large for gestational age (%)	9.5	5.2	6.8	1.3
Male (%)	51.2	51.6	49.7	50.1
Gestational length (weeks) [mean (SD)]	39.1 (1.1)	39.1 (1.1)	39.2 (1.1)	39.1 (1.1)

Small for gestational age and large for gestational age are defined as being <10th and >90th percentile, respectively, of the US birthweight reference.[10]