

# Findings and Implications of the Navajo Health and Nutrition Survey

## The Health of Navajo Women: Findings from the Navajo Health and Nutrition Survey, 1991–1992<sup>1</sup>

Karen F. Strauss,<sup>\*2</sup> Ali Mokdad,<sup>†</sup> Carol Ballew,<sup>†</sup> James M. Mendlein,<sup>†</sup> Julie C. Will,<sup>†</sup> Howard I. Goldberg,<sup>\*\*</sup> Linda White<sup>‡</sup> and Mary K. Serdula<sup>†</sup>

*\*Nutrition and Dietetics Section, Indian Health Service, Rockville, MD 20857; †Chronic Disease Prevention Branch, Division of Nutrition and Physical Activity, National Center for Chronic Disease Prevention and Health Promotion, Atlanta, GA 30341–3724; \*\*Centers for Disease Control and Prevention, Chronic Disease Prevention Branch, Division of Reproductive Health; and ‡Kayenta Service Unit, Navajo Area Indian Health Service, Kayenta, AZ 86033*

**ABSTRACT** Cancer-screening behaviors, reproductive history, risk behaviors during pregnancy and chronic disease risk factors were examined in a representative sample of 566 Navajo women residing on the Navajo Reservation in 1991–1992. Among all women 15 y and older, 59% were overweight, 4% were current smokers, 10% currently used smokeless tobacco and 12% were anemic. Seventy-one percent of Navajo women aged 18 and older reported ever having had a Pap smear, but only 35% of women aged 50 and over reported ever having had a mammogram. Among parous women, the prevalence of having received no prenatal care for any pregnancy declined from 60% among women 60 and older to 13% among women 20–29 y of age, and the prevalence of ever having had a child born at home declined from 82 to 2%. These data suggest marked secular improvement in these pregnancy-related risk behaviors. However, data on cancer-screening behaviors indicate opportunities to improve health of Navajo women by increasing their use of mammography and Pap smear screening services. *J. Nutr.* 127: 2128S–2133S, 1997.

**KEY WORDS:** • Navajo women • cancer screening • chronic disease • American Indians • pregnancy

Over the past several decades, the mortality rates of American Indian women for cancer, heart disease and diabetes have increased considerably [U.S. Department of Health and Human Services (USDHHS) 1985 and 1995a]. Even though they have a lower incidence of cancer than American women as a whole (Nutting et al. 1993), cancer has become the second most common cause of death among American Indian women (O'Brien 1992, Valway et al. 1992). In contrast, both infant and maternal mortality have declined substantially among American Indians over the past several decades (USDHHS 1995a), although birth rates among American Indians continue to be high. Among the Navajo Indians, for example, the birth rate for 1990–1992 was nearly double that of the general U.S. population (31.1 vs. 16.3 per 1000) (USDHHS 1995b).

In the Navajo population, heart disease ranks second and cancer third among causes of death (USDHHS 1995b). Case fatality rates from cancer are generally much higher among American Indian women than in the general population

(USDHHS 1993); the experience of the Navajo confirms this difference. For example, the 5-y fatality rate for breast cancer among American Indians residing in New Mexico or Arizona (where the Navajo represent the largest tribe) is the highest of any ethnic or racial group (USDHHS 1993) in those states. In 1990–1992, the age-adjusted mortality rate for Navajo women from cervical cancer was 8.5/100,000; for breast cancer it was 6.0/100,000 (USDHHS 1995b). Because mortality rates for both cancers are strongly influenced by the stage at which treatment begins, early detection by mammography or Papanicolaou (Pap) smear is a major determinant of case fatality.

The 1991–1992 Navajo Health and Nutrition Survey (NHNS) provided an opportunity to examine the following women's health issues among Navajo women: cancer-screening behavior, pregnancy-related behaviors and major risk factors for chronic disease. Detailed discussions of health behaviors and conditions related to heart disease or diabetes may be found elsewhere in this issue (Mendlein et al. 1997, Percy et al. 1997, White et al. 1997a, Will et al. 1997).

### MATERIALS AND METHODS

The methods and design of the NHNS are described in detail elsewhere (White et al. 1997b). Briefly, a three-stage cluster sampling design was used to select 985 respondents aged 12 y and older living within the eight Navajo Area service units. Of this group, 566 were women aged 15 y and older, 35 of whom were pregnant at the time

<sup>1</sup> Published as a supplement to *The Journal of Nutrition*. Guest editors for this publication were Tim Byers, Professor of Preventive Medicine, University of Colorado Health Sciences Center, Denver, CO 80262 and John Hubbard, Director of Navajo Area Indian Service, Window Rock, AZ 86515. The publication of this supplement was supported by funding from the Indian Health Service and the Centers for Disease Control and Prevention, Public Health Service, U.S. Department of Health and Human Services.

<sup>2</sup> To whom correspondence and reprint requests should be addressed.

TABLE 1

*Distribution of selected behavioral and demographic characteristics of Navajo women*

	Age in years						
	Total	15-19	20-29	30-39	40-49	50-59	60+
<i>n</i>	566	53	135	116	79	86	97
Education, % ( <i>n</i> = 551)							
<High school	60.1	57.9	40.1	40.0	47.9	88.6	95.8
High school graduate	28.0	33.3	42.1	40.0	35.3	9.2	3.2
Some college	11.9	8.8	17.8	19.9	16.8	2.2	1.0
Smoking, % ( <i>n</i> = 560)							
Never	92.3	93.5	86.6	91.1	92.3	95.4	97.8
Former	3.7	4.2	5.3	4.7	3.2	2.1	2.2
Current	4.0	2.3	8.1	4.2	4.5	2.5	0
Smokeless tobacco, % ( <i>n</i> = 550)							
Never	85.7	93.1	77.3	81.2	94.3	87.4	89.5
Former	4.2	2.3	3.8	5.8	1.7	5.2	5.0
Current	10.1	4.6	18.9	13.0	4.0	7.4	5.5
BMI, <sup>2</sup> % ( <i>n</i> = 514) <sup>3</sup>							
Underweight	1.9	0	4.0	1.2	1.7	1.1	2.1
Normal weight	39.3	79.0	40.2	38.4	28.5	30.1	36.9
Overweight	36.2	13.2	32.0	34.4	42.9	41.3	44.7
Obese	22.6	7.8	23.8	26.0	26.9	27.5	16.3
Physical activity, % ( <i>n</i> = 514) <sup>3</sup>							
Sedentary	28.9	25.8	27.4	27.1	34.0	29.2	29.9
Nonsedentary	71.1	74.2	72.6	72.9	66.0	70.8	70.1

<sup>1</sup> Number of subjects for each subcategory is shown next to the heading.

<sup>2</sup> BMI (body mass index) for underweight, <19.1 kg/m<sup>2</sup>; normal weight, ≥19.1 kg/m<sup>2</sup>; and <27.3 kg/m<sup>2</sup>, overweight, ≥27.3 kg/m<sup>2</sup> and <32.3 kg/m<sup>2</sup>; obese, ≥32.3 kg/m<sup>2</sup> (see text).

<sup>3</sup> Excludes pregnant women.

of the survey. Information was collected by physical examination, blood testing and interview. Pregnant women were excluded from analysis of weight, hematologic data and physical activity. The interview assessed several chronic disease risk factors, sociodemographic characteristics and health practices. All information about pregnancy, health behaviors and health status was self-reported and not confirmed with medical chart review. All measures used standardized protocols and data collection forms. Survey weights were used in calculating means and percentages. Standard errors were calculated with SUDAAN to account for the complex sampling design (Shah 1995). Mean age at first live birth was calculated with PROC LIFE-TEST (SAS Institute 1989).

Use of cancer screening was assessed through the following questions: 1) Have you ever had a Pap smear test for cancer?; 2) Did you receive your last Pap smear test at an Indian Health Service or tribal clinic?; 3) How long has it been since you had your last Pap smear?; 4) How long has it been since your last breast x-ray or mammogram? (If necessary, the interviewer read an explanatory statement: A mammogram is an x-ray of the breast commonly used to detect breast cancer in early stages); and 5) How often do you examine your breasts for lumps? A respondent was considered to have had a mammogram if she identified the time since her last x-ray and to have practiced breast self-examination if she reported the frequency of exam.

Parity and age at first live birth were assessed by asking the following questions: 1) How many children have you had who were born living?; and 2) How old were you when you had your first child who was born living? All parous women were asked whether they had had diabetes, hypertension or toxemia during their last pregnancy, and whether they had used alcohol or cigarettes. Gestational diabetes was defined by positive responses to the following two questions: 1) Were you told you had diabetes or gestational diabetes during your last pregnancy?; and 2) Did a doctor tell you your diabetes went away after the baby was born? These women were also asked whether they had ever had a child born at home or a pregnancy with no prenatal care. Women who had had a live birth within the previous 5 y were asked whether they had breast-fed their last child. Physical activity was assessed through the following question: During the past month, did you participate in any physical activities or exercises, such as

running, basketball, softball, aerobics, walking, hunting, getting wood, swimming or other activity for exercise? We defined sedentary behavior as a negative response to this question.

Height and weight, obtained for 514 nonpregnant women, were used to calculate body mass index (BMI) [weight (kg)/height (m<sup>2</sup>)]. A detailed description of the anthropometric methods is presented elsewhere (White et al. 1997a). We classified BMI into the following categories: <19.1 kg/m<sup>2</sup>, underweight; >19.1 to <27.3 kg/m<sup>2</sup>, normal; >27.3 to <32.3 kg/m<sup>2</sup>, overweight, and >32.3 kg/m<sup>2</sup>, obese (Najjar and Rowland 1987, USDHHS 1991). Hemoglobin data were available for 507 of the 531 nonpregnant women. We defined anemia as a hemoglobin <12.7 g/dL. [The 5th-percentile value for nonpregnant women age 18 years and older on the Second National Health and Nutrition Examination Survey was 12.0 g/dL, which we increased by 0.7 g/dL to account for the 6000-foot altitude of the reservation. (Centers for Disease Control 1989)].

## RESULTS

Fifty-nine percent of the 566 women age 15 and older were overweight or obese (Table 1). Only 4% were current cigarette smokers and another 4% were former smokers. Ten percent were current users of smokeless tobacco and 4% were former users. Women aged 20-29 y were more likely than those in other age groups to smoke cigarettes and use smokeless tobacco. About 30% of women were sedentary.

Eighty percent of women 20-29 y of age had had at least one live birth, and 35% had had three or more; thus, parity levels were high, even among younger women (Table 2). The mean age of first live birth was 20.7 y for women 20-29, 22.3 y for women 30-39, 23.7 y for women 40-49, 24.1 years for women 50-59, and 23.2 y for women 60 and older. The prevalence of pregnancy-related factors varied greatly by age for many of the factors. Among parous women 20-39 y of age who had given birth within the last 5 y, slightly over half reported breast-feeding their last child. Only 13% of parous

TABLE 2

Selected pregnancy-related conditions and behaviors among Navajo women, Navajo Health and Nutrition Survey, 1991–92

	Age in years					
	15–19	20–29	30–39	40–49	50–59	60+
All Women	%					
Parity, % (n = 526)						
Nulliparous	78.0 (6.8)	20.5 (2.9)	6.8 (2.3)	9.5 (3.3)	15.8 (4.7)	11.3 (3.8)
1–2	22.0 (6.8)	44.5 (4.5)	38.3 (4.9)	18.5 (4.7)	15.5 (4.0)	11.7 (3.6)
3–4	0	31.5 (4.3)	30.1 (3.7)	38.3 (5.6)	17.4 (5.3)	8.2 (3.1)
5+	0	3.4 (1.8)	24.9 (4.1)	33.7 (5.8)	51.3 (7.5)	68.8 (5.6)
Parous women only <sup>1</sup>						
Pregnancy in last 5 y						
Breast-fed last child (n = 168)		57.1 (6.7)	52.2 (4.9)	*	*	*
Most recent pregnancy						
High blood pressure or toxemia during last pregnancy (n = 286)		17.4 (4.3)	24.4 (5.9)	24.2 (5.8)	20.2 (7.9)	16.5 (6.2)
Gestational diabetes (n = 220)		7.8 (3.9)	10.4 (2.8)	25.7 (9.2)	0	5.0 (2.4)
Drank alcohol during last pregnancy (n = 399)		4.4 (1.7)	0	4.1 (2.1)	7.3 (3.0)	7.9 (3.5)
Smoked cigarettes during last pregnancy (n = 398)		1.9 (1.2)	2.1 (1.5)	0	6.5 (2.8)	3.8 (2.3)
No prenatal care during last pregnancy (n = 395)		4.6 (2.3)	7.1 (2.7)	9.1 (4.1)	22.3 (5.9)	54.5 (5.3)
Any pregnancy						
Ever had a pregnancy with no prenatal care (n = 339)		13.1 (4.2)	15.8 (6.5)	20.5 (5.6)	39.0 (7.9)	60.0 (8.1)
Ever had a child born at home (n = 406)		2.4 (1.4)	2.2 (1.5)	6.9 (4.5)	42.4 (6.8)	82.2 (4.4)

<sup>1</sup> Data on most recent pregnancy are not presented for 15–19 year olds because of small sample size for parous women (n = 12). The numbers in parentheses are the standard errors.

\* Percentages are not presented because of small sample size (n < 30).

women aged 20–29 reported having had a pregnancy with no prenatal care; this proportion increased to 60% among women 60 and older. Between 5 and 9% of women aged 20–49 reported no prenatal care in their most recent pregnancy. Only 2.4% of women 20–29 y had ever had a child born at home, but 42.4% of women 50–59 years old and 82.2% of those 60 and older had done so.

The prevalence of self-reported high blood pressure or toxemia during the last pregnancy ranged from 24.4% among those aged 30–39 y to 16.5% among those aged 60 y and older. For gestational diabetes, the prevalence during the last pregnancy peaked at 25.7% for those aged 40–49 y. A small percentage of women in all age categories reported smoking cigarettes (<7%) or drinking alcohol (<8%) during their last pregnancy. Anemia was present in 12% of women; those of childbearing age were more likely to be anemic than were older women (Table 3).

Seventy-one percent of women aged 18 or older reported ever having had a Pap smear (Table 4). Among these women, 85% reported that their Pap smear examination was conducted by the Indian Health Service (data not shown). Among women aged 50 or older, only slightly more than one third reported ever having had a mammogram. About 60% of all women 18 y of age and older reported practicing breast self-examination.

## DISCUSSION

Our finding that Navajo women are relatively low users of mammography and Pap smears is consistent with the

case fatality rates from breast and cervical cancer in this population. Clearly, focused interventions will be required to increase demand for these services with a corresponding effort to ensure that the Navajo Area Indian Health Service can meet a substantially increased demand. Consistent with social prohibitions against smoking by women, we found it very uncommon for Navajo women to smoke cigarettes and thereby increase their risk for cancer of the lung, esophagus, larynx, and certain other sites as well as nonmalignant disorders of the heart and lung. We also found that a very high percentage of Navajo women are overweight, a factor that increases the risk of heart disease, diabetes and several other disorders (Pi-Sunyer 1993). Correspondingly, many Navajo women appear to engage in little or no physical activity.

Consistent with the 1990 census (Rodgers 1993), we found high parity among Navajo women. We also found histories of going without prenatal care and giving birth at home were common among parous Navajo women aged 60 and older. This finding is not surprising, given the norms of the Navajo population several decades ago (Waxman 1990). Navajo women aged 20–29 were less likely to have such histories, but, even so, 13% of women in this group reported a pregnancy without prenatal care.

We found that only about half of Navajo women who delivered a baby within the previous 5 y had breast-fed their infants, but we had no information on the exclusiveness or duration of breast-feeding. This proportion falls well short of the Healthy People 2000 objective that 75% of American Indians and Alaska Natives breast-feed their

TABLE 3

*Anemia among Navajo women*

Age, y	n	Hemoglobin <sup>1</sup>	% Low <sup>2</sup>
15-19	46	14.0 (0.29)	13.7
20-29	114	13.9 (0.14)	13.9
30-39	103	13.7 (0.18)	17.2
40-49	75	14.1 (0.16)	17.3
50-59	80	14.6 (0.11)	2.8
60+	89	14.4 (0.15)	7.4
Total	507	14.1 (0.11)	12.1

<sup>1</sup> In g/dL, values are means (standard errors).

<sup>2</sup> Low hemoglobin is defined as a value <12.7 g/dL (see text).

infants during the early postpartum period (USDHHS 1991). Breast-feeding provides biochemical, immunologic, psychosocial and economic advantages, and studies among the Pima Indians of Arizona have shown a beneficial effect of breast-feeding (vs. bottle feeding) on the risk of gastroenteritis and upper respiratory infections (Forman et al. 1984a and 1984b). More recently, Pettitt and co-workers found a lower prevalence of Type II diabetes mellitus in breast-fed Pima Indians (Pettitt et al. 1995a) and lower glucose concentrations in pregnant and nonpregnant Pima Indians who were breast-fed as infants (Pettitt et al. 1995b). These advantages are compelling reasons for interventions to encourage breast-feeding among Navajo women.

The finding in the present study that 5-9% of parous women aged 20-49 received no prenatal care during their most recent pregnancy contrasts with the rate of 17.9% reported in 1993 by the Navajo Nation Supplemental Food Program for Women, Infants, and Children (WIC) for its enrollees (Navajo WIC 1993). Because the WIC figure is based on whether prenatal care had been delivered at the time of the first WIC visit, it likely represents an overestimate of the failure to receive prenatal care because some women begin prenatal care after the first WIC visit. We could not discern from these data the stage of pregnancy in which women actually began prenatal care, but two other reports indicate that only about 50% of Navajo women begin prenatal care during the first trimester (Navajo WIC 1993, USDHHS 1995b). To improve prenatal care, health officials should determine the barriers that keep Navajo women from beginning prenatal care in the first trimester and use this knowledge to develop appropriate interventions. Finally, the strong trend we found for away from home births has been supported by two other studies (Boyce 1986, Waxman 1990).

The low rates of smoking and drinking alcoholic beverages during pregnancy that we found are of the same order reported in 1993 by the Navajo Nutrition WIC program; their rates were 1.2% for smoking and 0.2% for drinking (Navajo WIC 1993). It is possible, however, that because both behaviors are considered socially undesirable, especially during pregnancy, women have underreported these behaviors in both studies. In the NHNS, 17-24% of women reported hypertension or toxemia during pregnancy, a rate about 50% higher than the 12.6% reported recently by Levy et al. (1994) in a study based on chart review at a single Navajo service unit during 1991. Much of the difference between our estimate and the one reported by Levy et al. may be methodological because the NHNS used self-reports not confirmed by chart review.

In our study, ~9% of all women aged 20 y and older and 25% of women aged 40-49 y reported gestational diabetes during their most recent pregnancy. These rates are higher than those previously reported among Navajo women (6.1%, Massion et al. 1987; 3.4%, Sugarman 1989), perhaps because of methodological differences in the two studies. The low reported prevalence (<5%) among women aged 50 y and older may reflect at least two trends: 1) an increasing tendency for diabetes to be detected during pregnancy and 2) a secular trend toward increased rates of gestational diabetes. Older women are less likely than younger women to have received a glucose challenge test during pregnancy because it was not until 1986 that standards of care for diabetes (American Diabetes Association 1986) included a recommendation that a glucose challenge be administered to all pregnant women. Because the same risk factors (e.g., obesity) predict both gestational diabetes and adult onset diabetes (Coustan 1995), it is reasonable to assume that both forms of diabetes would have followed a similar secular increase in prevalence. Hence, the eight-fold increase in overt diabetes among Navajo women living in the Many Farms-Rough Rock area of the reservation during an ~20-y period ending in the early 1980s (Hall et al. 1992) suggests similar trends in gestational diabetes.

Our finding that few Navajo women smoke has been confirmed by others. For example, Sugarman et al. (1992) reported from a telephone survey of American Indians living in the Southwest that 15% were smokers. The higher rate of current smoking among women aged 20-29 and the 19% prevalence of smokeless tobacco use in this age group that we observed, however, suggest that many younger Navajo women are placing themselves at great risk for tobacco-related diseases as they become older.

The extremely high prevalence of overweight among Navajo women is of concern. The Healthy People 2000 objective for American Indians is to reduce the prevalence of overweight to <30%, but we found a rate about twice that high. Engaging in physical activity is a key component of weight control and is associated with lower mortality rates (USDHHS 1996), but we found that 29% of women reported no physical activity at all in the previous 30 d. In their telephone survey, Sugarman et al. (1992), who used a different physical activity assessment and survey methodology, also found inactivity to be common; 55% of

TABLE 4

*Prevalence of cancer screening behavior by age and education*

	Ever had a Pap smear	Ever had a mammogram	Practice breast self-examination
Total <sup>1</sup>	513	509	507
Total	70.8 (2.5)	32.3 (3.6) <sup>2</sup>	60.6 (1.8)
Age, y			
18-39	73.5 (3.4)	22.9 (3.2)	67.8 (3.0)
40-49	68.2 (5.2)	26.1 (5.9)	69.4 (6.1)
50+	67.9 (3.9)	35.0 (4.0)	46.0 (3.4)
Education			
<High school	68.7 (2.9)	29.2 (3.5) <sup>2</sup>	51.2 (3.0)
High school	72.9 (4.8)	38.5 (7.4) <sup>2</sup>	75.5 (3.8)
Some college	78.6 (4.2)	55.3 (13.9) <sup>2</sup>	71.0 (5.5)

<sup>1</sup> Number of subjects varies because of missing data. The numbers in parentheses are the standard errors.

<sup>2</sup> Calculated for women ≥40 y of age only.

respondents reported less than three 20-min sessions of leisure-time physical activity per week. Physical activity must be emphasized as an adjunct to weight control as well as for its other health benefits.

Most Navajo women are not having screening mammography because only 30% of those aged 40 and above reporting ever having had a mammogram. Furthermore, these percentages are likely to be overestimates. We suspect that many respondents may have confused a mammogram with a chest x-ray: a relatively high percentage of women aged 18–39 reported having had a mammogram, and chest x-rays for tuberculosis were commonly performed. In addition, mammography facilities did not exist at service units on the reservation until after this survey had been completed. Regardless of their true level of mammography use, Navajo women are clearly very far from meeting the Healthy People 2000 objective that 60% of Indian women age 50 and over should have had a mammogram in the preceding 1 or 2 y (USDHHS 1991). We found that about 60% of Navajo women reported breast self-examination.

Navajo women are also unlikely to achieve the Healthy People 2000 objective that 95% of women aged 18 y and older with a uterine cervix should have ever had a Pap test (85% within the last 3 y). In the present study, only 71% of women overall and just 68% of women age 50 or older reported ever having had a Pap smear. Increasing the use of mammography and Pap smears in this population will require additional health care resources, active support from physicians (Rimer et al. 1991) and educational and outreach strategies consistent with the knowledge and culture of the target audience (Bryant and Mah 1992, Vernon et al. 1992). Clearly, universal availability is not enough to overcome barriers to undergoing mammography and Pap tests (Breen and Kessler 1994, Gordon et al. 1994, Katz and Hofer 1994, Kiefe et al. 1994, McBride et al. 1993, Urban et al. 1994).

The findings of the NHNS provide important information that should help health officials to develop interventions and more efficiently allocate resources to improve Navajo women's health. Continued promotion and monitoring of prenatal care will be important, as will be tracking the prevalence of tobacco use, overweight, other chronic disease risk factors and cancer screening. Our findings suggest that enhanced use of preventive services such as mammography and Pap smear tests is needed. Those who design cancer-screening programs should be aware that Navajo tradition holds that thought and language have power to shape reality. Thus, both written and verbal messages implying predictions of adverse outcomes (Carrese and Rhoades 1995, Waxman 1990) should be avoided. Preventive services can be conducted in a positive way though, and culturally effective models can be developed to guide special efforts to reach Navajo women.

### LITERATURE CITED

- American Diabetes Association (1986) Position statement—gestational diabetes. *Diabetes Care* 9: 430–431.
- Boyce, W. T., Schaefer, C., Harrison, H. R., Haflner, H.W.J., Lewis, M. & Wright, A. L. (1986) Social and cultural factors in pregnancy complications among Navajo women. *Am. J. Epidemiol.* 124: 242–253.
- Breen, N. & Kessler, L. (1994) Changes in the use of screening mammography: evidence from the 1987 and 1990 National Health Interview Surveys. *Am. J. Public Health* 84: 62–67.
- Bryant, H. & Mah, Z. (1992) Patients as reliable reporters of medical care process: recall of ambulatory encounter events. *Med. Care* 30: 400–411.
- Carrese, J. A. & Rhoades, L. A. (1995) Western bioethics on the Navajo reservation: benefit or harm? *J. Am. Med. Assoc.* 274: 826–829.
- Centers for Disease Control (1989) Criteria for anemia in children and childbearing aged women. *Morb. Mortal. Wkly. Rev.* 138: 400–404.
- Coustan, D. R. (1995) *Diabetes in America*, 2nd ed. NIH Publication No. 95–1468. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Washington, DC.
- Forman, M. R., Graubard, B. I., Beren, R., Hoffman, H. J., Harley, E. E. & Bennett, P. H. (1984a) The Pima infant feeding study: breastfeeding and gastroenteritis in the first year of life. *Am. J. Epidemiol.* 119: 335–349.
- Forman, M. R., Graubard, B. I., Hoffman, H. J., Beren, R., Harley, E. E. & Bennett, P. H. (1984b) The Pima infant feeding study: breastfeeding and respiratory infections during the first year of life. *Int. J. Epidemiol.* 13: 447–453.
- Gordon, P. R., Campos-Outcalt, D., Steele, L. & Gonzales, C. (1994) Mammography and Pap smear screening of Yaqui Indian women. *Public Health Rep.* 109: 99–103.
- Hall, T. R., Hickey, M. E. & Young, T. B. (1992) Evidence for recent increases in obesity and non-insulin-dependent diabetes mellitus in a Navajo community. *Am. J. Human Biol.* 4: 547–553.
- Katz, S. J. & Hofer, T. P. (1994) Socioeconomic disparities in preventive care persist despite universal coverage. Breast and cervical cancer screening in Ontario and the United States. *J. Am. Med. Assoc.* 272: 530–534.
- Keife, C. I., McKay, S. V., Halevy, A. & Brody, B. A. (1994) Is cost a barrier to screening mammography for low-income women receiving Medicare benefits? A randomized trial. *Arch. Intern. Med.* 154: 1217–1224.
- Levy, M. T., Jacobson, S. J. & Sowers, J. R. (1994) Hypertensive disorders of pregnancy in Southwestern Navajo Indians. *Arch. Intern. Med.* 154: 2181–2183.
- Massion, C., O'Connor, P. J., Gorab R., Crabtree B. F., Nakamura R. M. & Coulehan, J. L. (1987) Screening for gestational diabetes in a high-risk population. *J. Fam. Pract.* 25: 569–575.
- McBride, C. M., Curry, S. J., Taplin, S., Anderman, C. & Grothaus, L. (1993) Exploring environmental barriers to participation in mammography screening in an HMO. *Cancer Epidemiol. Biomarkers Prev.* 2: 599–605.
- Mendlein, J. M., Freedman, D. S., Peter, D. G., Allen, B., Percy, C. A., Ballew, C., Mokdad, A. H. & White, L. L. (1997) Risk factors for coronary heart disease among Navajo Indians: findings from the Navajo Health and Nutrition Survey. *J. Nutr.* 127: 2099S–2105S.
- Najjar, M. F. & Rowland, M. (1987) Anthropometric reference data and prevalence of overweight, United States, 1976–80. (*Vital and health statistics, Series 11: Data from the National Health Survey, No. 238*). DHHS Publication No. (PHS) 87–1688. National Center for Health Statistics, Hyattsville, MD.
- Navajo Nation Supplemental Food Program for Women, Infants, and Children (WIC): 1993 CDC Summary Data. Centers for Disease Control and Prevention. Window Rock, AZ.
- Nutting, P. A., Freeman, W. L., Risser, D. R., Helgeson, S. D., Paisano, R., Hisnanick, J., Beaver, S. K., Peters, I., Carney, J. P. & Speers, M. A. (1993) Cancer incidence among American Indians and Alaska Natives, 1980 through 1987. *Am. J. Public Health* 83: 1589–1598.
- O'Brien, M. (1992) *Urban Indian Health Comparative Analysis Report*, American Indian Health Care Association, St. Paul, MN.
- Percy, C., Freedman, D. S., Gilbert, T. J., White, L. L., Ballew, C. & Mokdad, A. H. (1997) Prevalence of hypertension among Navajo Indians: findings from the Navajo Health and Nutrition Survey. *J. Nutr.* 127: 2114S–2119S.
- Pettitt, D. J., de Courten, M. P., Nelson, R. G., Fernandes, R. J., Hanson, L., Roumain, J., Knowler, W. C. & Bennett, P. H. (1995a) Diabetes 44 (suppl. 1): 6A.
- Pettitt, D. J., Roumain, J., Hanson, R., Knowler, W. C. & Bennett, P. H. (1995b) *Diabetologia* 38 (suppl. 1): A61.
- Pi-Sunyer, F. X. (1993) Medical hazards of obesity. *Ann. Intern. Med.* 119: 655–660.
- Rimer, B. K., Troock, B., Engstrom, P. F., Lerman, C. & King, E. (1991) Why do some women get regular mammograms? *Am. J. Prev. Med.* 7: 69–74.
- Rodgers, L. (1993) 1990 Census: Population and Housing Characteristics of the Navajo Nation. Division of Community Development, Navajo Nation, Window Rock, AZ.
- SAS Institute Inc. (1989), *SAS/STAT User's Guide*, Version 6, 4th ed., vol 2. SAS Institute, Cary, NC.
- Shah, B. V., Barnwell, B. G. & Bieler, G. S. (1995) *SUDAAN User's Manual: Software for Analysis of Correlated Data*, Release 6.40. Research Triangle Institute, Research Triangle Park, NC.
- Sugarman, J. R. (1989) Prevalence of gestational diabetes in a Navajo Indian community. *West. J. Med.* 150: 548–551.
- Sugarman, J. R., Warren, C. W., Oge, L. & Helgeson, S. D. (1992) Using the behavioral risk factor surveillance system to monitor the year 2000 objectives among American Indians. *Public Health Rep.* 107: 449–456.
- Urban, N., Anderson, G. L. & Peacock, S. (1994) Mammography screening: how important is cost as a barrier to use? *Am. J. Public Health* 84: 50–55.
- U.S. Department of Health and Human Services (1985) *Indian Health Service Chart Service Book*. Indian Health Service, Rockville, MD.
- U.S. Department of Health and Human Services (1991) *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. DHHS Publication No. (PHS) 91–50212, Public Health Service, Washington, DC.
- U.S. Department of Health and Human Services (1993) *Documentation of the Cancer Research Needs of American Indians and Alaska Natives*. National Cancer Institute, Rockville, MD.
- U.S. Department of Health and Human Services (1995a) *Trends in Indian Health*, Indian Health Service, Rockville, MD.
- U.S. Department of Health and Human Services (1995b) *Regional Differences in Indian Health*. Indian Health Service, Rockville, MD.

- U.S. Department of Health and Human Services (1996) Physical Activity and Health: A Report of the Surgeon General. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Atlanta, GA.
- Valway, S., Kileen, M., Paisano, R. D. & Ortiz, E. (1992) Cancer Mortality among Native Americans in the United States: Regional Differences in Indian Health, 1984–88 and Trends of Time. Indian Health Service, Albuquerque, NM.
- Vernon, S. W., Vogel, V. G., Halabi, S., Jackson, G. L., Lundy, R. O. & Peters, G. N. (1992) Breast cancer screening behaviors and attitudes in three racial/ethnic groups. *Cancer* 69: 165–174.
- Waxman, A. G. (1990) Navajo childbirth in transition. *Med. Anthropol.* 12: 187–206.
- White L. L., Ballew C., Gilbert T. J., Mendlein J. M., Mokdad A. H. & Strauss K. F. (1997a) Weight, body image, and weight control practices of Navajo Indians: findings from the Navajo Health and Nutrition Survey. *J. Nutr.* 127: 2094S–2098S.
- White, L. L., Goldberg, H. I., Gilbert, T. J., Ballew, C., Mendlein, J. M., Peter, D. G., Percy, C. A. & Mokdad A. H. (1997b) Rationale, design, and methodology for the Navajo Health and Nutrition Survey. *J. Nutr.* 127: 2078S–2084S.
- Will, J. C., Strauss, K. F., Mendlein, J. M., Ballew, C., White, L. L. & Peter, D. G. (1997) Diabetes mellitus among Navajo Indians: findings from the Navajo Health and Nutrition Survey. *J. Nutr.* 127: 2106S–2113S.