PREDICTORS OF EARLY POSTPARTUM VITAMIN USE AMONG WOMEN OF MEXICAN ORIGIN: IMPLICATIONS FOR HEALTHCARE PROVIDER RECOMMENDATIONS

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Objective: High parity and short birth intervals among Hispanic women may deplete their folic-acid levels and place them at risk for neural tube defects (NTDs). The purposes of this study were to evaluate factors associated with multivitamin supplementation rates during the early (one to six weeks) postpartum period among Mexican-origin women and present their implications in preventing NTDs in subsequent pregnancies.

Design: A cross-sectional study was conducted among Hispanic mothers attending women, infant, and children (WIC) clinics in El Paso, Texas. Information was ascertained via interview on regular multivitamin use, and independent variables including sociodemographic characteristics, multivitamin knowledge, obstetric and health history, and birth control and infant feeding methods.

Results: Only 66% of 329 mothers took postpartum multivitamins. Multivitamin consumption declined by 29% for each postpartum week ($P=.0003$). Adjusted odds ratios indicated positive associations between multivitamin supplementation and prenatal care exclusively in the United States ($P=.007$), breastfeeding ($P=.071$), preconceptional ($P=.005$) and prenatal multivitamin use ($P=.0002$), and multivitamin recommendation from a healthcare provider ($P\leq.0001$). The majority of 247 women with multivitamin counsel (59%) were told to finish prenatal vitamins or to continue use while breastfeeding. Smokers were less likely to take multivitamins than nonsmokers ($P=.007$).

Conclusions: A provider recommendation highly motivates early postpartum women to consume multivitamins. Since most women have more than one child, this period likely represents an interpregnancy interval and is an opportune time to educate and encourage women to take multivitamins. This simple and inexpensive measure could prevent birth defects in future pregnancies. (*Ethn Dis*. 2006;16:194–200)

Key Words: Folic Acid, Mexican Americans, Neural Tube Defects, Postpartum Care, Preconception, Vitamin Use

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INTRODUCTION

Evidence consistently shows that a low folate level at the time of conception is associated with neural tube defects (NTDs) and that a daily supplement of 0.4 mg folic acid confers a protective effect against NTDs.[1–13] Some studies also suggest that folic acid may protect against other types of birth defects.[7–10] Consequently, in 1992 the US Public Health Service (USPHS) recommended that all women of childbearing age receive 0.4 mg folic acid daily in the form of a vitamin supplement.[13]

Although the USPHS recommendation on folic acid supplementation was issued >10 years ago, a 2003 Gallup survey of childbearing-age women indicated that nearly a quarter of the women are either unaware of the recommendation or not compliant.[14] This finding is of concern as the second National Health and Nutritional Examination survey, 1976–1980 (NHANES II), found high prevalence of low folate levels among the general population of childbearing-age women.[15] The Pregnancy Risk Assessment Monitoring System (PRAMS) data suggest that folic acid awareness has improved since the late 1970s; from 1995 to 1998, more than two thirds of postpartum women were aware that folic acid can prevent some birth defects.[16] Many women may be informed about the benefits of folic acid during pregnancy.

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Postpartum women have not been specifically targeted for preconceptional supplementation programs; yet with a median number of births in the United States of 2.1, for more than half of women the postpartum period represents a preconception period.[17] In addition, with >50% of US pregnancies unplanned,[18] these subsequent conceptions may occur at a times when the mother is not intending to become pregnant.

Mexican-American postpartum women may be at relatively increased risk for subsequent pregnancies complicated by NTDs because of associated high rates of NTDs,[19,20] high parity,[21] and low rates of preconceptional vitamin consumption.[22–25] A recent analysis of NHANES data found that Mexican-American women had lower plasma and red blood cell (RBC) folate (15.9 and 456 nmol/L) than non-

Hispanic White women (18.4 and 516 nmol/L).[26] A study of folic acid use among Mexican-American postpartum women found that few mothers met the recommended daily allowance for folate[27] and limited their vitamin intake to during pregnancy and early postpartum.[28]

Medium- to long-term iron and folate supplementation should continue throughout the reproductive cycle, before pregnancy to the end of the childbearing years.[29–30] Hispanic women may not take vitamins for a number of reasons: lack of knowledge, a low expectation of having a pregnancy in the near future (and thus not concerned with the USPHS recommendation), or other unknown factors.

The purposes of this paper were to identify factors associated with folic acid supplementation rates during the postpartum period among Mexican-American women and to present their implications in preventing NTDs in subsequent pregnancies. This analysis presents baseline data from an evaluation of an intervention to increase vitamin use and folate levels among Mexican-American postpartum women.

METHODS

The sampling frame consisted of El Paso, Texas, Women Infants and Children (WIC) participants of Mexican origin who were one to six weeks postpartum. The study took place from October 2002 through September 2003. Women who had a diagnosis of or who were taking medication for either epilepsy or seizures were excluded from the study. Of 617 eligible women, 329 (53.2%) agreed to participate in the study. The study was approved by the institutional review boards at The University of Texas-Houston School of Public Health, Texas Tech University Health Sciences Center at El Paso, the Texas Department of Health, and Medical University of South Carolina.

Two data collection methods were used in the study, questionnaires and diagnostic assays to measure folate in blood samples. Face-to-face surveys were conducted in either English or Spanish, depending on the language preference of the respondent. A sample of venous blood (5 mL) was drawn and analyzed by Quest laboratories for serum and RBC folate levels. Serum folate level was used in this study to validate self-reported current vitamin use. The RBC folate level, an indicator of longer-term folate nutritional status, will be used in future analyses.

The primary outcome of this study was multivitamin use as defined by PRAMS[31] and consisted of self-reported current multivitamin use $\geq$4 times per week in the early (one- to six-week) postpartum period. Serum folate levels were analyzed to corroborate self-reported postpartum vitamin intake. Independent variables that could have affected vitamin use were maternal sociodemographic and cultural characteristics of variables, including maternal age, education, marital status, birth country (United States vs Mexico), and language preference. Factors related to the maternal and obstetric health included parity, country where prenatal care was sought (United States vs Mexico or neither), preconceptional vitamin use, prenatal vitamin use, cigarette smoking, and healthcare provider recommendation for postpartum vitamin use. Information about birth control methods, infant feeding methods, and knowledge of folate was also obtained.

Data collected were entered into an Access (Microsoft Corp, Richmond, Wash, 2001) database with custom-designed data entry forms. These tables were converted to SAS format. Quality control checks on the data, as well as all data reduction and data analyses, were conducted by using SAS for Windows, (SAS Institute Inc, version 8.2, Cary, NC, 2001). The statistical significance of the bivariate association of vitamin use and maternal characteristics, smoking, and obstetric history was evaluated by chi-square tests. The strategy to fit multivariate logistic models used the Hosmer and Lemeshow criteria[32] of including in the initial model all variables with bivariate P values $\leq$.25. A backwards elimination algorithm, based on the significance level of odds ratios (ORs), was used to generate a "best" final model that included all statistically important variables at the $\leq$.10 significance level. The Hosmer-Lemeshow statistic was used to assess goodness-of-fit for the multivariate model.

RESULTS

Table 1 presents an overview of the sociodemographic and cultural characteristics and vitamin knowledge and use among the 329 study participants. Most respondents were 20–29 years of age. Low educational levels were evident; $\approx$30% of the women had not completed high school. Slightly more than half of the mothers were married (56%) and primiparous (57%). Slightly more than one third of the mothers were born in Mexico, and one third were predominately Spanish-speaking. Most study participants (88%) received prenatal care in the United States only, while $\approx$11% received at least some prenatal care in Mexico. Less than 2% received no prenatal care. Approximately 40% of the respondents had ever used tobacco. Sixty-nine percent of mothers had at least attempted breastfeeding at birth. Only one third of mothers were using birth control, and of these, $\approx$25% were using traditionally less effective methods such as rhythm, withdrawal, diaphragm, or condoms (data not shown).

Fewer than 20% of the new mothers took vitamins preconceptionally, but 88% took vitamins during pregnancy, and 66% were taking them during the early one- to six-week postpartum period. A total of 65% of women had

Table 1. Characteristics and vitamin knowledge and use among early postpartum WIC participants, El Paso, Texas, 2002–2003

Variable	*n*	%
Age group		
<20 years	56	17.0
20–24 years	130	39.5
25–29 years	121	36.8
30–39 years	22	6.7
Education level		
<12th grade	99	30.1
12th grade	113	34.3
>12th grade	117	35.6
Born in Mexico	118	35.6
Married/living with partner	184	55.9
Spanish language preference	108	32.8
Primiparous	188	57.1
Prenatal care country		
United States only	288	87.5
Some prenatal care in Mexico	31	9.4
Mexico only	6	1.8
Neither	4	1.2
Ever smoke cigarettes	132	40.1
Any breastfeed since birth	227	69.0
Currently using birth control		
No	105	32.0
Yes	108	32.9
Not sexually active	115	35.1
Preconceptional vitamin use ≥4×/week	64.0	19.5
Pregnancy vitamin use ≥4×/week	291	88.5
Postpartum vitamin use (1–6 weeks) ≥4×/week	217	66.0
Provider recommended postpartum vitamins	247	75.1
Ever heard of folic acid	213	64.7
Knowledge of purpose for taking folic acid		
Prevent birth defects	180	54.7
An incorrect or don't know response	149	45.3

heard about folic acid, but only 55% knew that it prevented birth defects. Healthcare providers recommended postpartum vitamin use for 75% of the postpartum women. However, 59% of these recommendations were limited to finishing the prenatal vitamins or continuing use while breastfeeding (data not shown).

Serum folate levels ranged from 5.2 to 24.0 units, with a mean of 20.23. Only one woman was defined as clinically borderline in serum folate. Self-reported current vitamin use was correlated with serum folate level, with a Pearson correlation coefficient of .332 ($P<.0001$).

Table 2 presents the bivariate relationship of postpartum folic acid supplementation with sociodemographic characteristics, knowledge of folic acid, preconceptional vitamin use, health and obstetric history, and infant-feeding methods. In the postpartum period, vitamin use was associated with having received prenatal care in the United States only ($P=.0196$), preconceptional vitamin use ($P=.0003$), pregnancy vitamin use ($P=.0001$), and a provider recommendation to continue vitamins in the postpartum period ($P<.0001$). Mothers who had ever heard of folic acid were more likely than those who had not heard of it to take vitamins in the early postpartum period ($P=.0408$). However, no significant difference was seen in whether women knew that folic acid helps prevent birth defects ($P=.1081$). Mothers who at least attempted breastfeeding once were more likely than their strictly bottle-feeding counterparts to take vitamins postpartum ($P=.0369$). Mothers who never smoked ($P=.0024$) were more likely to take vitamins than those who had ever smoked.

A multivariate logistic regression was conducted to predict folic acid–containing vitamin use during the postpartum periods. Variables in the bivariate analyses with P values $\leq .25$ that were evaluated in the initial multivariate model included prenatal care country, ever smoked, any breastfeeding since birth, preconceptional vitamin use, prenatal vitamin use, HCP recommendation for postpartum vitamins, knowledge of folic acid and its use in the prevention of birth defects, and weeks postpartum.

Table 3 presents the adjusted ORs, 95% confidence intervals, and P values for a final model in which all predictor variables for postpartum vitamin use had P values $<.10$. The Hosmer-Lemeshow test showed a good fit of the model, with a χ^2 goodness-of-fit 10.09, $P=.2585$. While adjusting for other factors, women who recall having received postpartum advice to continue taking their vitamins had an odds ratio of 7.3 for vitamin use in the early postpartum period as compared to women who did not recall such advice. Mothers who had breastfed any time since birth had an odds ratio of 1.7 compared to their strictly bottle-feeding counterparts. Both preconceptional and prenatal vitamin use remained highly associated with early postpartum vitamin use, with OR 3.4 ($P=.0054$) and 4.7 ($P=.0002$), respectively. Prenatal care exclusively in the United States remained a strong predictor of postpartum vitamin use (OR 2.9, $P=.0072$). Mothers with a history of smoking were approximately half as likely to be postpartum vitamin users as nonsmoking mothers (OR .467, $P=.0068$). Finally, in the multivariate

Table 2. Association of sociodemographic factors, obstetric history, and folic acid knowledge with early postpartum vitamin use, 2002–2003

Variable	*n*	Early Postpartum Vitamin Use ≥4 Times/Week *n*=214 *n* (%)	*P* Value
Age group			.8235
<20 years	56	35 (62.5)	
20–24 years	130	84 (64.6)	
25–34 years	121	82 (67.8)	
35–40 years	22	13 (59.1)	
Education level			.8301
<12th grade	99	62 (62.6)	
12th grade	113	75 (66.4)	
>12th grade	117	77 (65.8)	
Birth country			.3655
United States	211	141 (61.86)	
Mexico	118	73 (66.82)	
Marital status			.7592
Single/divorced	145	93 (64.14)	
Married	184	121 (65.76)	
Language preference			.4237
Spanish	108	67 (62.04)	
English	221	147 (66.52)	
Parity			.3167
Primiparous	141	96 (68.09)	
Multiparous	188	118 (62.77)	
Prenatal care country			**.0196**
United States only	288	194 (67.36.)	
Mexico or neither	41	20 (48.78)	
Ever smoke			**.0024**
No	197	141 (71.57)	
Yes	132	73 (55.30)	
Any breastfeed since birth			**.0369**
No	102	58 (56.86)	
Yes	227	156 (68.72)	
Preconceptional vitamin use ≥4×/week			**.0003**
No	265	160 (60.38)	
Yes	64	54 (84.38)	
Pregnancy vitamin use ≥4×/week			**.0001**
No	38	12 (31.58)	
Yes	291	202 (69.42)	
Current use of birth control			.4294
No	105	65 (61.90)	
Yes	108	68 (62.96)	
Not sexually active	115	80 (69.57)	
Provider recommendation for postpartum vitamin			**<.0001**
No	82	28 (34.15)	
Yes	247	186 (75.30)	
Ever heard of folic acid?			**.0408**
No	116	67 (57.76)	
Yes	213	147 (69.01)	
Purpose for taking folic acid			**.1081**
Prevent birth defects	180	124 (68.89)	
An incorrect or don't know response	149	90 (60.40)	

Bold *P* values represent significance.

model, each additional postpartum week was associated with a 29% drop in the probability (or odds) of the mother's taking her vitamins ($P=.0003$).

DISCUSSION

One limitation in this study is the low response rate, not fully unexpected since the study required three blood draws. Although demographic information on nonrespondents was not available, most nonparticipants stated they declined to join the study because they did not want to have their blood drawn. When compared with Texas Department of Health (TDH) data on all 2002 Hispanic births in El Paso,[33] the study population is slightly younger and more educated. However, the TDH statistics may not be truly representative of mothers living in El Paso because a significant number of Mexican women cross the US-Mexico border to deliver and return to their Mexican community shortly thereafter, although the exact number is unknown.

This study found supplemental vitamin use varied throughout the reproductive cycle, with vitamin use highest during pregnancy, lowest during the preconceptional period, and moderate but rapidly declining in the early postpartum period (one to six weeks). While the American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG) do not specifically recommend vitamin supplements during pregnancy,[34] routine prescriptions of prenatal vitamins for pregnant women is a common practice.[35–38] The prevalence of prenatal vitamin use in our study population (88%) demonstrates excellent compliance with provider recommendation for pregnancy vitamin use. Our rate was similar to the 90% rate reported for both a West Virginia rural population[35] and Florida population[37] and higher than a large Michigan Medicaid population whose vitamin

Table 3. Adjusted odds ratios for early postpartum vitamin use ≥4 times/week among WIC participants, 2002–2003

Variable	Adjusted OR*	95% CI	*P* Value
Prenatal care country			.0072
Mexico or no prenatal care	Referent		
United States only	2.967	1.342–6.560	
Postpartum week†	.710	.589–.855	.0003
Any breastfeeding since birth			.0705
No	Referent		
Yes	1.736	.955–3.155	
Provider recommendation for postpartum vitamins			<.0001
No	Referent		
Yes	7.334	3.926–13.701	
Preconceptional vitamin use ≥4×/week			.0054
No	Referent		
Yes	3.432	1.505–7.829	
Prenatal vitamin use ≥4×/week			.0002
No	Referent		
Yes	4.721	2.806–10.685	
Ever smoke			.0068
No	Referent		
Yes	.467	.269–.810	

Hosmer and Lemeshow goodness of fit χ^2=10.094, *P* value=.2585.
* Odds ratio adjusted for all other variable models.
† For each postpartum week.

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use prevalence was 69%.[38] A study conducted by Power et al,[39] found obstetricians were more likely to screen for and advise their pregnant patients about folic acid consumption than their non-pregnant patients of childbearing age. Given this fact and the nearly universal prenatal care (98.8%) in our population, many of our study participants likely obtained a prenatal vitamin recommendation as a part of their routine antenatal care.

The findings of our study indicate that the greatest predictor of early postpartum vitamin use is a healthcare provider recommendation that the mother use vitamins after the baby is born. This finding is supported by findings in a case-control study conducted on the Texas-Mexico border that also found that the provider plays a significant role in motivating women to consume vitamins in the postpartum period.[24] Both case and comparison mothers who reported receiving postpartum advice to take folic acid were almost twice as likely to take their vitamins as were their counterparts who did not recall such instructions. HCPs in the current study were more likely to advise vitamin use for mothers who at least attempted breastfeeding than those who did not breastfeed (*P*=.0705). When asked about what specific advice the provider gave regarding postpartum vitamins, 45% of women said they were told to continue their prenatal vitamins and another 14% were told to continue vitamins while breastfeeding. This finding likely reflects provider adherence to the AAP and ACOG guidelines that they provide their patients with the short-term suggestion that they finish their current supply of prenatal vitamin and/or continue vitamin use while breastfeeding rather than recommending a long-term approach for vitamin use throughout the reproductive cycle.

Since the early- to mid-1990s, folic acid awareness has increased among childbearing-age women, largely because of preconception health-promotion activities, such as public education and media campaigns.[16] However, current media campaigns and mass education programs may not be as effective in addressing health concerns of postpartum women, many of whom may not be considering future children soon after delivering a baby.

While our overall rate of 66% vitamin usage among mothers during the early postpartum period shows improvement over the 19% use in the preconceptional time period, our finding that use declines by 29% each week postpartum is noteworthy. The AAP and ACOG 2002 guidelines for perinatal care[34] currently state that a vitamin-mineral supplement is not routinely needed in the postpartum period. We suggest that this standard be reexamined to be consistent with the USPHS recommendation that all reproductive-age women take a daily multivitamin containing .4 mg folic acid.

Evidence consistently shows that folate levels decrease during the postpartum period.[28,40,41] Furthermore, with a median number of pregnancies of 2.1 in the United States and 3.3 for Mexican-American women, most women who have an infant will likely experience a subsequent pregnancy.[17] In fact, between 6% and 12% of all non-first pregnancies occur within six months after childbirth.[42] Given that women do not obtain sufficient dietary folate[43] and the high likelihood of a subsequent pregnancy,[17] HCP advice to merely finish prenatal vitamins may fail to adequately protect infants conceived in subsequent pregnancies. In-

fants of Mexican heritage may be at higher risk because of both high parity and shorter birth intervals among Hispanic women.[21]

Studies have shown that compliance with postpartum visits is poor, especially among disadvantaged populations.[44–46] Thus, postpartum and preconceptional vitamin use discussions should take place during prenatal as well as postpartum visits. In addition, other health professionals, such as pediatricians, family practitioners, nurses, and WIC nutritionists, who are likely to come in contact with postpartum women, should help disseminate and reinforce the folic acid message. Recommending continued supplemental vitamin use during the postpartum period is a relatively simple and inexpensive measure that will prevent birth defects.

ACKNOWLEDGMENTS

We acknowledge the contributions of Jessica Longoria, Grace Zavala, Anita Gutierrez, and Mariana Guerrero in their dedication in conducting study interviews. We thank Bertha Amaya and the WIC staff at the Lee Treveno and Carolinas clinics in El Paso, Texas for their support and allowing us to use their facilities as the study sites. Finally, we are grateful to the study participants for their time, thoughts, and efforts. This study was funded by the March of Dimes and the Paso del Norte Health Foundation, El Paso, Texas.

REFERENCES

1. Czeizel A, Didas I. Prevention of first occurrence of neural tube defects by periconceptional vitamin supplement. *N Engl J Med*. 1992;372(26):1832–1835.
2. Milunsky A, Jick H, Jick SS, et al. Multivitamin/folic acid supplementation in early pregnancy reduces the prevalence of the neural tube defects. *JAMA*. 1989;262:2847–2852.
3. Mulinare J, Cordero JF, Erickson JD, Berry RJ. Periconceptional use of multivitamins and the occurrence of neural tube defects. *JAMA*. 1988;260:3141–3145.
4. Werler MM, Shapiro S, Mitchell AA. Periconceptional folic acid exposure and the risk of occurrent neural tube defects. *JAMA*. 1993;269:1257–1261.
5. MRC. Vitamin Study Research Group. Prevention of neural tube defects: results of the medical research council vitamin study *Lancet*. 1991;338:131–137.
6. Berry R, et al. Prevention of neural tube defects with folic acid in China. *N Engl J Med*. 1999;341:1485.
7. Werler M, et al. Multivitamin supplementation and risk of birth defects. *Am J Epidemiol*. 1999;150:675–682.
8. Mills J, et al. Methylenetrahydrofolate reductase thermolabile variant and oral clefs. *Am J Med Genet*. 1999;86:71.
9. Kapusta L, et al. Congenital heart defects and maternal derangement of homocysteine metabolism. *J Pediatr*. 1999;135:773.
10. James SJ, Pogribna M, Pogrobny IP, et al. Abnormal folate metabolism and mutation in the methylenetetrahydrofolate reductase gene may be maternal risk factors for Down syndrome. *Am J Clin Nutr*. 1999;70:495–501.
11. Mills JL, Conley MR. Folic acid to prevent neural tube defects: scientific advances and public health issues. *Curr Opin Obstet Gynecol*. 1996;8(6):394–397.
12. Ubbink JB. Is an elevated circulating maternal homocysteine concentration a risk factor for neural tube defects? *Nutr Rev*. 1995;53(6):173–175.
13. CDC. Recommendations for the use of folic acid to reduce the number of cases of spina bifida and other neural tube defects. *Morb Mortal Wkly Rep*. 1992;41(RR-14)
14. March of Dimes. *Folic Acid and the Prevention of Birth Defects: A National Survey of Pre-Pregnancy Awareness and Behavior Among Women of Childbearing Age, 1995–2003*. Conducted by the Gallup Organization. White Plains, NY: March of Dimes; August 2003. Publication No. 31-1784-03.
15. Life Sciences Research Office. *Assessment of the Folate Nutritional Status of the US Population Based on Data Collected in the Second National Health and Nutritional Examination Survey, 1976–1980*. Bethesda, Md: Federation of American Societies for Experimental Biology; 1984.
16. Ahluwalia IB, Daniel KL. Are women with recent live births aware of the benefits of folic acid? *MMWR Recomm Rep*. 2001;50(RR06):3–14.
17. Martin JA, Hamilton BG, Ventura SJ, Menacker F, Park MM. Births: final data for 2000. National Vital Statistics Reports. 2002;50(5):1–102. Available at: www.cdc.gov. Accessed on: 9/1/04.
18. Henshaw SK. Unintended pregnancy in the United States. *Fam Plann Perspect*. 1998;30:24–29.
19. Shaw G, Velie E, Wasserman C. Risk for neural tube defect–affected pregnancies among women of Mexican descent and White women in California. *Am J Public Health*. 1997;87:1467–1471.
20. CDC. Neural tube defect surveillance and folic acid intervention—Texas-Mexico border, 1993–1998. *Morb Mortal Wkly Rep*. 2000;49(01):1–4.
21. Giachello A. Maternal/perinatal health. In: Molina C, Aguirre M, eds. In: *Latino Health in the US: A Growing Challenge*. Washington, DC: American Public Health Association; 1994: 135–187.
22. Suarez L, Hendricks KA, Cooper SP, Sweeney AM, Hardy RJ, Larsen RD. Neural tube defects among Mexican Americans living on the US-Mexico border: effects of folic acid and dietary folate. *Am J Epidemiol*. 2000;152(11):1017–1023.
23. Perlow JH. Comparative use and knowledge of preconceptional folic acid among Spanish- and English-speaking patient population in Phoenix and Yuma, AZ. *Am J Obstet Gynecol*. 2001;184(6):1263–1266.
24. Canfield MA, Anderson JL, Waller DK, Palmer SE, Kaye CI. Folic acid awareness and use among women with a history of neural tube defect pregnancy—Texas, 2000–2001. *MMWR Recomm Rep*. 2002;51(RR13):16–19.
25. Chacko MR, Anding R, Kozinetz CA, Glover JL, Smith PB. Neural tube defects: knowledge and preconceptional practices in minority women. *Pediatrics*. 2003;112(3, pt 1):536–542.
26. Ford E, Bowman B. Serum and red blood cell folate concentrations, race, and education: findings from the third National Health and Nutrition Examination Survey. *Am J Clin Nutr*. 1999;69:476.
27. O'Rourke K, Redlinger T. Postpartum supplemental vitamin use among Hispanic women on the US/Mexico border: need for community health education. *Int Q Community Health Educ*. 2000;19:33–41.
28. O'Rourke K, Redlinger T, Waller K. Declining levels of erythrocyte folate during the postpartum period among Hispanic women living on the Texas-Mexico. *J Womens Health Gender Based Med*. 2000;9(4):397–403.
29. Viteri FE. Iron supplementation for the control of iron deficiency in populations at risk. *Nutr Rev*. 1997;55(6):195–209.
30. Smits L, Essed G. Short interpregnancy intervals and unfavorable pregnancy outcome: role of folate depletion. *Lancet*. 2001;358:2074–2077.
31. Williams LM, Morrow B, Lansky A, et al. Surveillance for selected maternal behaviors and experiences, before, during, and after pregnancy. *MMWR Surveill Summ*. 2003;52(SS11):1–14.
32. Hosmer DW, Lemeshow S. *Applied Logistic Regression*. 2nd ed. New York, NY: John Wiley & Sons Inc; 2000.

33. Texas Department of Health. Texas birth data 2002. Available at: soupfin.tdh.state.tx.us. Accessed on: 9/1/2004.
34. American Academy of Pediatrics. *Guidelines for Perinatal Care*. 5th ed. Washington, DC: American College of Obstetricians and Gynecology; 2002.
35. Glover DD, Amonkar N, Rybeck BF, Tracy TS. Prescription, over-the-counter, and herbal medicine use in a rural obstetric population. *Am J Obstet Gynecol*. 2003;188(4):1039–1045.
36. Splinter MY, Sagraves R, Nightengale B, Rayburn WF. Prenatal use of medications by women giving birth at a university hospital. *South Med J*. 1997;90(5):498–502.
37. Taren DL, Grave SN. The association of prenatal nutrition and educational services with low birth weight rates in a Florida program. *Public Health Rep*. 1991;106(4): 426–437.
38. Piper JM, Baum C, Kennedy DL. Prescription drug use before and during pregnancy in a Medicaid population. *Am J Obstet Gynecol*. 1997;15(1):148–156.
39. Power ML, Holzman GB, Schulkin J. Knowledge and clinical practice regarding folic acid among obstetricians-gynecologists. *Obstet Gynecol*. 2000;95(6):895–898.
40. Ovist I, Abdulla M, Jagerstad M, Svensson S. Iron, zinc, and folate status during pregnancy and two months after delivery. *Acta Obstet Gynecol Scand*. 1986;65:15–22.
41. Smith AM, Picciano MF, Deering RH. Folate supplementation during lactation: maternal folate status, human milk folate content, and their relationship to infant folate status. *J Pediatr Gastroenterol Nutr*. 1983;2:622–628.
42. Kallen JE. Reexamination of interpregnancy intervals and subsequent birth outcomes: evidence from US linked birth/infant death records. *Soc Biol*. 1997;44(3–4):205–212.
43. King JC. Risk of maternal nutritional depletion and poor outcomes increases in early and closely spaced pregnancies. *J Nutr*. 2003; 133(5, suppl 2):1732S–1736S.
44. Miller LP, Greenspan B, Dowd JS. The medical database as a tool for improving maternal/infant continuity of care. *J Med Syst*. 1999;23(3):219–225.
45. Pistella CY, Synkewecz CA. Community postpartum care needs assessment and systems development for low income families. *J Health Soc Policy*. 1999;11(1):53–64.
46. Weinman ML, Smith PB. US-Mexico-born Hispanic teen mothers: a descriptive study of factors related to postpartum compliance. *Hisp J Behav Sci*. 1994;16(2):188–194.

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