Effects of Parity on Pregnancy Hormonal Profiles Across Ethnic Groups with a Diverse Incidence of Breast Cancer

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Abstract

Epidemiologic evidence suggests that a full-term pregnancy may affect maternal risk of breast cancer later in life. The objective of this cross-sectional study was to compare circulating levels of maternal hormones affecting breast differentiation (human chorionic gonadotropin and prolactin) and proliferation [α-fetoprotein, insulin-like growth factor I (IGF-I), and estradiol] between women at a low to moderate risk (Asians and Hispanics), as compared with women at a high risk for breast cancer (Caucasians and African-Americans). Between May 2002 and December 2004, a total of 586 pregnant women were approached during a routine prenatal visit. Among them, 450 women (206 Caucasian, 126 Asian, 88 Hispanic, and 30 African-American) met the inclusion criteria and signed the informed consent. Only singleton pregnancies were considered. Blood samples were drawn during the second trimester of pregnancy. Laboratory analyses were done using the IMMULITE 2000 immunoassay system. Gestational age standardized mean levels of estradiol, IGF-I, and prolactin were significantly higher in Hispanic women compared with Caucasian women. Mean concentration of IGF-I was significantly higher in African-American women compared with Caucasian and Asian women. No significant differences in pregnancy hormone levels were observed between Caucasian and Asian (predominantly second-generation Chinese) women in this study. Irrespective of ethnicity, women who had their first pregnancy had substantially higher mean levels of α-fetoprotein, human chorionic gonadotropin, estradiol, and prolactin compared with women who previously had at least one full-term pregnancy. These data suggest that circulating pregnancy hormone levels may explain some of the ethnic differences in breast cancer risk. (Cancer Epidemiol Biomarkers Prev 2006;15(11):2123–30)

Introduction

Breast cancer is characterized by considerable variability in disease incidence between ethnic groups. Within the U.S., the 1992 to 2002 age-adjusted incidence rates based on both first and subsequent generations of immigrants were substantially higher in non–Hispanic Whites (138.3/100,000) and Blacks (120.2/100,000), as compared with Asians (92.8/100,000) and Hispanics (88.2/100,000; ref. 1). The reasons for the lower risk of breast cancer among Asians and Hispanics are not completely understood. Socioeconomic, cultural, and genetic factors may account for some but not all such disparities (2, 3).

It is well established that a woman's reproductive experience affects her risk of breast cancer. A large body of epidemiologic evidence in a variety of populations indicates that a full-term pregnancy occurring before age 25, and to a lesser degree, subsequent pregnancies, confer the mother a lifelong protection against breast cancer (4, 5). The association is well characterized epidemiologically, but its biological basis remains elusive. Several mechanisms have been proposed that take into consideration the role of hormonal changes during pregnancy. Pregnancy hormones of particular interest include human chorionic gonadotropin (hCG; refs. 6, 7), α-fetoprotein (AFP; refs. 8-12), and prolactin (13, 14).

Although data on pregnancy hormone concentrations across ethnic groups are sparse, several recent studies reported that pregnancy hormone concentrations may differ between ethnic groups (15-19). Because hormones are thought to play a role in breast cancer, evaluating hormonal profiles during pregnancy across different ethnic groups may provide insight into ethnic disparities in breast cancer rates and the potential importance of specific pregnancy-related hormones in breast cancer.

The primary objective of this cross-sectional study was to compare maternal hormone levels affecting breast differentiation [hCG (ref. 20), prolactin (ref. 21), and proliferation (estradiol; ref. 22), insulin-like growth factor I (IGF-I; ref. 23), and AFP (ref. 8)] during the second trimester of pregnancy between women at a low to moderate risk (Asians and Hispanics), as compared with women at a high risk for breast cancer (Caucasians and African-Americans). The secondary objective of the study was to assess and compare hormonal levels between the first and subsequent full-term pregnancies.

Materials and Methods

Subjects. Study subjects were pregnant women recruited between May 2002 and December 2004 during the second trimester of pregnancy from the maternity clinics of the New York University (NYU) Hospitals Center. To accommodate study participants of different ethnic groups, the recruiting staff were fluent in English, Spanish, and Chinese (Mandarin and Cantonese), and study questionnaires and informed consent forms were available in these languages. The study was approved by the NYU School of Medicine Institutional Board of Research Associates and by the Bellevue Hospital Center Research Protocol Review Group.

Women 18 years or older who fully understood and signed an Institutional Review Board–approved informed consent

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form and who agreed to have a blood sample drawn during the second trimester of pregnancy (12-27 weeks of gestation) were eligible for participation in this cross-sectional study. Only singleton pregnancies resulting in a live birth were considered. Gestational age was defined as the time since the first day of the last menstrual period.

Between May 2002 and December 2004, a total of 586 pregnant women were approached during a routine prenatal visit to the NYU Hospitals Center. Among them, 450 (77%) women met the inclusion criteria and signed the informed consent.

Data Collection. Basic information regarding past medical, surgical, gynecologic and obstetric histories, selected demographic characteristics, including age, ethnicity, place of birth, and education, anthropometric data including height, prepregnancy weight and body mass index (BMI), information on antepartum, intrapartum, and postpartum clinical course, complications and neonatal outcome were obtained through an administered study questionnaire at enrollment, complemented with data from the NYU Hospitals Center Institutional Review Board–approved perinatal database.

Blood Collection. For each study subject, 5 mL of peripheral venous blood was collected into sterile tubes without preservatives. Blood samples were drawn between 8 a.m. and 5 p.m. and kept refrigerated at 4°C for up to 4 hours until centrifugation. After centrifugation, the supernatant serum was separated, divided into 1 mL aliquots and stored locally at −80°C until laboratory analyses. The aliquots were labeled with a blind code linked to the subject's ID, time, and date of blood draw. The laboratory personnel were unaware of the subjects' identities.

Laboratory Analyses. Laboratory analyses were done at the NYU Reproductive Biology Research Laboratory using the IMMULITE 2000 immunoassay system (Diagnostic Products Corporation, Los Angeles, CA). Serum concentrations of the following hormones were measured: AFP, hCG, estradiol, IGF-I, and prolactin. Between 5 and 10 blinded duplicate samples serving as quality controls were inserted in each laboratory run to assess the performance of the assays. The interassay and intraassay coefficients of variation were, respectively, 10.2% and 2.2% for AFP, 6.8% and 2.5% for hCG, 9.2% and 4.9% for estradiol, 7.2% and 3.8% for IGF-I, and 11.7% and 2.5% for prolactin.

Statistical Analyses. Because the hormones under study are known to vary as pregnancy progresses, hormone values were analyzed as the difference (residual) between the woman's individual measurement and the estimated mean concentration of each hormone for that day of gestation. This approach allowed us to adjust for differences in gestational age between the study subjects. The mean temporal curve for each hormone was estimated using locally weighted linear regression (''lowess''), a nonparametric smoothing method that employs weighted regression through the use of subsets of the data to estimate the curve at each gestational age, i.e., a weighted mean over the number of days of gestation (24). To address the heterogeneity of variance in the original scale of measurements, the residual values were determined after natural log-transformation of the original values. For ease of interpretation and to allow comparisons with previously published studies, in the tables of results, residual values were standardized to the same point of reference (gestational day 109 corresponding to the middle of week 16) by adding a constant equivalent to the mean log-hormone level on this day, followed by back transformation to original units.

We decided a priori to use the largest group (Caucasians) as a reference group to which the three other ethnic groups were compared. Statistical significance was assessed using the χ^2 test or χ^2 test for trend for categorical variables and a generalized linear model for continuous variables. Correlations between hormone levels and pregnancy characteristics adjusted for gestational age were computed using the Spearman correlation coefficient.

Results

Maternal, pregnancy, and newborn characteristics across ethnic groups are presented in Table 1. The study population included 206 Caucasian (46%), 126 Asian (28%), 88 Hispanic (20%), and 30 African-American (7%) women reflecting the ethnic distribution of the participating clinics at the time of enrollment. Asian women were predominantly second-generation U.S.-born Chinese (110 of 126, 87%). Caucasian women were about 3 years older at index pregnancy than all three other ethnic groups, and had more years of education (Table 1). Hispanic women were the only group with earlier age at menarche than Caucasian women (P = 0.0003; Table 1). They also tended to have higher parity (P = 0.001). Both Asian (P < 0.0001) and Hispanic (P < 0.0001) women were shorter than Caucasians. BMI was higher among African-Americans (P = 0.0001) and Hispanics (P < 0.0001) as compared with Caucasians. There were moderate differences in gestational age at blood donation but no differences in gestational age at delivery.

The mean gestational ages at blood draw were 17.6, 18.1, 18.6, and 19.5 weeks for Caucasian, Asian, Hispanic, and African-American women, respectively, with overall mean gestational age of 18.1 weeks. Asian women experienced a higher prevalence of gestational diabetes (P = 0.0002) compared with Caucasians. Neither mean birth weight nor the proportion of male to female newborns was statistically different between Caucasians and the three other ethnic groups.

Figures 1-5 show the distribution of log-transformed hormone levels by week of gestation for all ethnic groups combined. As expected during the second trimester, mean hormone concentrations increased markedly with increasing gestational age for AFP, estradiol, and prolactin, increased moderately for IGF-I, and decreased appreciably for hCG. Patterns of hormonal changes in the second trimester were similar across the four ethnic groups (figures not shown). The hormonal values were within the expected values, with wide ranges observed during the second trimester for AFP (100-fold), hCG (80-fold), estradiol (70-fold), prolactin (70-fold), and IGF-I (10-fold). The distributions of hormone levels according to gestational age were not substantially different between the four ethnic groups (data not shown).

Table 2 presents the levels of pregnancy hormones standardized at the 16th week of gestation. We observed no significant differences in the levels of AFP and hCG between Caucasians and the three other ethnic groups before and after adjustment for age, BMI, and number of full-term pregnancies.

Hispanic women had significantly higher 16th week levels of estradiol than Caucasians (mean, 14.8 versus 11.1 nmol/L, respectively; P < 0.0001), IGF-I (mean, 194.8 versus 161.4 ng/mL, respectively; P < 0.0001), and prolactin (mean, 87.6 versus 68.9 μg/L, respectively; P = 0.0003). These differences remained statistically significant after adjustment for age, BMI, and parity (Table 2). IGF-I levels at the 16th week were significantly higher in African-American women (mean, 209.4 ng/mL) compared with Caucasians (mean, 161.4 ng/mL) or Asians (mean, 168.8 ng/mL), a difference that remained significant after adjustment for age, BMI, and parity (Table 2). We repeated these analyses after exclusion of subjects with pregnancy complications (n = 45) and the results remained essentially the same (data not shown).

Table 3 shows Spearman correlation coefficients adjusted for gestational age for all subjects combined. AFP was positively

Table 1. Maternal, gestational, and newborn characteristics of 450 participating women, NYU Hospitals Center (2002-2004)

Characteristic	Caucasian (*n* = 206)	Asian (*n* = 126)	Hispanic (*n* = 88)	African-American (*n* = 30)
Maternal				
Age (years), mean (SD)	30.2 (5.5)	27.7 (5.1)	27.5 (6.0)	27.9 (7.0)
*P**		0.0001	0.0001	0.02
Age at menarche (years), mean (SD)	13.2 (1.3)	13.4 (1.6)	12.5 (1.5)	13.1 (2.1)
*P**		0.40	0.0003	0.56
Parity, *n* (%)†				
0	120 (63%)	68 (57%)	38 (45%)	14 (52%)
1	50 (26%)	27 (23%)	19 (22%)	7 (26%)
2	10 (5%)	18 (15%)	16 (19%)	5 (19%)
3+	10 (5%)	6 (5%)	12 (14%)	1 (4%)
Missing	16	7	3	3
*P**		0.11	0.001	0.42
Education, *n* (%)				
<9 years	10 (5%)	26 (21%)	26 (30%)	5 (17%)
9-12 years	58 (28%)	37 (29%)	26 (30%)	7 (23%)
>12 years	138 (67%)	63 (50%)	36 (41%)	18 (60%)
*P**		<0.0001	<0.0001	0.10
Place of birth				
U.S.	181 (88%)	110 (87%)	22 (25%)	18 (60%)
Outside of U.S.	25 (12%)	16 (13%)	66 (75%)	12 (40%)
Weight (kg), mean (SD)	63.4 (12.4)	57.6 (9.2)	64.7 (13.0)	75.5 (21.2)
*P**		<0.0001	0.47	0.0001
Height (cm), mean (SD)	164.2 (7.2)	156.6 (5.1)	156.9 (7.5)	165.2 (8.2)
*P**		<0.0001	<0.0001	0.48
BMI (kg/m^2), mean (SD)	23.5 (4.2)	23.4 (3.7)	26.4 (4.9)	27.6 (7.3)
*P**		0.99	<0.0001	0.0001
Gestation				
Gestational age at blood draw (weeks), mean (SD)	17.6 (3.8)	18.1 (3.9)	18.6 (3.7)	19.5 (3.6)
*P**		0.33	0.03	0.008
Gestational age at delivery (weeks), mean (SD)	38.9 (2.2)	39.0 (1.7)	39.1 (1.0)	39.6 (1.1)
*P**		0.59	0.49	0.11
Pregnancy complications, *n* (%)				
Preeclampsia	7 (3%)	4 (3%)	3 (3%)	0
PIH	4 (2%)	0	0	1 (3%)
Gestational diabetes	2 (1%)	12 (10%)	4 (5%)	1 (3%)
Preterm labor	6 (3%)	1 (1%)	0	0
Newborn				
Birth weight (g), mean (SD)	3,373 (595)	3,271 (454)	3,434 (467)	3,388 (427)
*P**		0.28	0.39	0.72
Gender				
Male	107 (53%)	60 (55%)	40 (50%)	12 (44%)
Female	95 (47%)	50 (45%)	40 (50%)	15 (56%)
Missing	4	16	8	3
*P**		0.79	0.65	0.41

*Compared with Caucasian women.
† Number of full-term pregnancies (excluding the index pregnancy).

associated with estradiol and prolactin, and negatively associated with maternal prepregnancy weight, height, BMI, and birth weight. Estradiol was positively associated with prolactin and birth weight, and negatively associated with age, weight, height, and BMI. Prolactin was negatively associated with age, weight, height, and BMI (Table 3). Spearman correlation coefficients were comparable in the analyses according to ethnic subgroups (data not shown).

Because several studies have found higher levels of estrogens during the first than during the second pregnancy (25, 26), we examined maternal age-adjusted hormone levels according to parity (Table 4). The strongest differences according to parity were observed for age-adjusted prolactin levels, which were considerably reduced in women with a previous history of full-term pregnancy compared with women who gave birth to their first child across all ethnic groups, except Hispanics. Similarly, age-adjusted hCG was significantly lower in Caucasian and Asian women with a previous full-term pregnancy compared with women who gave birth to their first child ($P = 0.006$ and $P < 0.05$, respectively). Among Caucasian women, estradiol levels were significantly lower in women with previous births compared with those who gave birth to their first child ($P = 0.04$). No significant differences in IGF-I levels by parity were observed in any of the ethnic groups.

Discussion

Ethnic differences in the second trimester hormone levels have been described previously. It has been reported that independently of maternal body weight, Asian and African-American women have higher levels of hCG and AFP compared with Caucasian and Hispanic women (27-30), which is consistent with the results of our study.

In a cross-sectional study, Lipworth et al. (15) compared hormone levels in serum collected during the 16th and 27th weeks of pregnancy among Chinese women in Shanghai and Caucasian women in Boston. Contrary to their initial study hypothesis, the levels of estradiol, estrone, prolactin, growth hormone, and sex hormone–binding protein at both the 16th and 27th weeks were significantly higher in Chinese women (who are at low risk of breast cancer), as compared to Caucasian women who are at high risk (15). A recent study by Potischman et al. (19) found significantly higher levels of androgens, estrone, and prolactin at 6 to 20 weeks of gestation in Hispanic women compared with Caucasian women. Estradiol levels were also lower in Caucasians compared with Hispanic and African-American women, although these differences were not statistically significant.

Comparing our observations to those reported previously by Lipworth et al. (15) for the 16th week of gestation, mean

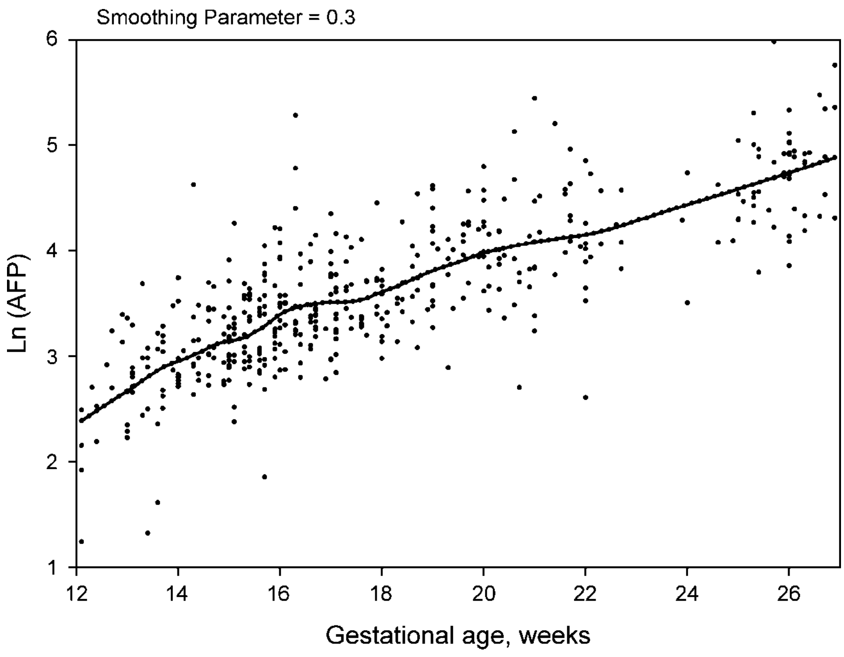

Figure 1. Log-transformed second-trimester AFP levels (IU/mL) according to gestational age for all ethnic groups, NYU Hospitals Center (2002-2004).

estradiol levels were comparable for Caucasians (11.1 versus 14.0 nmol/L, respectively) and lower for Asians (11.7 versus 20.7 nmol/L, respectively), whereas the mean prolactin in our study was higher for Caucasians (68.9 versus 44.7 μg/L, respectively) and Asians (75.3 versus 63.1 μg/L, respectively).

Our findings are consistent with those of Potischman et al. (19) with regard to the higher gestational levels of estrogens and prolactin in Hispanic women compared with Caucasian women. We found no significant differences in pregnancy hormonal levels between Caucasian and Asian (mostly second-generation Chinese) women. This is at variance with the observations of Lipworth et al. who reported that during the second and third trimester of pregnancy, Chinese women had significantly higher levels of estrogens and prolactin compared with Caucasian women (15).

One possible explanation for such differences is that the Asian women in our study were predominantly second-generation Chinese born in New York, as opposed to native Chinese born in China, as in the Lipworth et al. study. It has been shown that foreign-born women have significantly higher estrone levels in the cord blood than U.S.-born women of the same ethnicity (31). The lack of differences in pregnancy hormones between Caucasian and mostly second-generation Asian-American women in this study suggests that the increasing incidence of breast cancer and other hormone-dependent conditions in Asian immigrants to the U.S. (32, 33) may reflect, in part, profound changes in the pregnancy hormonal milieu among immigrants who were originally at low risk. Potential factors that may play a role in pregnancy hormonal alterations in Asian immigrants include changes in environmental exposures, diet, life-style, height, prepregnancy weight, BMI, and shifts in the distribution of menstrual and reproductive factors in Asian women towards that of U.S. Whites (34).

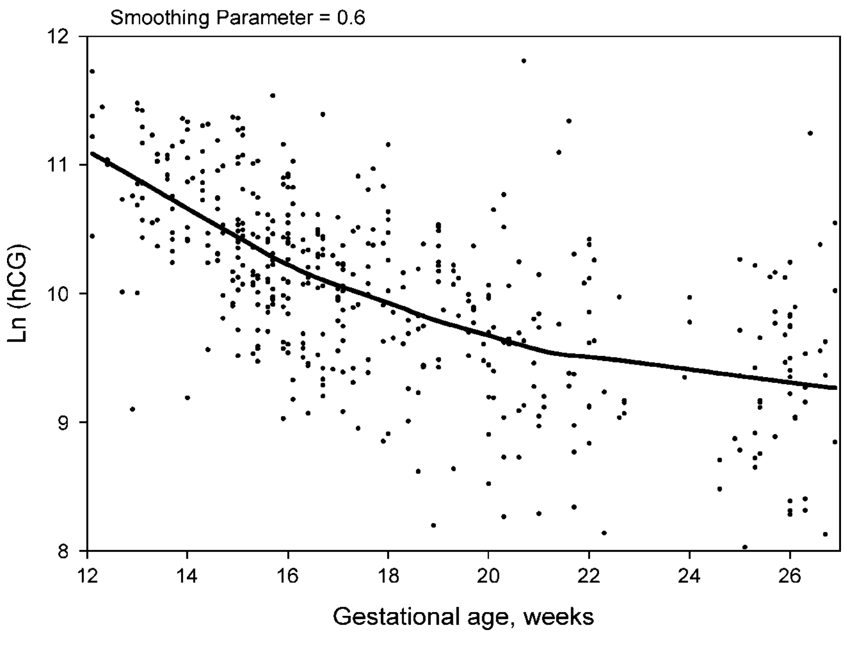

Figure 2. Log-transformed second-trimester hCG levels (mIU/mL) according to gestational age for all ethnic groups, NYU Hospitals Center (2002-2004).

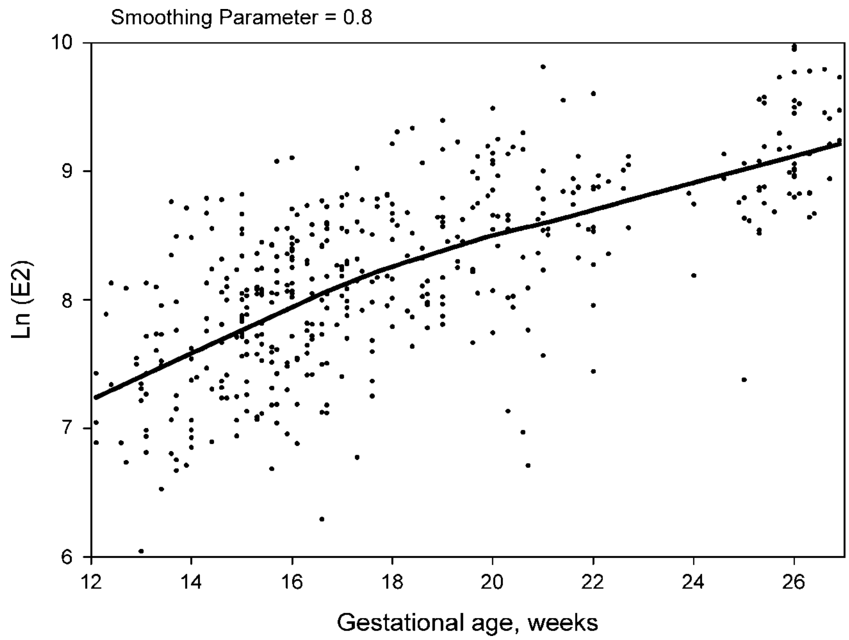

Figure 3. Log-transformed second-trimester estradiol levels (nmol/L) according to gestational age for all ethnic groups, NYU Hospitals Center (2002-2004).

There seemed to be an effect of parity on pregnancy levels of AFP, hCG, estradiol, and prolactin, with a tendency for women who had previously at least one full-term pregnancy to have lower hormone levels compared with primiparous women. These results are consistent with previous observations on long-term effects of a first pregnancy on the hormonal environment. Reductions in hormone concentrations after a first full-term pregnancy were reported in both pregnant and nonpregnant states for estrogens in serum (16, 25, 26, 35, 36) and breast fluid (37), serum adrenal androgens dehydroepiandrosterone and sulfated dehydroepiandrosterone (38), serum hCG (39-42), and prolactin (13, 43). Musey et al. have described significant long-term decreases after a first pregnancy in basal and perphenazine-stimulated levels of prolactin (13), as well as with dehydroepiandrosterone and sulfated dehydroepiandrosterone (38).

Studies that directly evaluated the association between serum steroid hormone levels during pregnancy and maternal risk of breast cancer are limited. To date, two case-control studies nested within a cohort of predominantly Caucasian pregnant women who were members of the Kaiser Health Plan and enrolled in the Child Health and Development studies (9, 44), and one population-based cohort of pregnant women in Denmark (10), investigated the relationships between pregnancy levels of AFP and steroid hormones with subsequent maternal risk of breast cancer.

Richardson et al. (9) found an inverse association between high third-trimester levels of maternal serum AFP and the risk of breast cancer later in life if the pregnancy occurred before age 23 [odds ratio, 0.62; 95% confidence interval (CI), 0.41-0.92]. Melbye et al. (10) reported that a high AFP (above the median) during any pregnancy is associated with a low overall incidence of breast cancer (relative risk, 0.59; 95% CI, 0.41-0.85) and, in particular, with a low incidence of locally advanced breast cancer at diagnosis (relative risk, 0.24; 95% CI, 0.11-0.50). In the current cross-sectional study, we have not

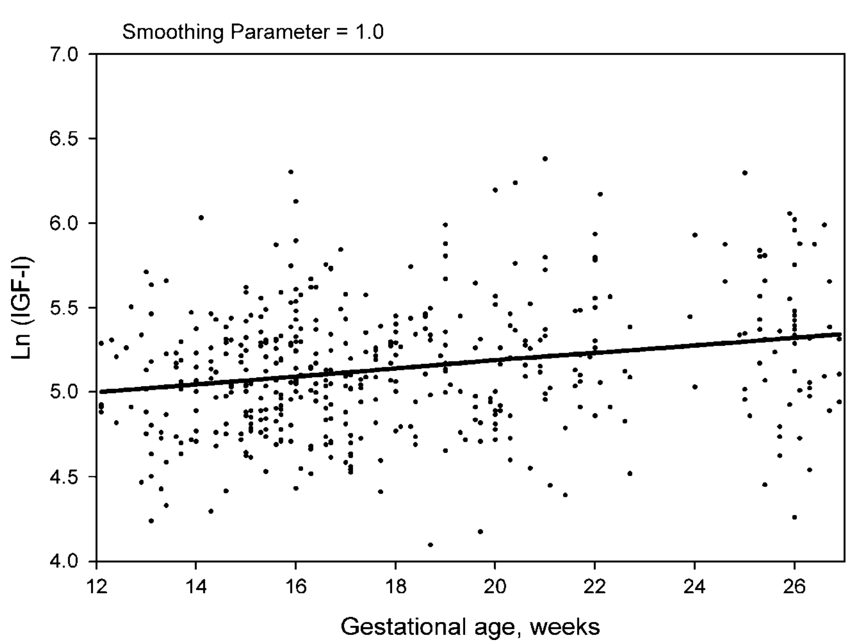

Figure 4. Log-transformed second-trimester IGF-I levels (ng/mL) according to gestational age for all ethnic groups, NYU Hospitals Center (2002-2004).

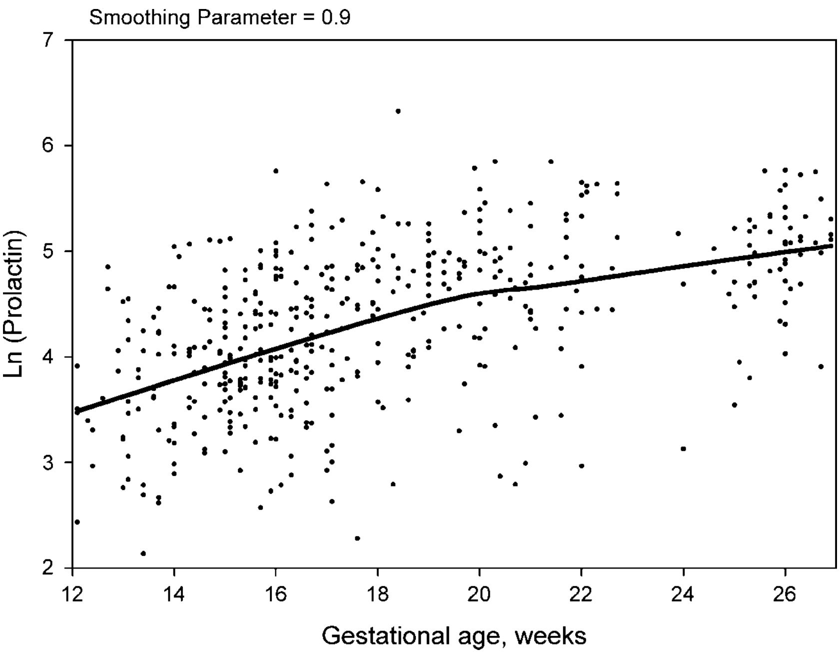

Figure 5. Log-transformed second-trimester prolactin levels (μg/L) according to gestational age for all ethnic groups, NYU Hospitals Center (2002-2004).

observed significant differences in second-trimester AFP levels between four ethnic groups with a diverse incidence of breast cancer.

Recently, Peck et al. (44) reported that elevated (top 10% versus lowest 10%) third-trimester progesterone levels were associated with a decreased risk of breast cancer (odds ratio, 0.49; 95% CI, 0.22-1.10). On the contrary, increased estrone levels were associated with an increased incidence of breast cancer (odds ratio for highest decile of estrone, 2.5; 95% CI, 1.0-6.2), whereas no statistically significant association were observed for estradiol and estriol (44). Because the average gestational age in the Peck et al. study was 39 weeks compared with 18 weeks in our study, the hormone concentrations reported in both studies may characterize different stages of pregnancy and may not be directly comparable.

Some of the effects of the first full-term pregnancy on hormonal milieu may include altered maternal hormone metabolism, changes in placental size or function between the first and subsequent pregnancies, increased levels of binding proteins leading to a reduced hormone bioavailability, and modulation of hormone receptor expression. The concept that a full-term pregnancy may induce alterations in a woman's hormonal milieu deserves further investigation because of its profound implications for subsequent risk of breast cancer and, possibly, other hormone-dependent conditions.

The sample size for certain ethnic groups (Hispanic, African-American) in this study was limited and, thus, the results for these ethnic groups should be interpreted cautiously. Women included in the current study were enrolled during a routine second-trimester visit to the maternity clinic and were comparable in terms of demographic characteristics and rate of pregnancy complications to nonparticipants from the same clinic, suggesting that selection bias is an unlikely explanation. Asian women had a

Table 2. Levels of pregnancy hormones standardized at the 16th week of gestation, NYU Hospitals Center (2002-2004)

Hormone	Caucasian (*n* = 206)	Asian (*n* = 126)	Hispanic (*n* = 88)	African-American (*n* = 30)
AFP, IU/mL				
Mean (SD)	32.3 (16.0)	34.4 (15.7)	31.6 (15.6)	35.3 (16.2)
*P**		0.15	0.75	0.35
P †		0.20	0.70	0.20
hCG, mIU/mL				
Mean (SD)	30,894 (19,438)	31,787 (18,190)	28,768 (14,780)	37,463 (29,614)
*P**		0.56	0.45	0.24
P †		0.21	0.18	0.14
Estradiol, nmol/L				
Mean (SD)	11.1 (5.7)	11.7 (5.3)	14.8 (7.1)	11.9 (6.1)
*P**		0.20	<0.0001	0.41
P †		0.95	<0.0001	0.36
IGF-I, ng/mL				
Mean (SD)	161.4 (57.5)	168.9 (67.2)	194.8 (70.2)	209.4 (89.5)
*P**		0.38	<0.0001	0.0004
P †		0.30	0.0002	0.0003
Prolactin, μg/L				
Mean (SD)	68.9 (42.5)	75.3 (52.5)	87.6 (50.8)	65.2 (32.8)
*P**		0.36	0.0003	0.95
P †		0.40	<0.0001	0.30

*Compared with Caucasian women, unadjusted.
† Compared with Caucasian women, adjusting for age, BMI, and number of full-term pregnancies.

Table 3. Spearman correlation coefficients adjusted for gestational age for all ethnic groups, NYU Hospitals Center (2002-2004)

	AFP	hCG	Estradiol	IGF-I	Prolactin	Age	Weight	Height	BMI	Birth weight
AFP	–	0.05	0.34	−0.001	0.22	−0.03	−0.25	−0.13	−0.18	−0.17
P		0.25	<0.001	0.98	<0.001	0.50	<0.001	0.01	0.001	0.03
hCG		–	0.03	−0.03	0.01	−0.02	−0.09	−0.004	−0.09	−0.11
P			0.54	0.47	0.80	0.69	0.07	0.94	0.09	0.05
Estradiol			–	0.01	0.36	−0.29	−0.16	−0.14	−0.10	0.15
P				0.84	<0.001	<0.001	0.001	0.007	0.05	0.01
IGF-I				–	0.14	−0.08	0.11	−0.04	0.16	0.12
P					0.003	0.10	0.03	0.42	0.002	0.04
Prolactin					–	−0.11	−0.22	−0.13	−0.16	0.04
P						0.02	<0.001	0.01	0.002	0.53
Age						–	0.18	0.17	0.09	0.02
P							0.0004	0.001	0.08	0.67
Weight							–	0.38	0.86	0.19
P								<0.001	<0.001	0.001
Height								–	−0.11	0.18
P									0.03	0.001
BMI									–	0.11
P										0.06

significantly higher prevalence of gestational diabetes compared with Caucasians. This observation is consistent with previously published studies (45-48). Although the exact reasons for higher incidence of gestational diabetes in Asians are unknown, the differences in lipid and carbohydrate metabolism between Asian and Caucasian women may provide some explanation for this finding (46).

In summary, this cross-sectional study found marked ethnic differences in the maternal pregnancy hormone levels between Caucasian and Hispanic women, but not between Caucasian and mostly second-generation Asian-American women. We also observed substantial hormonal differences between the first and subsequent full-term pregnancies, suggesting a profound effect of parity on maternal hormone levels. These

Table 4. Levels of pregnancy hormones by parity, standardized at the 16th week and adjusted for maternal age, NYU Hospitals Center (2002-2004)

Hormone	Caucasian		Asian		Hispanic		African-American	
	Primiparous	Nonprimiparous	Primiparous	Nonprimiparous	Primiparous	Nonprimiparous	Primiparous	Nonprimiparous
AFP, IU/mL; mean (95% CI)	33.6 (30.4-36.7)	29.8 (26.7-32.9)	36.5 (32.5-40.6)	30.7 (27.1-34.3)	32.9 (27.4-38.3)	30.3 (26.6-34.1)	36.7 (27.8-45.7)	32.0 (24.9-39.1)
n	118	70	68	51	39	47	14	13
*P**	0.11		0.06		0.73		0.20	
P †	0.01							
hCG, mIU/mL; mean (95% CI)	32,427 (29,141-35,713)	27,444 (22,360-32,527)	34,497 (30,284-38,710)	29,014 (23,024-35,004)	29,420 (23,728-35,112)	28,016 (21,863-34,169)	33,582 (24,269-42,895)	38,119 (26,185-50,053)
n	118	69	68	50	39	47	14	13
*P**	0.006		<0.05		0.98		0.74	
P †	0.004							
Estradiol, nmol/L; mean (95% CI)	12.6 (11.4-13.7)	9.8 (8.7-11.0)	12.3 (10.8-13.8)	10.0 (8.7-11.4)	14.8 (12.8-16.8)	14.0 (12.6-15.4)	11.8 (8.5-15.1)	10.7 (8.0-13.4)
n	118	67	68	51	39	47	14	13
*P**	0.04		0.11		0.65		0.73	
P †	0.04							
IGF-I, ng/mL; mean (95% CI)	160.1 (147.7-172.4)	160.1 (145.1-175.0)	167.2 (151.3-183.2)	164.5 (146.9-182.1)	205.2 (183.5-227.0)	179.1 (160.9-197.4)	219.4 (184.2-254.6)	206.9 (172.2-241.6)
n	119	70	68	51	38	47	14	13
*P**	0.85		0.73		0.51		0.52	
P †	0.37							
Prolactin, μg/L; mean (95% CI)	79.6 (70.9-88.2)	49.8 (39.0-60.5)	86.0 (74.9-97.1)	59.9 (47.3-72.6)	95.4 (80.4-110.5)	80.2 (67.2-93.2)	78.8 (54.2-103.4)	53.5 (28.8-78.2)
n	119	69	68	50	39	47	14	13
*P**	<0.0001		<0.0001		0.26		0.11	
P †	<0.0001							

*Primiparous versus nonprimiparous according to ethnic group, adjusted for age.
†Primiparous versus nonprimiparous, adjusted for age and ethnicity.

results are consistent with the hypothesis that hormonal changes during pregnancy may influence the risk of breast cancer and, possibly, other hormone-dependent conditions later in life.

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