
Knowledge and Use of Folic Acid Among North Carolina Women

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Neural tube defects (NTDs) are severe, often lethal, congenital malformations of the spine and central nervous system, the most common of which are spina bifida, anencephaly, and encephalocele. NTDs are among the most common and preventable birth defects in the United States. Still, every year in North Carolina, about 1 in every 500-700 pregnancies is affected by an NTD.¹ For reasons we don't yet understand, the rate of NTDs is higher in the Southeastern states, including North Carolina, than in the rest of the country. Some specific causes (single gene or chromosomal disorders, maternal diabetes, valproic acid use, and hyperthermia) have been identified, but in most cases no specific etiology is identifiable.²

It is well documented that women who take a daily dose of the B-vitamin folic acid *before conceiving* can reduce the risk of NTDs by up to 70%.³⁻⁶ Because the neural tube closes by the fourth week after conception, it is important that folic acid be consumed on a regular basis before the woman becomes pregnant. In 1991, the Medical Research Council released its findings from a randomized, controlled trial of folic acid, and in the following year the Centers for Disease Control and Prevention (CDC) recommended that all women of childbearing age consume 400 micrograms (mcg) of folic acid daily in order to decrease their risk of having an NTD-affected pregnancy.⁶⁻⁷ In 1996, the Food and Drug Administration required that by January 1, 1998, all enriched grain products be fortified with 140 mcg of synthetic folic acid per 100 g of cereal.⁸ Because the current fortification level is estimated to increase the average woman's dietary intake of folic acid by only 100 mcg/day (one-fourth of the recommended amount), the CDC, the Institute of Medicine, the

March of Dimes, and other groups continue to urge all women capable of becoming pregnant to supplement their usual diet with 400 mcg of synthetic folic acid in the form of a daily multivitamin.⁹

The CDC recommends that women who have already had a pregnancy affected by an NTD take 400 mcg of synthetic folic acid every day, increase to 4,000 mcg (4 mg) daily at least one month before a planned pregnancy, and continue at that dose throughout the first trimester. This higher amount of folic acid should be obtained through prescription, not by taking multivitamins.

Since the mid-1990s, there have been local, state, and national efforts to increase public awareness of the benefits of folic acid. In North Carolina, a statewide folic acid conference was held in 1995 to help raise awareness within the public health and medical communities. This conference led to the development of the North Carolina Folic Acid Council, which helps coordinate and oversee folic acid education activities throughout the state.

In order to assess trends in knowledge about and use of folic acid by women in North Carolina, the North Carolina Division of Public Health's Center for Health Statistics has added some questions on folic acid into its ongoing survey called Pregnancy Risk Assessment Monitoring System (PRAMS). In this paper we provide information for doctors, public health workers, and the public about current patterns in the awareness and intake of folic acid as reported to PRAMS. This information will serve as a baseline for tracking progress in increasing folic acid use among women in the years ahead.

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Table 1. Percentage of North Carolina women delivering a live birth who reported having heard or read about folic acid, N.C. PRAMS, 1999

Demographic groups	Total respondents	Yes		
		Num.	%	95% CI
Total	1759	1338	76.8	74.1-79.4
Age				
< 20 years	268	162	60.9	52.4-68.7
20-24 years	459	313	66.4	60.4-71.8
25-34 years	832	704	86.1	82.8-88.9
35+ years	200	159	82.9	74.8-88.8
Race				
White	1182	958	80.8	77.7-83.5
Black	513	340	67.2	60.9-72.9
Other	64	40	56.6	40.0-71.8
Education				
< High school	407	233	54.8	48.1-61.3
High school	581	417	74.0	68.8-78.6
> High school	770	687	90.3	87.4-92.6
Marital status				
Married	1150	956	82.5	79.5-85.2
Other	609	382	64.1	58.6-69.3
Income				
< \$16,000	516	339	63.6	57.6-69.2
\$16,000-\$24,999	274	201	75.8	68.5-81.9
\$25,000-\$39,999	264	207	78.3	71.1-84.1
\$40,000 or more	532	480	91.4	87.9-93.9
WIC recipient				
No	921	755	83.6	80.2-86.5
Yes	827	572	69.1	64.6-73.2
Medicaid recipient				
No	868	743	85.9	82.6-88.6
Yes	891	595	66.9	62.5-71.1

Methods

We obtained data for this study from the 1999 North Carolina PRAMS survey. The North Carolina PRAMS was begun in 1997 through a cooperative agreement between the Center for Health Statistics and the CDC's Division of Reproductive Health. PRAMS is an ongoing, population-based survey of North Carolina residents who have recently given birth. The survey is carried out according to strict protocols specified by CDC. Each month, approximately 200 women who are 2 to 4 months postpartum are randomly selected from the North Carolina birth certificate files. Participants are asked to complete a self-administered questionnaire sent by mail, which collects information on a variety of risk factors for poor pregnancy outcomes (behavioral and psychosocial risks, access to and use of health care services, and other issues). Non-respondents are contacted by telephone and the overall response rate is approximately 75%.

The North Carolina PRAMS questionnaire contains three questions that pertain to folic acid:

- ◆ Have you ever heard or read that taking the vitamin folic acid can help prevent some birth defects?
- ◆ Where did you hear or read that taking the vitamin folic acid can help prevent some birth defects?
- ◆ Before you knew you were pregnant, how frequently did you take either vitamins containing folic acid or multivitamins?

Sample responses were weighted so that they are representative of all North Carolina women who delivered live born infants during calendar year 1999. All percentages reported here are based on the weighted estimates. The 95% confidence intervals (CIs) surrounding the weighted responses were generated using Survey Data Analysis (SUDAAN) software for analysis of weighted data from complex samples.¹⁰

Table 2. Percentage of North Carolina women delivering a live birth who reported hearing about folic acid from selected sources, NC PRAMS, 1999

Source	Total respondents	Yes		
		Num.	%	95% CI
Doctor, nurse, or health clinic staff	1780	912	51.3	48.2-54.3
Information at health care providers office	1780	646	37.3	34.4-40.3
Media	1780	859	49.7	46.6-52.7
Other	1780	239	13.7	11.8-15.9

Results

A total of 1,780 women responded to the North Carolina PRAMS survey in 1999, for a total response rate of 73.8 percent. The survey indicated that, overall, 76.8 percent of women who delivered in 1999 had heard or read that taking the vitamin folic acid can help prevent birth defects (Table 1). However there were marked differences in folic acid awareness according to maternal demographics. Knowledge of folic acid was highest among women ages 25-34 (86.1 percent) and women ages 35 and above (82.9 percent), and lowest among women under 20 years old (60.9 percent).

White women were more likely than black women or women of other races to have heard or read about folic acid (80.8 percent, 67.2 percent, and 56.6 percent, respectively). The difference in knowledge of folic acid by mother's education was quite pronounced. Among women with more than a high school education, 90.3 percent had heard or read about folic acid, compared to only 54.8 percent among women with less than a high school education. Awareness of folic also increased with increasing family income, ranging from 63.6 percent for women with annual incomes less than \$16,000, to 91.4 percent among women with incomes of \$40,000 or more. Mothers who were unmarried, who were enrolled in WIC, or who received Medicaid were also less likely to have heard or read about folic acid.

Table 2 shows the percentage of women who had heard or read about folic acid from various sources. Among all women who delivered in 1999, 51.3 percent were told about folic acid by their doctor, nurse, or other clinic staff. Slightly less than one-half of women heard about folic acid through the media (radio, TV, newspaper). About 37 percent of women read about folic acid through brochures or other literature obtained from their health care provider's office, and about 14 percent heard about it through other sources (e.g., friends, family members, coworkers).

As shown in Table 3, 26.1 percent of women who delivered in 1999 took multivitamins or folic acid supplements on a daily basis before becoming pregnant, according to the CDC recommendations. The differences in daily, preconceptional consumption of multivitamins by sociodemographic characteristics were striking. Women ages 35 and above were more than five times as likely to take daily multivitamins as women under 20 years of age (40.5 percent and 7.6 percent, respectively). Women with family incomes of \$40,000 or more were 4.5 times as likely to take daily multivitamins as women in the lowest income group (43.9 percent and 9.8 percent). Daily multivitamin use increased with increasing education, with mothers having more than a high school education being 3.7 times as likely to consume multivitamins as women with less than a high school education (39.6 percent and 10.6 percent). A three-fold difference in folic acid intake was evident between married and unmarried women (33.1 percent and 10.5 percent), and between Medicaid recipients and non-recipients (12.6 percent and 38.5 percent). Mothers who were not enrolled in WIC were about twice as likely as WIC participants to consume folic acid preconceptionally, as were white mothers compared to their black counterparts.

Discussion

The findings from this study are both encouraging and discouraging. The fact that nearly 77 percent of all North Carolina women who delivered in 1999 had heard about folic acid is a positive indication that the folic acid message is beginning to get out. Although this percentage is only slightly higher than that reported in the 1998 PRAMS survey (74.1 percent), we are optimistic that awareness of folic acid among women who have given birth is increasing. The estimated percentage of women from the PRAMS survey

who had heard about folic acid is considerably higher than that estimated from the North Carolina Behavioral Risk Factor Surveillance System (BRFSS) for that same year (45.4 percent, 95 percent CI 40.7-50.3).¹¹ This difference is likely to be due, in large part, to the fact that PRAMS surveys women who have recently completed a pregnancy (and thus were probably more likely to read and/or retain information related to having a healthy baby), while BRFSS covers all women of reproductive age.

While a majority of women who delivered babies in 1999 did know about the benefits of folic acid, just slightly more than one-half reported that they had heard about it from their doctor or health care provider. This suggests that there is considerable room for improvement in the number

of health care providers who discuss folic acid with their patients. Because folic acid must be consumed prior to pregnancy in order to reduce the risk for NTDs, and because about one-half of all live births are the result of unintended pregnancies, it is imperative that physicians take the time to discuss folic acid with all of their patients who are capable of becoming pregnant, not just those who are contemplating pregnancy. For the woman who is already pregnant, it is too late. For these reasons, the best opportunity for prevention lies with primary care providers, including general practitioners, gynecologists, pediatricians, health department staff, and others who come into frequent contact with reproductive-age women. Every visit with a woman of childbearing age is an opportunity for health care providers to discuss folic acid.

Table 3. Percentage of North Carolina women who reported taking multivitamins containing folic acid on a daily basis prior to pregnancy, NC PRAMS, 1999

<i>Demographic groups</i>	<i>Total respondents</i>	<i>N</i>	<i>Yes %</i>	<i>95% CI</i>
<i>Total</i>	1770	1320	26.1	23.5-28.9
<i>Age</i>				
< 20 years	270	25	7.6	4.2-13.2
20-24 years	461	60	13.7	10.1-18.4
25-34 years	838	291	35.4	31.3-39.6
35+ years	201	74	40.5	32.0-49.6
<i>Race</i>				
White	1186	362	29.8	26.7-33.2
Black	521	75	14.5	10.6-19.5
Other	63	13	27.7	15.1-45.3
<i>Education</i>				
< High school	411	42	10.6	7.1-15.4
High school	583	101	18.3	14.3-23.1
> High school	775	307	39.6	35.4-43.9
<i>Marital status</i>				
Married	1159	383	33.1	29.8-36.6
Other	611	67	10.5	7.6-14.4
<i>Income</i>				
< \$16,000	518	53	9.8	6.8-14.0
\$16,000-\$24,999	276	52	25.4	19.1-32.8
\$25,000-\$39,999	267	61	20.2	14.7-27.0
\$40,000 or more	53	242	43.9	38.7-49.1
<i>WIC recipient</i>				
No	922	329	36.0	32.1-40.1
Yes	833	114	14.8	11.9-18.4
<i>Medicaid recipient</i>				
No	874	344	38.5	34.5-42.5
Yes	896	106	12.6	9.8-15.9

The gap between the percentage of women who knew about folic acid and the percentage who took it on a daily basis before pregnancy is disconcerting. Whereas almost 77 percent of women had heard about the benefits of folic acid, only about 26 percent, or slightly more than one-third of those who had heard about it, reported that they took it daily before pregnancy as recommended. One likely explanation for this apparent gap between knowledge and use of folic acid is that the PRAMS survey ascertains current knowledge (i.e., 2-4 months postpartum) rather than knowledge prior to pregnancy. As noted above, many of the women in the survey probably learned about folic acid only after becoming pregnant, and thus would not have had a chance to alter their preconceptional behavior.

The relatively high prevalence of daily folic acid intake

among some sociodemographic groups was encouraging, and suggests that folic acid education efforts may be beginning to make a difference among some women—mostly those from more affluent populations. However, this study also demonstrated a pattern of low daily folic acid intake among socioeconomically disadvantaged groups. Not surprisingly, it is this latter population that tends to have the highest rates of NTDs.¹² There is a great need to intensify folic acid education programs with a focus toward disadvantaged groups. One place to start is within our state's rapidly growing Hispanic community, which has both high rates of NTDs and low rates of multivitamin use.

One of the strengths of using the PRAMS survey to assess folic acid use is that the survey's target population is women who have recently given birth. This is probably the most appropriate population to study with regard to assessing the potential impact of folic acid education on neural tube defect prevention. The fact that PRAMS is a relatively large, random, population-based survey means that the results can be generalized to all women who give birth within a given period of time. While other surveys such as BRFSS and the March of Dimes/Gallup survey ascertain information on folic acid knowledge and use among all reproductive-age women, these data may be less relevant to the true population at risk for NTDs (i.e., those women who do become pregnant).

One limitation of the PRAMS survey with respect to this analysis concerns the reliability of information on preconceptional intake of multivitamins. Because the questionnaire is administered 3-4 months after delivery, the

ability to accurately recall multivitamin use prior to pregnancy (one year ago for most respondents) is questionable. Too, because most of the respondents in the survey knew about the benefits of folic acid, there may have been a tendency to over-report multivitamin use. Keeping such limitations in mind, data from the PRAMS survey can provide a useful means of tracking trends in folic acid knowledge and use in North Carolina.

This study shows that North Carolina has a long way to go in its effort to promote preconceptional folic acid use among women in our state, particularly those of lower socioeconomic status. The fact that folic acid can prevent a large majority of neural tube defects has been clearly demonstrated in the scientific literature, and evidence is growing that it may also reduce the risk of limb reduction defects, orofacial clefts, certain cardiac defects, and possibly prematurity/low birth weight. As Stevenson et al.¹³ have shown in South Carolina, reducing the rate of neural tube defects by promoting folic acid use among women of reproductive age is an intervention that can work in practice.

Medical and public health professionals have an obligation to prevent disease that is readily preventable. With regard to folic acid-preventable birth defects, that obligation has not yet been met. While some progress is being made to increase folic acid consumption among certain groups of women, much more work remains to be done. However, that will require considerably more resources than have been available thus far. Until that time comes, the health and well-being of our children and their families will continue to be unnecessarily compromised.

References

- 1 Morgan A, Randolph L, Meyer R, et al. North Carolina Birth Defects Monitoring Program Surveillance Report. Raleigh, NC: NC Division of Public Health, October, 2000.
- 2 Elwood JM, Little J, Elwood JH. *Epidemiology and Control of Neural Tube Defects*. Oxford:Oxford University Press, 1992.
- 3 Mulinare J, Cordero JF, Erickson JD, et al. Periconceptional use of multivitamins and the occurrence of neural tube defects. *JAMA* 1988;260:3141-5.
- 4 Milunsky A, Jick H, Jick SS, et al. Multivitamin/folic acid supplementation in early pregnancy reduces the prevalence of neural tube defects. *JAMA* 1989;262:2847-52.
- 5 Vergel RG, Sanchez LR, Heredero BL, et al. Primary prevention of neural tube defects with folic acid supplementation: Cuban experience. *Prenatal Diag* 1990;10:149-52.
- 6 MRC Vitamin Study Research Group. Prevention of neural tube defects: results of the Medical Research Council Vitamin Study. *Lancet* 1991;338:131-7.
- 7 Centers for Disease Control and Prevention. Recommendations for the use of folic acid to reduce the number of cases of spina bifida and other neural tube defects. *Morbidity and Mortality Weekly Report* 1992;41:1-7.
- 8 Federal Register. March 5, 1996; 61:8781-97.
- 9 Institute of Medicine, Food and Nutrition Board. *Dietary reference intakes: thiamine, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline*. Washington, DC: National Academy Press, 1999.
- 10 SUDAAN Survey Data Analysis Software. Research Triangle Park, North Carolina: Research Triangle Institute, 1993.
- 11 North Carolina Behavioral Risk Factor Surveillance System Annual Report. Center for Health Informatics and Statistics, Division of Public Health. (in press).
- 12 Meyer RE. Neural tube defects in North Carolina, 1989-1993. North Carolina Birth Defects Monitoring Program Report. Raleigh, NC: State Center for Health Statistics, 1997.
- 13 Stevenson RE, Allen WP, Pai, GS, et al. Decline in prevalence of neural tube defects in a high-risk region of the United States. *Pediatrics* 2000;106:677-83.