AN ESTIMATE OF THE FOLATE INTAKE IN OKLAHOMA WOMEN OF CHILDBEARING AGE

By

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CHAPTER I

INTRODUCTION

During our entire lifespan, our body requires nutrients for life support. Diet is the main source of nutrients to the body, and some nutrients are more important at certain periods of time. For instance, during their childbearing years, women have increased needs for specific nutrients.

Some birth defects are related to nutrient deficiencies. Folate deficiency in the mother can affect the development of the central nervous system of the fetus during the early stage of development. As a consequence, malformation of the neural tube occurs. The central nervous system is formed from the neural tube, which develops during the first month of pregnancy. If the mother has an inadequate folate status, the malformation can occur (Butterworth & Bendich, 1996). In 1994, birth defects were the leading cause of infant mortality in the United States (Petrini et al., 1997). Spina bifida and anencephaly are two birth defects related to folate deficiency. The incidence of these defects should decrease with adequate amounts of folate intake in women in childbearing age (Mulinare & Erickson, 1997).

In Oklahoma the incidence of neural tube defects was 0.89:1000 births during 1994 (Oklahoma State Department of Health, 1996) and decreased to 0.72:1000 births during 1995-1997 (Oklahoma State Department of Health, 1998). Although the incidence has been decreasing slowly through the years (Petrini et al., 1997; Food and Nutrition Board, 1998), the population must still be aware of the risk associated with an inadequate intake of folate.

In 1990, $775 million was estimated as the cost of all children with spina bifida in the United States (CDC, 1989). In Oklahoma, estimates of the lifetime cost for children with spina bifida were over five million dollars during 1992, based on data from the California Birth Defects Monitoring Program and the Metropolitan Atlanta Congenital Defects Program (Harris & James, 1997).

Since the seventeenth century there has been evidence that malformations in children could be caused by a deficient harvest. But the first report related to a vitamin deficiency and birth defects was in 1933 when Hale demonstrated that vitamin A deficiency in pigs produced birth defects (Hale, 1933). Hibbard (1964), in a retrospective study, suggested a possible relationship between folate intake and neural tube defects (Hibbard, 1964). In 1965, Hibbard and Smithells conducted a study in pregnant women with a diagnosis of fetal malformations to verify previous findings (Hibbard & Smithells, 1965). Since then, interest in determining folate's relationship to neural tube defects has increased.

In the United States the Recommended Dietary Allowances (RDAs) have been established to give the amount of nutrient needed to meet the requirements for adequate nutrition of healthy people. During the 1940s, the RDAs were proposed as a guide to enhance the nutrition of the population and as standard values to be used in research (Roberts, 1958). About every ten years, the RDAs were evaluated to update the information about nutrients. In 1993, the Food and Nutrition Board conducted a symposium to review the RDAs. In 1994, it was determined that with the new knowledge and technology available, the RDAs could be reviewed to provide better information about different nutrients. Various groups were formed to develop what are now the new

Dietary Reference Intakes (DRI) (National Academy of Science, 1997a). The DRIs include not only the RDAs but also an Estimated Average Requirement (EAR), Adequate Intake (AI) and Tolerable Upper Intake Level (UL) for each nutrient, when that is possible (National Academy of Science, 1997b; 1997c). One of the groups was assigned to study the B vitamins, folate, vitamin B12, and choline (National Academy of Science, 1997a). In the final report it was determined that the RDA for folate is 400 μg/day and the EAR is 320 μg/day for an adult population from 19 to 50 years old. During pregnancy the EAR is established at 520 μg/day and the RDA is 600 μg/day to maintain a normal folate status. However, to prevent neural tube defects 400 μg/day from supplements or fortified food in addition to the amount provided from the diet is needed (Food and Nutrition Board, 1998). In 1992, the U.S. Public Health Service recommended the consumption of 400 μg of folate a day in women of childbearing age (CDC, 1992).

Since January 1998, all enriched grain products are fortified with folic acid (US Department of Health and Human Services, 1996). This increases the folate consumption in the total population. It is hypothesized that the increased folate content of grain products will decrease the incidence of neural tube defects.

The uses of dietary assessment methods have expanded with research in nutrition areas. Since 1938, researchers have been using the 24-hour recall as a method to record food intake (Witschi, 1990). In the 24-hour recall, persons need to remember the amounts of food and drink that they consumed during that period of time. During the 1950s, the food frequency questionnaire was developed as an inexpensive method to evaluate food intake not only for one day, but also for the past month (Willet, 1990; Block et al, 1990a). The food frequency questionnaire determines how often the person consumed different types of foods during a longer period of time than the 24-hour recall. Another kind of dietary assessment tool is the food record. The individual must write down all the foods and drinks, with specific portion sizes, and for a specific number of days (Lee & Nieman, 1996).

Food Patterns

Food patterns in the population are influenced by different factors. Bennett et al. (1942) found that food patterns vary based on culture, society, environment, economy, region, urbanization, and food availability. In addition, seasonal variability affects the diet. They classified the types of food that the population eats as core, secondary core, and peripheral foods (Bennett et al., 1942). Jerome (1976) modified the basic classification of Bennett by introducing frequency of consumption into those definitions. Foods consumed daily or two to three times per week form the core; foods consumed once a week form the secondary core; and food consumed once a month were considered peripheral foods. Jerome (1976) found that the variety of foods available, social influence, and rapid changes in food distribution affect the food pattern of the individual. These factors affect the food habits of the individual by adding and eliminating some types of foods from the usual core.

Although much research has been done, there is a need to know if the folate intake is adequate and what sources of folate are in the diets of Oklahoma women of childbearing age. The food patterns in women of childbearing age affect the folate intake Determining which core and secondary core foods currently provide folate should be helpful to develop strategies to enhance dietary folate intake of women of childbearing age. In that way, nutrition education can be addressed to more effectively increase the folate intake in this population.

The purposes of this study were to determine the amount of folate consumed by women of childbearing age in Oklahoma, to compare three different dietary assessment methods, and to determine core foods that provide folate to women of childbearing age.

Objectives

1. To determine how folate intake in young women in Oklahoma compares to the recommended amounts.

2. To estimate the amount of folate intake based on one 24-hour recall.

3. To estimate the amount of folate intake based on a food frequency questionnaire (FFQ).

4. To estimate the amount of folate intake based on 3-day food records

5. To determine the relationship among the folate intake by 24- hour recall, FFQ and food records.

6. To determine the amount of folate provided by the core foods.

7. To determine the amount of folate provided by secondary core foods.

8. To describe the frequency of consumption of good sources of folate

9. To determine the amount of folate provided by fortified foods.

Assumptions

- The nutrient databases provide an accurate estimate of the amount of folate in foods.

- The sample will reflect the actual amounts of folate intake in women from Oklahoma.

- The intake that is recorded will accurately represent the usual food intake.

Limitations

- The focus group before the interview may have motivated the subject to alter their report of their 24-hour recall and food frequency questionnaire and change their food habits during food record.

- The use of memory to record the foods is a limitation because there are many foods that are easy to forget.

- Keeping the record can modify the food intake.

- The accuracy of dietary assessment methods depends on the respondent's perception of the portion sizes.

- Since the subjects are volunteers, it is a non-randomized sample and would not be representative of the population.

Definitions of Unusual Terms

Acculturation: the process of adopting the cultural traits or social patterns of another group.

*Adequate Intake (*AI): average observed or experimentally derived intake by a defined population or subgroup that appears to sustain a defined nutritional state, such as normal circulating nutrient values, growth, or other functional indicators of health.

Anencephaly: absence of cerebral hemispheres.

Childbearing age: women capable of being pregnant.

Core foods: foods that are consumed more than three times a week.

Dietary Reference Intake (DRI): a set of at least four nutrient-based reference values that can be used for planning purposes. These reference values are RDA, EAR, AI, and UL.

Estimate Average Requirement (EAR): the intake that meets the estimated nutrient need of 50 percent of the individuals in that group.

Folate: water soluble B vitamin, are pteroylpolyglutamates. Folates contain from one to six glutamate molecules joined in a peptide linkage to the γ-carboxyl of glutamate. Its main function is related to one-carbon metabolism.

Folic Acid: synthetic form of folate composed of a *p*-aminobenzoic acid molecule linked at one end to a pteridine ring and at the other end to one glutamic acid molecule.

Food fortification· process by which vitamins and/or minerals have been added to food products in excess of what was originally found in the product.

Food frequency questionnaire: a questionnaire listing foods on which individuals indicate how often they consume each listed item during certain time intervals (daily, weekly, or monthly). Standard portion sizes are used on the questionnaire.

Food record: method by which the subject records foods and beverages and amounts eaten for a specific number of days.

Good source of folate: contains a substantial amount of folate in relation to its calorie content and contributes at least 10 percent of the RDA (400 μg/day) for folate in a selected serving size.

Multiple pass 24-hour food recall: a dietary recall method that consists of three passes. In the first pass, a trained interviewer asks the subject to remember all foods and beverages consumed during the previous 24 hours. Second, the interviewer verifies and clarifies all the foods and beverages with specific serving size and remind the subject about any other foods that could be forgotten (snacks, candies, cookies). Third, the interviewer asks details about the foods (brand names, way of preparation, items added to foods, etc.), if anything is added to specific foods such as sugar on cereal or coffee, milk on cereal, cream in coffee, butter on bread or vegetables) and review all the 24-hour recall.

Neural tube defects: a defect in the formation of the neural tube occurring during early fetal development. Two common defects are anencephaly and spina bifida.

Peripheral foods: foods that are consumed once a month or less.

Recommended Dietary Allowance (RDA): the intake that meets the nutrient need for almost all (97 to 98 percent) healthy individuals in a group.

Secondary core: foods that are consumed between two times a week and two times a month.

Spina bifida: congenital anomalies where there is a failure of the posterior spinous processes on the vertebrae to fuse, which may permit the meninges and spinal cord to herniate, resulting in a neurological impairment.

Tolerable Upper Intake Level (UL): the maximum intake by an individual that is unlikely to pose risks of adverse health effects in almost all (97 to 98 percent) healthy individuals.

CHAPTER II

LITERATURE REVIEW

Folate

History

For many centuries, people have tried to give rational explanations related to food and health problems. Many people have tried to explain the effect of the diet on health. The observation of the relationship between specific eating habits and health problems was used to explain the origin of some diseases. Based on those empirical observations, nutritional deficiencies were detected and treated. In 1878, Takaki, a Japanese General, observed that the Japanese sailors died in great numbers every year during their trips because of beriberi. Takaki was surprised by the health of the British sailors. By observing and comparing the diet of both groups, he made some changes in the diet of the Japanese sailors. The polished rice that the sailors consumed was changed for barley, they incorporated milk and meat into the diet. With these adjustments the sailors were in better health. Beriberi was eradicated when the diet changes were implemented (McCollum, 1957).

Funk in 1911, described a component of the rice polishing that cured beriberi. The component was called vitamin B. Later research determined that the rice polishing had various components, then the name was changed to vitamin B1. Discovery of additional components followed the vitamin B1 (Goodwin, 1963). Different numbers were given to the new compounds that were discovered.

At the beginning folic acid was named vitamin B_c (Goodwin, 1963). Later, Mitchell et al. (1941) named the compound folic acid because they found this component in spinach.

In 1933, the Texas Agricultural Experiment Station reported a study with a vitamin A deficient diet that was fed to a pregnant pig. At birth, 11 baby pigs were without eyeballs, this congenital defect was assumed to be due to vitamin A deficiency (Hale, 1933). This was the first congenital problem that was related to a specific type of vitamin deficiency.

Hibbard (1964), in a retrospective study, suggested a possible relationship between folate intake and neural tube defects (Hibbard, 1964). In 1965, a study conducted by Hibbard and Smithells was published showing a relationship between folate metabolism and the production of congenital malformation. A sample of 98 women with a previous diagnosis of fetal malformation or with a baby born with a congenital malformation was used. A control group was matched with the women with malformed infants. An urinary excretion test of a folate metabolite, called formimino glutamic acid (FIGLU), was performed in all women. High FIGLU values were found in the women with malformed infants. In contrast, low values of FIGLU were found in those women with a normal baby (Hibbard & Smithells, 1965).

Researcher interest has increased since then, with researchers trying to determine the relationship between folic acid deficiency and congenital malformation, especially neural tube defects.

Physiology

Folate is a B vitamin whose main function is related to one-carbon metabolism. The main function of folate is the transference of carbon units during the DNA and RNA synthesis, methionine synthesis, and serine and glycine interconversion (Murray et al., 1996; Gregory, 1997; Berdanier, 1998). Its chemical structure has a pteroyl acid, glutamic acid, and para-aminobenzoic acid (PABA). Its name is derived from this type of structure, Pteroylglutamic acid (Murray et al., 1996).

Folates are present in foods, generally with a long chain of glutamic acids attached (Murray et al., 1996; Gregory, 1997). In order to be used by the body, folates need to be in the form of monoglutamates. In the intestine, folates are deconjugated to monoglutamates by hydroxylases in order to be absorbed across the cell membrane using carriers (Gregory, 1997). Once folate is in the cell, its active form, tetrahydrofolic acid, is formed by the action of reductases. Then, it goes to portal circulation to be distributed in the organs and tissues (Gregory, 1997). Most of the folate circulating is in the form of methyltetrahydrofolate (Butterworth & Bendich, 1996). Folate that is not used by the cells is then excreted, with more excreted in the urine than the bile (Gregory, 1997; Berdanier, 1998).

Folate and Other Vitamins

Folate metabolism is tightly related to vitamin B12 and B6 metabolism. During folate metabolism, vitamin B12 acts as a coenzyme to regenerate tetrahydrofolate from 5-methyl tetrahydrofolate, and methionine from homocysteine (Brody et al., 1984; Berdanier, 1998).

Folate and Drugs

Different types of drugs can alter folate metabolism. Methotrexate, a chemotherapy drug, is similar to the folate structure. Methotrexate inhibits the formation of tetrahydrofolate from dihydrofolate by competing for the enzyme dihydrofolate reductase. As a result, DNA synthesis is inhibited, producing death of the cancer cells (Lazaros & Theoharides, 1992). Trimethoprim and sulfamethoxazole, antimicrobial drugs, inhibit the use of dihydrofolate reductase and dihydropteroate synthetase respectively. Trimethoprim acts basically as methotrexate; sulfamethoxazole inhibits the conversion of para-aminobenzoic acid (PABA) to dihydrofolate. Pyrimethamine, an antimalaric drug, inhibits the enzyme dihydrofolate reductase (Gorbach & Theoharides, 1992).

Toxicity

Few toxic effects have been shown with a high folate intake. However, there is a major concern related to vitamin B12 deficiency. Folate intake in high amounts can prevent the megaloblastic anemia by vitamin B12 deficiency, but the nerve damage still continues, as a consequence neurological manifestations can occur. Those neurological problems are irreversible (Food and Nutrition Board, 1998).

Folate Deficiency: Related Diseases

Folate and Neural Tube Defects

After the results of Hibbard study in 1964, and Hibbard and Smithells in 1965, different studies have been conducted to demonstrate the relationship between folate intake and the production of congenital malformations.

Laurence et al. (1980) conducted a study on the adequacy of diets of women with a history of a pregnancy with a neural tube defect. They found that women who received counseling and enhanced their diet during pregnancy had less risk of neural tube defects than the ones who did not receive counseling and had poor diets.

Later, Laurence et al. (1981) conducted a randomized controlled double-blind study to evaluate the effect of folate in women who had a previous pregnancy with neural tube defect. They used a placebo group and a treatment or supplement group (400 μg folate/day). They found that women who used the supplement had babies who did not develop a neural tube defect, but women in the placebo group and the non-compliers had a high recurrence of infants with neural tube defects. However, they recommended the verification of these findings with a larger study (Laurence et al., 1981).

A nonrandomized study was conducted in volunteer women with a previous neural tube defect pregnancy. Pregnavite Forte F (a multivitamin containing 360 μg of folate) was used one month before pregnancy and after the second missed menstruation. During the first and second cohort (1976-1981) they found that women who used the multivitamin had a lower recurrence of neural tube defects (3:426) than women without the multivitamin (24:486). In the first, second, and third cohort (1976-1984) they found that women with multivitamin had a lower recurrence (14:1093) than women who partially used the multivitamin (Schorah & Smithells, 1991; Smithells et al., 1983; Schorah et al., 1983).

A group of researchers conducted a study in Cuba to determine if folic acid supplementation was an effective way to prevent neural tube defects. They used folic acid supplementation of 5 mg a day from the last menstruation through the tenth week of pregnancy. Three experimental groups were formed: supplemented, partially supplemented, and nonsupplemented. Among the supplemented and partially supplemented groups there were no cases of neural tube defects. However in the nonsupplemented group a recurrence rate of 3.5 % was found (Vergel et al., 1990).

The Medical Research Council conducted a larger randomized double-blind study. The study was designed to evaluate the effect of folic acid supplementation on the prevalence of neural tube defects in women of childbearing age. A previous history of an infant with a malformation was a requirement to participate in the study. A sample of 1817 women was divided into four groups: one with 400 μg folic acid supplementation, second with multivitamins (vitamin A, D, B1, B6, C, Nicotinamide) and folic acid, third with a placebo (dried ferrous sulfate and di-calcium phosphate), and fourth with other vitamins only. Blood and urine samples were used to determine baseline levels of folic acid. The results showed a prevalence of neural tube defects of 6/593 (1%) in women receiving folic acid, and 21/602 (3.5%) in women without folic acid (relative risk: 0.28) After the exclusion of the women who did not comply with the treatment or were pregnant before the experiment started, the prevalence did not change. They concluded that the folic acid supplementation decreased the prevalence of neural tube defects in women who had previous pregnancies with neural tube defects (MRC Vitamin Study

Research Group, 1991). The authors concluded that if women in childbearing age are supplemented or have an adequate intake of folate, they have less risk of suffering a neural tube defect in their first pregnancy. Because most of the pregnancies with neural tube defects occur without a previous history, folic acid supplementation could be used to decrease the incidence of neural tube defects (CDC, 1992).

Holmes-Siedle et al. (1992) conducted a study with results similar to the Medical Research Council study. They found a recurrence rate of neural tube defects of 10.7 % (3:28) in women without folic acid supplementation, and 0.49 % (1:204) on women with folic acid supplementation.

Folate and Vascular Disease

Studies have shown that subjects with vascular disease have higher levels of plasma homocysteine than healthy subjects (Tucker et al., 1996; Selhub et al., 1996; Rimm et al., 1998; Obeid et al, 1998). Folic acid, vitamin B12 and vitamin B6 are tightly related to homocysteine metabolism. When one of these vitamins is deficient, high levels of homocysteine can be present in blood and endothelial damage can occur in the blood vessels (Larkin, 1998).

A follow up of the Framingham Heart Study (1989-1990) demonstrated that folic acid, vitamin B12 and vitamin B6 were strongly associated with plasma homocysteine levels. It was observed that individuals with low levels of these vitamins had increased values of homocysteine in blood. However, individuals with moderate and high vitamin levels did not have significantly different homocysteine levels (Selhub et al., 1996).

The specific pathogenic mechanisms of damage in the blood vessels due to hyperhomocysteinemia have not been determined, but it is possible that toxic effects of sulfur amino acids can damage the endothelium and alter the platelet function, producing vascular damage (Selhub & Rosenberg, 1996).

Different enzymatic abnormalities (congenital or acquired) can produce hyperhomocysteinemia. The acquired abnormalities are mainly related to nutritional deficiencies. The deficiency of cystathionine synthase that is a vitamin B6 dependent enzyme produces vascular abnormalities, arterial and venous thromboses. Vitamin B6 is directly related to the transsulfuration reactions during homocysteine metabolism. When this vitamin is deficient, hyperhomocysteinemia occurs. Deficiency of methyltetrahydrofolate homocysteine methyl transferase, a vitamin B12 dependent enzyme can produce rapidly progressive atherosclerosis. Vitamin B12 and folate are required for homocysteine remethylation. Vitamin B12 is an essential cofactor of methionine synthase. As a result, in vitamin B12 deficiency, there is an increase of homocysteine levels in plasma. Deficiency of methylenetetrahydrofolate reductase, a folic acid dependent enzyme can cause atherosclerotic plaques. 5-methyltetrahydrofolate is a cosubstrate to homocysteine metabolism that helps the conversion of homocysteine to methionine by the action of the methionine synthase. So, when folate deficiency occurs, there is an increase in homocysteine concentration in blood. Normally, this pathway metabolizes 50% of the homocysteine. If folate is deficient, the administration of folic acid can reduce the homocysteine concentrations (Green & Jacobsen, 1995).

Folate and Cancer

Giovannucci et al. (1993) conducted a large sample size study where a inverse relationship between the amount of folate intake and the incidence of colon cancer was found. Baron et al. (1998) studied a group of patients with a diagnosis of colon adenoma. Each subject was evaluated by colonoscopy during the first and fourth year of follow up. including dietary assessment at baseline and at fourth year. They also found an inverse relationship between folate intake and adenoma risk. Other types of cancer have been studied to evaluate if there is a relationship between folate availability and carcinogenesis, but there is no specific proof of other relationships (Mason, 1995).

Assessment of Folate Status

There are different methods to assess folate status in the body. In blood, serum folate and red blood cell folate can be measured to assess folate. Excretion of FIGLU via urine is another test used to assess folate status. However, urinary FIGLU is not considered specific for folate because it can be altered by other vitamin deficiencies and other diseases (Brody et al, 1984; Gibson, 1990). During histidine degradation, FIGLU is formed. Folate is necessary for FIGLU to be converted to glutamic acid. In folate deficiency, FIGLU is excreted by urine (Gibson, 1990). Plasma homocysteine has been used as a predictor or indicator of folate status (Selhub & Rosenberg, 1996). In the Framingham Heart Study (1989-1990) it was shown that in folate deficient patients, homocysteine values in the blood were high (Selhub et al., 1996). Blood homocysteine values vary depending on folate consumption (Brody et al, 1984).

Dietary Sources of Folate

The main food sources of folate are green leafy vegetables, yeast, grains, legumes, organ meats such as liver, and fruits (Food and Nutrition Board, 1989; Food and Nutrition Board, 1998; Berdanier, 1998). Subar et al. (1989) found that the main sources of folate in adult population of the United States during the Second National Health and Nutrition Examination Survey (NHANES II) were orange juice, followed by white breads, beans, green salad, and ready-to-eat cereals. Orange juice is not a very high source of folic acid, but its high consumption makes it a good folate source in the American population (Subar et al., 1989). Gates and Holmes (1999) studied the main sources of folate in women in childbearing age (11-50 years old) during the 1994-95 Continuing Survey of Food Intakes by Individuals (CSFII) based on two 24-hour recalls. They found that the five main foods that provided folate were ready-to-eat cereal, citrus fruits, mixtures mainly grains, breads and rolls, and mixtures mainly meat, poultry, fish. They also found low consumption of high content folate foods such as dark green vegetables and liver.

Schaller and Olson (1996) analyzed data from the 1989-1991 CSFII and the 1987-1988 NFCS. Results showed vegetables, ready-to-eat cereals, meat, grains, other foods, desserts and snacks, orange juice, other beverages, milk and fruit as the main providers of folate in women of childbearing age. In the Framingham Heart Study it was found that the main providers of folate in elderly women were lettuce, oranges, broccoli, cauliflower, winter squash, grapefruit and mixed vegetables (Tucker et al., 1996).

Folate Availability

The availability of folate in food varies. Folate availability is affected by cooking methods (Brody, 1984), preparation, and storage (Gregory, 1997). Folate losses vary depending on the method used to prepare the food. About half of the folate content is lost with heat. The stability of the form of folate influences the degree of folate degradation during heating. (Brody, 1984). In some types of food, such as legumes and cabbage, the availability of folate is decreased by the presence of enzyme inhibitors or oxidant agents that prevent the absorption of folate (Brody, 1984; Albertson & Marquart, 1999). In orange juice, although the availability is not the best, the folate content is stable because of the vitamin C content of the juice (Wei et al., 1996). Folic acid in cereals and grain products is absorbed in similar amounts than folic acid supplements (Tamura, 1997).

Folate Fortification

During this century many micronutrients have been discovered and many deficiency diseases have been eradicated. Food fortification policy has improved the nutrient intake in the United States during this century. However, after the traditional nutrient deficiencies disappear, new nutrient deficiencies were discovered (Mertz, 1997).

In 1940, fortification of flour began in the United States with three water-soluble vitamins (riboflavin, niacin, thiamin) and iron. Later, fortification of other grain products was approved (Mertz, 1997).

Different methods have been suggested to improve folate intake in women of childbearing age. One of them was the folate fortification of the food supply (Mulinare & Erickson, 1997). The addition of vitamins to the food supply does not require any behavioral change by the target population (Romano et al., 1995). So folic acid fortification is the simplest way to increase folate intake in the US population (Tamura, 1997).

The approval of folic acid fortification took many years. Researchers were required to put together enough evidence to sustain the need for folic acid fortification in the United States food supply. Since Hibbard (1964) found a relationship between folate and congenital malformation, many different studies confirmed Hibbard's work (MRC Vitamin Study Research Group, 1991; Smithells et al., 1983; Schorah, 1983; Laurence et al., 1981; Czeizel & Dudas, 1992; Daly et al., 1997).

In 1992, the U.S. Public Health Service recommended the consumption of 400 μg of folic acid a day in women of childbearing age to prevent neural tube defects (CDC, 1992). Because many pregnancies are unplanned, women who are folate deficient during the first weeks of gestation may have a baby affected by a neural tube defect. The Centers for Disease Control (CDC) estimated that increasing the folic acid intake in childbearing age women could prevent about 75% of those birth defects each year (CDC, 1998).

In 1996, the Food and Drug Administration amended the standards for folic acid fortification of enriched grain products (US department of Health and Human Services, 1996) due to the low cost of food fortification with folic acid (Romano et al., 1995) and the high benefit to the population. A cost-benefit analysis by Romano et al. (1995) found that folic acid fortification would save $94 million with 140 μg of folic acid per 100 gr. of grain product.

Folic acid fortification is estimated to increase folate intake by about 80 μg a day or more (Food and Nutrition Board, 1998). Different studies were used to support the specific amount needed to increase folate intake. Daly et al. (1997) conducted a study to determine the minimum dose of folic acid that would be effective to minimize the incidence of neural tube defects. They used four groups: placebo, 100 μg, 200 μg, and 400 μg of folic acid supplement a day. They found an increased amount of folic acid in red blood cells in the treatment groups when compared to the placebo group. They determined that 200 μg would be an adequate amount of folic acid to implement food fortification because it would decrease the incidence of neural tube defects and it would be safe for the rest of the population. They estimated that the approval of 100 μg of folic acid as the value for food fortification by the FDA was safe, but may be insufficient to meet the requirements to decrease the incidence of neural tube defects.

A recent study conducted by Werler et al. (1999) evaluated the different strategies to enhance folate intake in women of childbearing age proposed by the US Department of Health and Human Services in 1996. They studied a population of women of childbearing age with previous history of a baby with congenital malformation. They found that 71% of the women did not take folic acid as a supplement before pregnancy. The average amount of folate provided by foods was 250 μg/day and the average amount of folic acid provided by fortified foods was approximately 130 μg/day. These results showed that although folic acid fortification was implemented, women of childbearing age were not meeting the recommended amounts of 400 μg/day of folic acid to prevent neural tube defects. Only 32 % of these women knew about the relationship of folate intake and neural tube defects.

Firth et al. (1998) conducted a small study to estimate the folate intake in women that could become pregnant. They found that the fortification of grain products with folic acid would be enough to meet the recommendations of 400 μg a day of folic acid.

Jacques et al. (1999) evaluated plasma folate concentrations in subjects before fortification (1991-1994) and after fortification (1995-1998) in the Framingham Offspring Study. They found a considerable increase in plasma folate concentrations and decrease in homocysteine concentrations after fortification. This research shows that the folate fortification of grain products enhanced the folate intake in US population.

Folate and Recommended Dietary Allowances

The Recommended Dietary Allowances (RDAs), after a process of revisions, have been included into the Dietary Reference Intakes (DRIs). The latest scientific knowledge about different nutrients allowed the creation of new terms to express the recommendations in the population. The DRIs are formed by four reference values for specific nutrients. The RDAs are reference values of intake for individuals that are supposed to meet the requirements of almost all healthy individuals. The Estimated Average Requirement (EAR) expresses the necessary nutrient intake to meet 50% of the population's nutrient requirement. Adequate Intake (AI) represents the nutrient requirement of a specific nutrient that has been established based on the best scientific knowledge available about the nutrient to meet the needs of the individual, but there is not enough evidence to define a RDA value. The Tolerable Upper Intake Level (UL) is the maximum intake is to be safe for individuals without any side effect or risk of toxicity (Yates, 1998; National Academy of Sciences, 1997b; 1997c).

Folate availability varies depending on whether the folate is provided by food (50% available) or synthetic supplements (85% available). Dietary folate equivalents (DFE) were created to assess in a more realistic way the amount of folate available to the body. To calculate the EAR for folate, the μg of DFE were calculated based on the amount of folate provided by food plus 1.7 times the μg of synthetic folic acid provided by fortified foods or supplements (Food and Nutrition Board, 1998; Bailey, 1998).

Recommended values for folate have been set based on gender and age. EAR and RDA for folate in adults and elderly were derived from different well-controlled metabolic studies. Women of childbearing age should have a synthetic folic acid intake of 400 μg/day plus the folate from the diet. During pregnancy folate requirement increase, so 100 μg of synthetic folic acid (approximately 200 μg/day DFE) was added to the EAR for nonpregnant women. During lactation folate values were set based on the folate needed by nonlactating woman and the amount of folate excreted in milk daily (Food and Nutrition Board, 1998).

Table 2.1. Dietary reference intake of folate depending of life cycle stage (Food and Nutrition Board, 1998).

Group	EAR	RDA
Adults > 19 years old	320 μg/day	400 μg/day
Pregnancy	520 μg/day	600 μg/day
Lactation	450 μg/day	500 μg/day

Folate Intake

Folate intake has been evaluated in different populations, and using different methods (de Bree, 1997; Subar et al., 1989; Subar et al., 1990; Block & Abrams, 1993; Schaller & Olson, 1996; Rimm et al., 1998; Firth et al., 1998; Jacques et al., 1999; Gates & Holmes, 1999).

Subar et al. (1989) examined 24-hour recalls from the 1976-1980 NHANES II. They studied the US population between 19 to 74 years old to determine the main sources of folate. Mean adult folate intake was 242 ± 2.8 μg. They found males' mean folate intake was 281 ± 3.6 μg/day and women's was 207 ± 2.9 μg/day. Blacks had lower folate intake than whites. Women between 19 to 50 years of age had a mean intake of 218 μg/day. None of the groups meet the 1998 RDA for folate.

Subar et al. (1990) analyzed data from the 1976-1980 NHANES II to determine nutrient intake between smokers and non-smokers. They found that the mean intake of folate in non-smoking and smoking men was very similar (249 μg and 248 μg, respectively). In non-smoking women the mean intake of folate was 204 μg/day, and in smoking women it was 188 μg/day. They found a negative association between smoking and folate intake in both sexes (males: $\beta = -0.06$, SE = 0.014; females: $\beta = -0.09$, SE = 0.017).

Data from women 20 to 45 years of age in the 1989-1991 Continuing Survey of Food Intakes by Individuals, and the Nationwide Food Consumption Survey were analyzed. Mean intakes varied depending on the use of ready-to-eat cereal. Women who did not consume ready-to-eat cereal had a 42 % lower folate intake than women who consumed ready-to-eat cereal (Schaller & Olson, 1996).

de Bree et al. (1997) studied folate intake in adult European populations. They found that the mean intake of folate was 291 μg in men, and 247 μg in women. The recommended folate intake was met by a tiny part of the population. They recommended motivating the population to increase the consumption of green vegetables and grain products to enhance the folate intake.

Gates and Holmes (1999) analyzed data from the 1994-95 CSFII to determine the folate intake in 2,086 women of childbearing age by two non-consecutive 24-hour recalls. Folate intake averaged 215 ± 3 μg and 50 % of the subjects consumed less than 180 μg/day of folate.

Rimm et al. (1998) assessed folate intake in women who participated in the Nurses' Health Study. They found that the average folate intake was 366 μg/d with a median of 277 μg/d. Those values were above the national average of 224 μg/d.

In 1998, Firth et al. studied folate intake in women of childbearing age. They collected fourteen 1-day randomly selected food records during a 60-day period. They found that the mean intake of folate was 288 ± 195 μg in a population sample of 21 women. Only two women met the RDA. After simulation of folate fortification (adding 140μg /100 gr flour), they found that folate intake increased to 550 ± 279 μg without supplements and to 609 ± 327 μg with supplements.

Jacques et al. (1999) analyzed data from the fifth (1991-1994) (base line or before fortification), and sixth (1995-1998) (follow-up, after fortification) examination of the Framingham Offspring Study cohort. They chose subjects that were examined after folate fortification was implemented as the study group. They established as a control group people from the sixth cohort that were not exposed to folate fortification. A food frequency questionnaire was used to assess the usual folate intake, folate supplements use, and folate from fortified foods. Subjects were separated in two groups based on B vitamin supplement use. Before fortification study group subjects who used B vitamins had a folate intake of 650 μg/day, and the control group had a folate intake of 651 μg/day. Study group subjects who did not use B vitamin supplements had a folate intake of 266 μg/day, and the control group had a folate intake of 275 μg/day. After the implementation of fortification they found a mean folate intake of 686 μg/day in the study group that used B vitamins, and the control group had a mean folate intake of 675 μg/day. The study group that did not use B vitamin had a mean folate intake of 271 μg/day, and the control group had a mean folate intake of 291 μg/day. They concluded that folic acid fortification improved folate status in that population.

Cuskelly et al. (1999) examined the effect of folate fortification in young women who consumed or did not consume fortified foods. They found at baseline that women who consumed fortified foods had a higher folate intake (265 ± 72 μg) than women who did not consume fortified foods (197 ± 72 μg; $p = 0.002$). After exclusion of fortified foods from the diet for 12 weeks, folate intake decreased in people who consumed fortified foods before the study, but did not change in people who did not consume fortified foods before the study.

Dietary Assessment Methods

Dietary assessment methods are very important in nutrition research. Since early years in this century, researchers tried to develop tools that could be used to evaluate the food intake of individuals.

24-Hour Recalls

In 1938, based on the research work of Burke and Stuart, the 24-hour recall started the long journey as an essential tool for nutrition assessment. Since then, 24-hour recalls have been used in large national surveys and for research purposes (Witschi, 1990). Usually the interviewers are well trained to generate appropriate information about specific features of the food consumed (Thompson & Byers, 1994).

Different strategies have been developed to enhance the data obtained from 24-hour recalls. One strategy is to announce the visit to the person in advance so the individual can be aware of the types and specific amounts of foods eaten. A list of foods can be presented to help the person remember if those foods were eaten during the previous day (Wright et al., 1993). Encoding and retrieval strategies have been used to enhance memory to recall foods that were eaten in the past (Ervin & Smiciklas-Wright, 1998).

The multiple pass strategy for the 24-hour recall was used in NHANES III and the 1994-1996 CFSII. It refers to an elaborate triple round of questions about the food consumed during the day. First, the person tells the foods and drinks consumed during the day. In the second pass, the interviewer verifies all the foods and drinks with their specific serving size and usually forgotten foods (snacks, candies, cookies). In the third pass, the interviewer asks details about the foods (name brands, specific amounts, if anything is added to specific foods such as sugar on cereal or coffee, milk on cereal, cream in coffee, butter on bread or vegetables) and review all the 24-hour recall (Smiciklas-Wright & Mitchell., 1998).

Johnson et al. (1996) conducted a study to determine the accuracy of the multiple-pass 24-hour recall for estimating energy intake in children compared with the doubly labeled water method. Data from 24 children were used to evaluate the method. Three non-consecutive 24-hour recalls were collected during a 14-day period. There was no statistical difference between the two methods in estimates of energy intake (p = .65). However, in another study conducted by Johnson et al. (1998) in low-income women, a significant difference was found between the energy intake estimated by the multiple pass 24-hour recall and the doubly labeled water method. Underreporting of food intake may have been related to the low literacy and high body fatness of the respondents.

Fanelli and Stevenhagen (1986) compared 24-hour recalls and 1-day food records to assess energy and nutrient intake in older adults. They found no significant differences in energy and nutrient intake estimated by those two methods.

Liu et al. (1992) conducted a study to assess the relationship between a food frequency questionnaire, 24-hour recalls and biochemical measures of nutritional status. They conducted a food frequency questionnaire to evaluate nutrient intake during the past year. Twenty four-hour recalls were collected four times. Blood samples were collected at each visit and analyzed for different nutrients. A correlation between folate as determined by the 24-hour recall and by the food frequency questionnaire was 0.22.

When adjusted by calorie intake the correlation between the two methods for folate decreased (r = 0.20).

Twenty four-hour recalls have advantages and disadvantages. They are easy, cheap, can be used in large populations, do not require of the respondent to be literate, and they are less likely to cause diet modification because food intake information is collected after food is consumed (Thompson & Byers, 1994; Gibson, 1990). However, some disadvantages are related to the use of memory to recall the foods eaten, and difficulty in estimating an individual's usual intake because of the variability of the diet from day to day (Thompson & Byers, 1994).

Food Frequency Questionnaire

During the 1950s, the food frequency questionnaire was developed as a cheap method to evaluate food intake for periods longer than one day (Willet, 1990). A food frequency questionnaire is composed of a list of food items, an indication of frequency of consumption, and in some cases, specific serving sizes. Usually, specific features of the food items such as method of preparation are not required (Thompson & Byers, 1994). One of the advantages of the food frequency questionnaire tool data is that it quickly estimates the usual dietary intake of individuals during a specific period of time (Gibson, 1990; Thompson & Byers, 1994). In addition, this method is inexpensive because it can be used in large population studies, can be self-administrated, requires little time to be administrated, and is useful for epidemiological studies. Some disadvantages of this method include the difficulty to estimate portion size of foods when is not included in the questionnaire and the nutrient intake may be overestimated or underestimated depending on the number of foods included in the questionnaire (Thompson & Byers, 1994; Krebs-Smith, 1995). It is difficult for individuals to express which diet they follow or to estimate the amounts of foods that they consumed (Thompson & Byers, 1994).

The Health Habits and History Questionnaire (HHHQ) food frequency questionnaire was developed based on data from the NHANES II. Food items were selected based on their contribution to the total energy intake of the population that participated in the study. Portion sizes were determined based on the portions most frequently used by the population based on three-dimensional food models (Block et al., 1986).

Data from the Women's Health Trial (WHT) Feasibility Study was used to validate the HHHQ food frequency questionnaire compared with 4-day food records. Food records were collected during three times of the year from 277 women. Subjects who were assigned to two different diets (usual diet and low-fat diet) completed the 4-day food records and the food frequency questionnaire. Food records were collected during baseline, 6 months, and one year later. The food frequency questionnaire was collected one year later. The average correlation for nutrients between the usual diet and low fat diet group was r = 0.55. There was a slight increase in the average correlation when the data was adjusted for energy intake (r = 0.57) in the usual diet group, but no changes were found in the low fat group (Block et al., 1990a).

Based on the questionnaire develop by Block (Block et al., 1986), an abridged questionnaire was developed. This short questionnaire assessed macronutrients as well as micronutrients. When compared to three 4-day food records in women and two 7-day food records over a period of 10-15 years in a group of old men, they found underestimation for macronutrients, but a good estimation for micronutrients (Block et al., 1990b).

Block et al. (1992) conducted a study with 228 participants to validate and compare two food frequency questionnaires (University of Michigan food frequency questionnaire and HHHQ) with multiple dietary records collected during a 1-year period. After the completion of the diet record collection, both FFQs were administered to the sample population. A total of 16 days of dietary information were collected (four 24-hour recalls during the year and after each one, 3-day food records were collected) from 85 people. These two food frequency questionnaires were highly correlated for energy and most nutrients (r = 0.7 to 0.8). The HHHQ with specific portion sizes (small, medium and large) had better correlation with energy intake (r = 0.57) when compared to the food records than the University of Michigan questionnaire (r = 0.48) (Block et al, 1992).

Eck et al. (1991) developed a short-term food frequency questionnaire (7 days) based on the Willet's food frequency questionnaire. The questionnaire was compared to three 24-hour recalls. Correlations between the mean nutrient estimates from the 24-hour recalls and the food frequency questionnaire for different nutrients ranged from 0.43 to 0.88 with an average of 0.74 (Eck et al., 1991).

Food Records

Food records are called the "gold standard" of the dietary collection methods because the data is usually more accurate than the other methods (Thompson & Byers, 1994). However, food records are more time consuming for the subject. The individual must write down all the food and drinks consumed with specific portion sizes, for a specific number of days (Lee & Nieman, 1996). In addition, features of the food consumed and mode of preparation must be included, such as kind of cooking method (fried, steam or baked), as well as brand names of the foods. Sometimes subjects are asked to measure or weigh food and beverages (Gibson, 1990). Food records should be collected during periods not longer than 7 days. Food records of longer periods of time are inadequate because the individual can get exhausted with the process and this can produce incorrect data (Lee & Nieman, 1996; Thompson & Byers, 1994).

Food Patterns

The study of food patterns in populations has been the subject of study because of the close relationship between society and culture (Linton, 1936). At the beginning of this century, anthropologists developed theories about the interrelationships between society and culture (Linton, 1936), and how changes in culture can affect diet patterns in the population (Jerome, 1980). Linton (1936) explained that culture and society are dependent on each other. Food patterns are the food habits of a group of people seen as a part of the social structure of the population based on their customs. Food patterns are developed in the population based on their parents' influence, availability of foods, nutrition knowledge, and culture (Guthe & Mead, 1945). In each culture, social status influences the way that people eat. It is believed that different social classes have different food patterns. Foods eaten by individuals in the high social class are different than the ones eaten by the middle and low social classes. Some foods are categorized as symbols of wealth (Guthe & Mead, 1945).

Linton (1936) classified the elements of culture as Universals, Specialties and Alternatives. Universals are the elements of the culture that are common to almost all individuals and form the stable core. Specialties are the elements that are shared by some specific members of that culture but not by all people. Alternatives are the elements of the culture that are present in few individuals and are not common to the rest of the population. Besides these classifications another category can be added: Individual Peculiarities. This classification includes individual preferences that are exclusive to an individual. However, these peculiarities are not considered to be part of the culture (Linton, 1936).

Food patterns have been affected by taboos about different events in the life span when specific foods must be eaten. For example, some foods are classified as only for babies, or women. Culturally, foods have been classified in different ways such as edible and non-edible, heavy and light, essential and luxury, primary and secondary, old and new and, farm and store. Other foods are categorized as "ceremonial", and are reserved only for specific events such as Christmas, Lent, or Thanksgiving (Guthe & Mead, 1945).

Food patterns depend on influences such as the kind of food people like, seasons of the year, when the people eat specific foods, and relation of the type of food with the mealtime. Seasonal variability is important because fresh foods are not available or are more expensive during periods of the year when these foods are not produced. However, increased production of frozen and preserved foods may compensate for the lack of fresh foods. Food patterns sometimes are maintained for specific meal times (Guthe & Mead, 1945).

Reaburn et al. (1979) studied the social determinants of food selection in a low-income sample of 112 women. Demographic information and a 52-item food frequency were recorded. The food frequency questionnaire measured intake using a 5-point scale of consumption of foods. The scale was from 1 (never use) to 5 (daily use). The following formula was used to determine a score for each food item (Reaburn, 1979).

$$\text{Score} = \frac{R1S1 + R2S2 + \ldots RnSn}{n}$$

where:

R1...Rn = % of respondents selecting a rating.

S1...Sn = scale ratings

n = maximum scale rating.

Based on the resulting scores, high use foods (core foods) were identified as having scores between 100 to 74.70; medium use foods (secondary core) were between 74.69 to 49.41; and low use foods (peripheral foods) were between 49.40 and 24.12 (Reaburn, 1979). Reaburn et al. (1979) found that core foods were milk, bread, cheese, coffee, orange juice, and margarine. Lettuce, sodas, cold cereal, and ice cream formed the secondary core. Peripheral foods included soyburger, granola, broccoli, nuts, and porridge.

Fanelli and Stevenhagen (1985) evaluated the uses and limitations of two methods of measuring food patterns. A variety index was represented by the total number of foods consumed in a specific period of time. Core foods were the most frequently consumed foods for the population. Non-institutionalized older adults (>54 years old) from the 1977-1978 Nationwide Food Consumption Survey were selected for the study. Subjects were divided into three groups by age to determine differences in core foods. Frequency of consumption and the Reaburn et al. (1979) formula were used to determine core foods. They found that identification of core foods could be influenced by the method used to determine core foods, season of the year, and cultural habits of the population in the study.

Based on the classification of the components of culture made by Linton (1936). Bennett et al. (1942) evaluated food patterns in the cultures present in a specific community. It was explained that core foods were those foods considered as basic or necessary to survive. If other types of foods were used but as a complement of the core or traditional foods, those foods were called secondary core. Peripheral foods were those foods used occasionally and depended on the individual's food choices. However, the food choices were influenced by the degree of urbanization of the community and the economic situation of the family. Those two factors influenced which foods they could afford to maintain in their core foods. The secondary core and peripheral foods were the ones that varied depending on the availability and the opportunity to buy specific types of foods (Bennett et al., 1942; Passin & Bennett, 1943).

Jerome (1980) studied the dietary patterns of black people in the Milwaukee area. He observed the food patterns that people had for each meal during the week and the variations during weekends. In that way Jerome established which types of food were the main components of the core, secondary core, and peripheral foods in that population. Meal patterns varied depending on the time of the year and the availability of some types of food. Incorporation of new types of foods into the meal pattern was possible because of the increased availability of commercially prepared foods that can be kept for a longer time.

Jerome (1976) also conducted a study in the Kansas City area. He found that food patterns varied depending on the evolution of the society. As the food supply increased, the food patterns of the population changed based on a cyclic process. Consumption of foods in that population was based on specific foods they needed (core foods), foods they liked (secondary core), and new foods they would like to try (peripheral foods). Jerome found that the availability of new foods in the market allowed people to try new foods, and if they liked the new food they would incorporate the new food into their food core or secondary core. In this study Jerome introduced the frequency of consumption of foods as an element to determine which foods were included in the core, secondary core, and periphery.

In another study, Jerome (1975) selected two black populations of an urban area to evaluate acceptability of foods. Texture and flavor were the main factors that affected food preferences in Afro-Americans of the southern region; that implies that specific foods and methods of preparation influenced their food consumption. Jerome found that methods of preparation (boiling and frying) and texture of the foods were very important in the food pattern of this population. On the other hand, the pungency and color were the main factors that affected the food preferences in West Indian-Americans. For West Indian-Americans the methods of preparation were the main factor that influenced their food choices. Based on the food texture, the foods were categorized as heavy, coarse, light or rich. Legumes and meats were categorized as heavy, and formed the main foods or core. Heavy foods produced more energy and kept health. Light foods were eaten as snack, breakfast, lunch, or during convalescence periods. Staple foods or heavy foods were classified as core; foods that were added or substituted from the core were classified as secondary core; and foods that were eaten sporadically were classified as peripheral foods (Jerome, 1975; Guthe & Mead, 1945).

Different populations groups (native Indians, Europeans, Africans, and Orientals) have influenced food patterns in the Caribbean islands. Grain products and starchy vegetables were the main foods in the core, flavored with herbs and spices. Vegetables rarely were served raw. Fruits were eaten at any time during the day (Jerome, 1975).

Koehler et al. (1989) used the core, secondary core, and peripheral food classification to compare food patterns of three different ethnic groups. A population sample of 160 children from 9 to 16 years old was used (42 Hispanics, 68 Navajo Indians, and 50 Jemez Indians). A 77-food item questionnaire with the common foods eaten by these populations was used to determine the core, secondary core and peripheral foods. Core foods were determined on a frequency of consumption of 3 times a week to 3 times a day. Secondary core included foods eaten from 2 times a week to 1 time a month. A peripheral food included foods eaten less than once a month. They found that whole milk, eggs, five grain products or starchy vegetables, four fruits, and three sweets or snacks constituted core foods. It is noteworthy that fat added to foods was a core food for some ethnic groups; most of the core foods were fried and 45% of the core foods were sweets and snacks.

Caster (1980) studied the core foods of a group of low-income women in Georgia. Caster found that 24% of the foods formed the core and provided most of the energy. The core foods were snack foods, cereal, milk, meats, fruit, and beverages. The secondary core was formed by 33% of the foods and provided 27% of the energy but it was influenced by the differences in cultural patterns between the white and black women.

For example, black women consumed more ham, roast beef, and organ meats than white women. The rest of the foods were not a significant source of energy (Caster, 1980).

Summary

Folate status in women is important because of the relationship between folate intake and development of neural tube defects in the fetus. Women do not consume enough folate to prevent neural tube defects in the newborn. In the present study dietary assessment tools were used to assess folate intake and determine the relationship among the dietary assessment tools. Food patterns influence the types of foods that women eat. Core and secondary core foods that provide folate in the diet were assessed to determine the possible substitution or addition of folate rich foods into the diet of women from Oklahoma. Determining the main providers of folate would help to develop strategies to enhance folate intake of women.

CHAPTER III

METHODS

Research Design

This study was designed as a correlational and descriptive study.

Sample

Prior to the selection of the sample, the study received the approval of the Institutional Review Board of Oklahoma State University for studies involving human subjects (see Appendix A). A convenience sample of 75 women of childbearing age (18 to 44 years old) was selected. The sample was obtained by advertising the study in newspapers and flyers (see Appendix B) distributed in the community. The flyers explained how to participate in the study and the inclusion criteria for the participants. Women participating in the study could not have any chronic disease or be dieting for weight loss. Some women were recruited in person at a soup kitchen, community shelter for homeless people, and Payne County Health Department. Funding for this project was provided by the Oklahoma Center for the Advancement of Science and Technology.

Materials and Methods

Focus groups interviews were held in the Human Environmental Sciences building, at the soup kitchen, and homeless shelter. Focus group size varied from 4 to 11 participants. A moderator and an assistant moderator conducted focus groups. A doctoral student or a masters student conducted individual interviews in the Payne County Health

Department. A set of questions was used to determine preferences and perceptions about foods that are good sources of folate. Before beginning the interviews each participant signed a consent form (see Appendix C).

After each focus group or individual interview, a multiple-pass 24-hour recall was conducted by a trained interviewers(a doctoral student, two masters students, and two principal investigators). Instructions for a 3-day food record were given to the subjects. Each subject completed a self-reported food frequency questionnaire.

Each participant received $10 when they completed an interview, filled out the food frequency questionnaire (see Appendix D) and completed the multiple-pass 24-hour recall (see Appendix E), and $15 when they returned the complete 3-day food record (see Appendix F).

A pilot study was conducted before data collection started to determine if the instructions to complete the dietary assessment tools were clear to the participants and to train the interviewers in gathering the data.

Dietary Assessment Tools

Food Frequency Questionnaire

The 100-item semi-quantitative food frequency questionnaire from the Health Habits and History Questionnaire (HHHQ) was used to determine the usual folate intake during the past year (Block, 1990a). This self-administered tool requests specific serving sizes and the frequency that the foods were eaten. The DIETSYS Program was used to analyze the food frequency questionnaire information (National Cancer Institute, HHHQ

DIETSYS Analysis Software, Version 3.0, 1993). The nutrient intake was calculated by multiplying the nutrient composition of the foods by the frequency of consumption.

Because folate fortification has been implemented since the DIETSYS program was revised in 1992, the folate content of grain products in the DIETSYS was updated. The updated folate content of the food categories was calculated based on the latest USDA nutrient database values (USDA Nutrient Database for Standard Reference, 1999) and weighted to reflect the frequency of consumption of each food in the category by women of childbearing age (USDA, 1998). The number of times each food was consumed was multiplied by the folate content in 100g of the food. Then, this value was divided by the total number of times any food in this HHHQ food category was consumed. The following formula was used for each HHHQ category of foods:

$$\sum \frac{(FEF * TFC)}{(ToT)}$$

where:

$FEF = \mu g\ folate\ in\ each\ food$

$TFC = number\ of\ times\ the\ food\ was\ consumed$

$ToT = total\ number\ of\ times\ women\ consumed\ all\ foods\ in\ the\ HHHQ\ food\ category$

For example: if women ate white rice 150 times, and women ate brown rice 8 times, and the amount of folate was 58 μg/100g white rice and 4 μg/100g brown rice, this was the calculation for the new folate value for the rice category:

Food	# times the food was consumed	Folate (µg/100 g)	# times * folate
White rice	150	58	8700
Brown rice	8	4	32
Total	158		8732

$$\sum \frac{(FEF * TFC)}{(ToT)} = \frac{8732}{158} = 55\mu g\ folate$$

After all calculations were completed for the grain foods affected by the folate fortification, the new folate content was used to analyze the HHHQ food frequency questionnaire.

Based on the average frequency of consumption of food groups from the food frequency questionnaire, the core, secondary core, and peripheral foods were determined (Koehler et al., 1989). Core foods were determined to be the foods consumed three to four times per week, five to six times per week, once a day, or two or more times per day. Secondary core foods were determined to be the foods consumed two to three times per month, once a week, or twice a week. Peripheral foods were determined to be the foods consumed once a month, or less than once a month.

Serving sizes on the HHHQ that were different than the pyramid serving sizes were transformed to food pyramid serving sizes (USDA, 1999). First, the servings were multiplied by the specified portion size in the HHHQ (small = 0.5, medium = 1; large = 1.5 serving). For example, a medium serving for applesauce is ½ cup, so if the respondent selected a small serving size, this means that the respondent ate ¼ cup of applesauce. These adjusted portion sizes were then multiplied by the appropriate factor to convert it to a pyramid serving. For example, a medium serving size of bread in the HHHQ is 2 slices of bread and a pyramid serving of white bread is 1 slice. Therefore, HHHQ medium serving of white bread represents two pyramid servings.

Based on the HHHQ manual, daily frequency was calculated (National Cancer Institute, HHHQ DIETSYS Analysis Software, Version 3.0, 1993). Daily frequency of consumption was calculated by multiplying the specific factor based on time units by the frequency of consumption shown in the food frequency questionnaire. For example, the factor for frequency of intake for a food consumed once a month is 0.0333. This factor was multiplied by the number of pyramid servings for each food for person.

The total list of foods was sorted by the mean of the pyramid serving consumption times the frequency of consumption. Cutoff points based on Koehler et al. (1989) were determined as follows: core foods were from values of 0.37 and above (more than 1 serving every 3 days); secondary core foods were from values 0.36 to 0.06 (between 2 servings a month and one serving every 3 days); and peripheral foods were values 0.05 and lower (1 or fewer servings per month). Those values explain the amount of a specific food that was consumed per day (National Cancer Institute, HHHQ DIETSYS Analysis Software, Version 3.0, 1993).

24-hour Recall

A multiple-pass 24-hour recall was used to obtain information about the foods consumed and to train subjects to keep the food record (Wright et al., 1993). Three passes were used to obtain accurate information about the food intake and a list of easy forgotten foods was reviewed. During the first pass, the interviewer asked the subject to recall the foods that were consumed during the previous 24 hours. During the second pass, a list of easy forgotten foods was reviewed with the subject to remind her of some foods such as soft drinks, cookies, coffee, tea, ice cream, and alcoholic beverages. In the third pass, a review of all meals and snacks was conducted, each meal was reviewed, and specific amounts were determined as well as modes of preparation, features of the food, and brand names. Bidimensional (pictures) and three-dimensional (dried beans in nylon mesh) food models were used to estimate serving sizes. In addition, spoon and cup measures were used to enhance the quality of the information.

Food Records

Three-day food records were also used to measure nutrient intake. The subjects were trained with food models to estimate the portion size of the foods to keep the food record. Measuring cups and spoons were used to assist with estimating the amount of food consumed. Instructions and a list of easily forgotten foods were given to the subjects. Participants kept the food records during three consecutive days.

Data Analysis

Analyses of the 24-hour recall and food record data were determined using the Food Processor Program version 7.2 (ESHA Researh,1999). This program provides information about energy, macronutrients and micronutrients. Generic products (usually a USDA food) were used to analyze the foods consumed to avoid missing nutrients because most of the brand name products in the database did not provide information on folate.

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) 9.0 for windows (SPSS, 1999). Folate data was log transformed because the data were skewed.

The following hypotheses were analyzed:

1. The folate intake in women in Oklahoma will be lower than the EAR and the RDA for the appropriate age.

Statistical procedure: one-sample *t* tests were used to analyze the data.

2. There will be a significant rank order correlation between the amount of folate reported by the food frequency questionnaire and the food records.

Statistical procedure: Spearman correlations were used to analyze the data.

3. There will be a significant rank order correlation between the amount of folate reported by the food frequency questionnaire and the 24-hour recall.

Statistical procedure: Spearman correlations were used to analyze the data.

4. There will be a significant rank order correlation between the amount of folate reported by the food records and the 24-hour recall.

Statistical procedure: Spearman correlations were used to analyze the data.

5. There will be a significant relationship among folate estimated by food record and food frequency questionnaire, and 24-hour recall.

Statistical procedure: Regression analysis was used to analyze the data with the food record as the dependent variable.

6. Folate content in core foods will be lower than EAR and the RDA.

Statistical procedure: one-sample *t* tests were used to analyze the data.

7. Folate content in secondary core will be lower than the EAR and RDA.

Statistical procedure: one-sample *t* tests were used to analyze the data.

8. Folate provided by good sources of folate will be lower than the EAR and RDA.

Statistical procedure: one-sample *t* tests were used to analyze the data.

9. Intake of folate from fortified foods will be lower than 400 μg of folate.

Statistical procedure: A one-sample *t* test was used to analyze the data.

Table 4.4. Mean and standard deviation of folate intake by dietary assessment tool.

	Median	Mean	Percent of RDA	Standard deviation	Standard Error of Mean
Folate FFQ	358	442 [a]	111	247	29
Folate 24 HR	299	346 [b]	87	233	28
Folate FR	313	334 [b]	84	160	19

N=72

[a] significantly higher than 320 μg using one sample *t* test.

[b] significantly lower than 400 μg using one sample *t* test

Mean folate intake as estimated by the food frequency questionnaire was significantly higher than the EAR (320 μg), but not significantly higher than the RDA (400 μg) using one sample *t*-test. The mean folate intake estimated by the food record and the 24-hour recall were significantly lower than the RDA (400 μg) using one sample *t*-tests.

The relation among folate intake as estimated by the food record, 24-hour recall and the food frequency questionnaire were assessed by Spearman correlations using a logarithm transformation of the estimated folate because the data were skewed. Table 4.5 shows the correlation between dietary assessment methods. There was a significant positive rank order correlation ($r = 0.352$, $p = 0.002$) between the folate estimated by food record and the food frequency questionnaire (see Figure 1). The correlation was higher when estimated folate intakes were adjusted for energy intake ($r = 0.547$, $p < .001$).

Table 4.5. Spearman correlations among dietary assessment tools.

	Lg Folate FFQ	**Lg Folate 24-hour Recall**	**Lg Folate Food Record**	**Lg Folate Density of 24-hour Recall**	**Lg Folate Density of Food Record**
Lg Folate 24-hour Recall	0.254*				
Lg Folate Food Record	0.352**	0.323**			
Lg Folate Density of 24-hour Recall	0.335**	0.727**	0.324**		
Lg Folate Density of Food Record	0.306**	0.197	0.708**	0.329**	
Lg Folate density of FFQ	0.497**	0.193	0.435**	0.316**	0.547**

* $p < .05$
** $p < .01$
Lg: Logarithm

There was a significant positive rank order correlation ($r = 0.254$, $p = 0.031$) between the folate estimated by the food frequency questionnaire and the 24-hour recall. The correlation increased ($r = 0.316$, $p = 0.007$) after estimated folate intake was adjusted for energy intake.

There was a significant positive rank order correlation ($r = 0.323$, $p = 0.006$) between the folate estimated by the food record and the 24-hour recall (see Figure 2). After estimated folate intake was adjusted for energy, the correlation increased only slightly ($r = 0.329$, $p = 0.005$).

Regression analysis was conducted using estimated folate intake from the food record as dependent variable. and estimated folate intake in the food frequency questionnaire and 24-hour recall as independent variables. Based on the bivariate correlation it was found that the folate estimated by both methods would be associated with the estimate folate intake in the food record (R = 0.444, p = 0.001). However, the 24-hour recall (β = 0.395, t = 3.524) more accurately predicted the folate intake in the food record than the food frequency questionnaire (β = 0.123, t = 1.101). Twenty percent of the variability was shared by the two independent variables. Figures 1 and 2 show the relationship between the dependent variable and the independent variables.

Core, secondary core and peripheral foods based on the food frequency questionnaire are listed on Tables 4.6, 4.7 and 4.8. Mean estimated folate intake in the core foods was 129 ± 94 μg (See Table 4.9). Mean folate intake in the secondary core was 358 ± 240 μg. Mean estimated folate intake in peripheral foods was 11 ± 18 μg.

Mean estimated folate in the core foods (t_{EAR} = -17.140; $p < 0.001$; t_{RDA} = -24.328; $p < 0.001$) and peripheral foods (t_{EAR} = -147.23; $p < 0.001$; t_{RDA} = -185.394; $p < 0.001$) were significantly lower than the EAR (320 μg) and RDA (400 μg) for folate using one sample t-tests. The mean folate intake estimated in secondary core foods was not significantly different from the EAR or RDA for folate (t_{EAR} = 1.342; p = 0.184; t_{RDA} = - 1.481; p = 0.143).

Good sources of folate are listed in Table 4.10. Mean estimated folate intake from good dietary sources of folate (397 ± 250 μg) was significantly higher than the EAR (t = 2.616; p = 0.011), but not the RDA (t = -0.096; p = 0.924). White bread and highly fortified cereals provided about 24 % of the folate. Orange juice provided 9 % of folate. Good sources of folate such as liver, mustard greens and spinach provided from 1 to 3 % of the folate because of their low consumption.

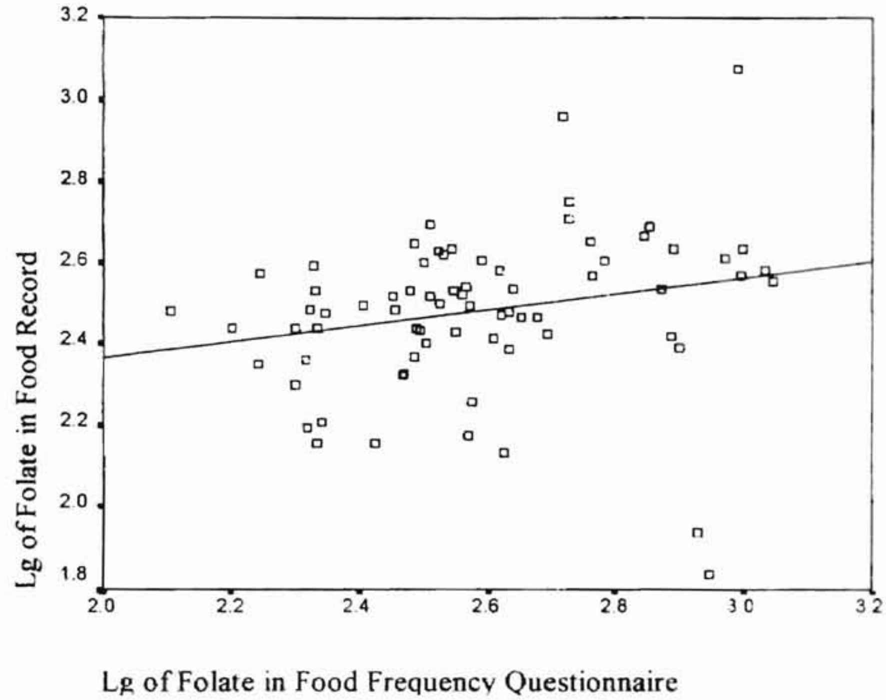

Figure 1. Relation between folate in food record and folate in food frequency questionnaire ($r = 0.352$; $p = 0.002$).

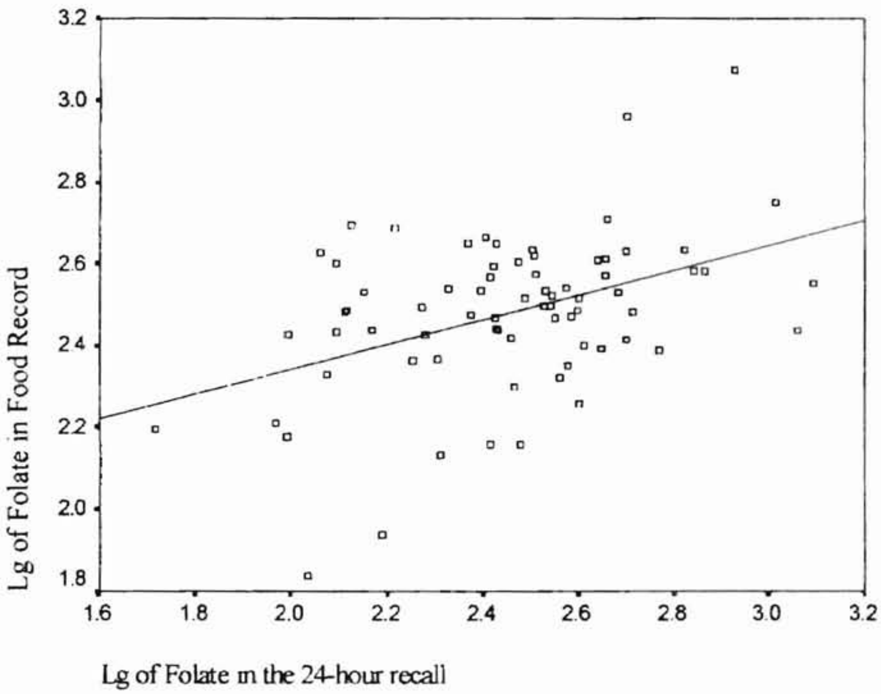

Figure 2. Relation between folate in food record and folate in 24-hour recall ($r = 0.323$; $p = 0.006$).

Table 4.6. Core foods calculated by daily frequency of intake and estimated pyramid serving.

Rank	Food	Mean[1]	Standard Deviation
1	Water	1.98	1.82
2	White bread	1.21	1.49
3	Dark bread	0.73	1.22
4	Coffee	0.65	1.16
5	Regular salad dressing	0.61	0.57
6	Soft drinks	0.49	0.62
7	Butter, margarine	0.46	0.52
8	Orange juice	0.43	0.64
9	Other cheeses and cheese spreads	0.41	0.47
10	Milk on cereal	0.41	0.56
11	Tea	0.41	0.66
12	Potatoes	0.36	0.43

[1] Mean values represent how often each food was consumed during a single day based on pyramid servings.

Table 4.7. Secondary core foods calculated by daily frequency of intake and estimated pyramid serving.

Rank	Food	Mean[1]	Standard Deviation
13	Tomatoes	0.35	0.46
14	Green salad	0.34	0.40
15	Margarine on bread	0.32	0.41
16	Chocolate candy	0.32	0.42
17	Chicken or turkey	0.30	0.39
18	Salty snacks	0.29	0.30
19	Cookie	0.29	0.45
20	High fiber cereal	0.29	0.43
21	Banana	0.29	0.46
22	Hamburger	0.27	0.26
23	Carrot	0.27	0.33
24	Salsa	0.27	0.39
25	Broccoli	0.26	0.41
26	Green beans, string beans	0.26	0.39
27	Biscuits	0.24	0.38
28	Rice	0.24	0.34
29	Candy	0.23	0.34
30	Cream	0.23	0.60
31	Eggs	0.23	0.45
32	Pasta	0.23	0.27
33	Corn	0.22	0.25
34	Beef	0.21	0.31
35	Peanuts	0.21	0.45
36	Fruit drink	0.21	0.53
37	French fries	0.20	0.21
38	Other vegetable	0.20	0.35
39	Cold cereal	0.19	0.28

Table 4.7. Secondary core foods calculated by daily frequency of intake and estimated pyramid serving (cont.).

Rank	Food	Mean[1]	Standard Deviation
40	Other fruit (berries, grapes, fruit cocktail)	0.19	0.39
41	Ham, bologna	0.18	0.28
42	Apple	0.18	0.21
43	Skim milk	0.18	0.28
44	Butter on bread	0.18	0.35
45	Mixed dishes with cheese	0.18	0.22
46	Strawberries	0.17	0.37
47	Tuna	0.17	0.39
48	Watermelon	0.16	0.39
49	Milk 2 %	0.16	0.39
50	Other beans (baked beans, pintos, kidney)	0.16	0.40
51	Yogurt	0.15	0.39
52	Bacon	0.14	0.35
53	Other soups	0.13	0.22
54	Cottage cheese	0.13	0.31
55	Orange	0.13	0.37
56	Sugar in coffee	0.12	0.29
57	Vegetable soup	0.12	0.22
58	Sausage	0.12	0.36
59	Pizza	0.12	0.09
60	Pork	0.12	0.39
61	Highly fortified cereal	0.10	0.25
62	Cantaloupe season	0.10	0.18
63	Cornbread	0.10	0.15
64	Peas	0.09	0.12
65	Gravies	0.09	0.12

Table 4.7. Secondary core foods calculated by daily frequency of intake and estimated pyramid serving (cont.).

Rank	Food	Mean[1]	Standard Deviation
66	Sugar in cereal	0.08	0.22
67	Beef stew	0.08	0.17
68	Milk in coffee	0.07	0.24
69	Fried chicken	0.07	0.14
70	Fish	0.07	0.35
71	Cooked cereal	0.07	0.13
72	Cabbage	0.06	0.14
73	Peaches	0.06	0.07
74	Cream real, half and half	0.06	0.29
75	Cauliflower	0.06	0.12
76	Liver	0.06	0.36
77	Cooked spinach	0.06	0.15
78	Hot dog	0.06	0.11
79	Lemon in tea	0.06	0.15
80	Beer	0.06	0.12

[1] Mean values represent how often each food was consumed during a single day based on pyramid servings.

Mean estimated folic acid intake from fortified foods (271 ± 181 μg) was significantly lower (t = -6.044; p < .000) than the 400 μg recommended to decrease the incidence of neural tube defects (Food and Nutrition Board, 1998). White breads and highly fortified cereals provided 20 % and 14 % respectively of the folate from fortified foods. Rice, mixed dishes, pasta, and dark bread provided approximately 40% of the folate from fortified foods in this sample. Other fortified foods provided less than 10 % of folate.

Table 4.8. Peripheral foods calculated by daily frequency of intake and estimated pyramid serving.

Rank	Food	Mean[1]	Standard Deviation
81	Chili with beans	0.04	0.05
82	Raw spinach	0.04	0.16
83	Whole milk	0.04	0.13
84	Sweet potatoes	0.04	0.14
85	Other fish (broiled or baked)	0.04	0.06
86	Ice cream	0.03	0.05
87	Wine	0.03	0.07
88	Winter squash	0.03	0.08
89	Shellfish	0.03	0.04
90	Grapefruit	0.02	0.08
91	Other pies	0.02	0.04
92	Mustard greens	0.02	0.13
93	Liquor	0.02	0.06
94	Cantaloupe year	0.01	0.04
95	Pumpkin pie	0.01	0.04
96	Liverwurst	0.01	0.03
97	Oyster	0.00	0.01

[1] Mean values represent how often each food was consumed during a single day based on pyramid servings.

Table 4.9. Amount of folate (μg) provided by the core, secondary core and peripheral foods.

	Mean	Standard Deviation
Core foods	129[a, b]	94
Secondary core foods	358	240
Peripheral foods	11[a, b]	18

[a] Significantly different than 320 μg using one sample *t* test.
[b] Significantly different than 400 μg using one sample *t* test.

Table 4.10. Amount of folate (μg) and percent of folate provided by good sources of folate

Foods	Mean folate	Standard Deviation	Percent of folate[1]
White bread, rolls	55	68	14
Highly fortified cereal (Total, Product 19)	39	92	10
Orange juice	35	52	9
Rice	29	40	7
Mixed dishes with cheese (macaroni)	26	33	7
Spaghetti, lasagna, other pasta with tomato sauce	25	30	6
Dark bread (wheat, rye)	24	40	6
Other beans, pinto beans, kidney beans, limas, lentils	18	47	5
Other cold cereals	17	26	4
Broccoli	15	24	4
High fiber, bran or granola cereals	15	22	4
Green salad	15	17	4
Biscuits, muffins, pancakes, waffles	13	20	3
Liver	11	67	3
Corn	8	10	2
Cooked cereals	8	14	2
Cookies, doughnuts	8	12	2
Corn bread, corn muffins, corn tortillas	7	11	2
Pizza	7	5	2
Cooked spinach	6	16	2
Oranges	4	11	1
Peas	4	4	1
Raw spinach	3	14	1
Peanuts, peanut butter	3	6	1
Cauliflower, brussels sprouts	3	6	1
Mustard greens, collards, turnip greens	1	5	0
Grapefruit	1	1	0

[1] Percent of the total amount of folate provided by good sources of folate

Table 4.11. Estimated amount of folate (μg) and percent of folate provided by fortified foods.

Food	Mean folate	Standard Deviation	Percent of folate[1]
White bread, rolls	55	68	20
Highly fortified cereal (Total®, Product 19®)	39	92	14
Rice	29	40	11
Mixed dishes with cheese (macaroni)	26	33	10
Spaghetti, lasagna, other pasta with tomato sauce	25	30	9
Dark bread	24	40	9
Other cold cereals (corn flakes, rice krispies)	17	26	6
High fiber, bran or granola cereals	15	22	6
Biscuits, muffins, pancakes, waffles	13	20	5
Cooked cereals	8	14	3
Cookies, doughnuts	8	12	3
Corn bread, corn muffins, corn tortillas	7	11	3
Pizza	7	5	3

[1] Percent of the total amount of folate provided by fortified foods.

CHAPTER V

DISCUSSION

Despite the recent fortification of grain products many women in this study were not consuming enough folate to prevent neural tube defects according to the Food and Nutrition Board guidelines (1998). Estimates of folate intake in women varied depending on the tool used. Estimates of folate intake by the food record and 24-hour recall tools were 87% and 84% of the recommended amounts of 400 μg/day of folic acid (Food and Nutrition Board, 1998). However, the food frequency questionnaire estimated folate intake as 110% of the recommended values, showing an overestimation relative to the other two tools. According to Krebs-Smith et al. (1995) food frequency questionnaires tend to overestimate nutrient intake.

Estimates of folate intake in this study varied between 442 μg of folate in the food frequency questionnaire, 346 μg of folate in the 24-hour recall and 334 μg of folate in the food record. These values are approximately 100 to 130 μg greater than previous studies based on data from the US population (Subar et al. 1989; Subar et al., 1990; Gates & Holmes, 1999). This increase in the estimated amount of folate intake could be caused by the implementation of folic acid fortification of grain products as shown in the study conducted by Jacques et al. (1999). After folic acid fortification was implemented in January 1998, it was expected to increase folic acid intake by about 100 μg/day (US Department of Health and Human Services, 1996).

Analysis of correlations between folate estimated by different diet assessment methods is limited. Most of the studies comparing diet assessment methods did not specify correlations between folate estimates by the different methods (Fanelli and Stevenhagen, 1986; Block et al., 1986; Block et al., 1990a; Block et al., 1990b; Eck et al., 1991; Block et al., 1992; Rothenberg, 1994; Eck et al.,1996).

In this study correlations between estimates of folate intake by the food record and the food frequency questionnaire were statistically significant for the raw estimates of folate intake and estimates of folate adjusted for energy intake. These results are similar to the findings of Bonifacj et al. (1997). The correlation between the food record and food frequency questionnaire in our study was statistically significant ($r = 0.352$), and it was similar to the correlation found by Bonifacj et al. (1997) ($r = 0.33$). The correlation with adjusted folate intake in the present study ($r = 0.547$) was similar to the folate intake found by Bonifacj et al. (1997) ($r = 0.58$).

The correlation between the folate estimated by 24-hour recall and food frequency questionnaire in our study ($r = 0.254$) was similar to the correlation reported by Liu et al. (1992) ($r = 0.22$). When estimates of folate intake were adjusted by energy intake, the correlation in the present study was higher ($r = 0.335$) than the correlation found by Liu et al. (1992) ($r = 0.20$). In this study the correlation between the food frequency questionnaire and the food records ($r = 0.352$) was slightly higher than the correlation between 24-hour recall and food records ($r = 0.323$).

Correlations of nutrient intake between the assessment tools vary depending on the nutrients studied. Block et al. (1990a) found that the average correlation for different nutrients was 0.55 when the HHHQ food frequency questionnaire was compared to 4-day food records. When adjusted by energy intake, most correlations increased slightly ($r = 0.57$). Eck et al. (1996) found that the average correlation between a food frequency questionnaire and three days of 24-hour recalls was 0.61. But when correlations were adjusted by energy intake, they decreased slightly ($r = 0.59$) (Eck et al., 1996). Liu et al. (1992) found that correlations between a food frequency questionnaire and 24-hour recall varied from 0.39 to 0.22 for vitamins, and from 0.49 to 0.25 for macronutrients. However, when adjusted by energy intake, correlations between the two methods decreased (vitamins: $r = 0.31$ to 0.17; macronutrients: $r = 0.36$ to 0.11).

Regression results in the present study suggested that folate intake estimated by the food frequency questionnaire and the 24-hour recall were significant predictors of folate intake estimated by the food records of women of childbearing age in Oklahoma. However, the results of this study suggested that the 24-hour recall ($\beta = 0.395$) was a better predictor of folate intake estimated in the food record than the food frequency questionnaire ($\beta = 0.123$).

Core foods and peripheral foods did not provide the recommended amounts of folate intake (400 μg/day) or the EAR (320 μg/day) in women of childbearing age However, the folate provided by the secondary core foods was not significantly different from the EAR (320 μg/day) or the RDA (400 μg/day). Breads (white and dark) and orange juice were the only good sources of folate that were present in the core foods. Most good sources of folate were included in the secondary core. Raw spinach and mustard greens, very good sources of folate, were rarely consumed by this sample Increasing the amount of folate in the diet could be accomplished if women were willing to move good sources of folate from the secondary core to core foods.

Core foods and secondary core foods in our study were similar to the ones found by Reaburn et al. (1979). However, core food consumption was different in two studies that examined different population groups (Koehler et al., 1989; Jerome, 1975b).

Consumption of good sources of folate in the present study provided enough folate to meet the EAR but did not meet the recommended 400 μg/day. Grain products such as bread (white and dark), cereals (highly fortified and cold cereals), rice, mixed dishes with cheese (macaroni), spaghetti; orange juice; other beans such as pinto, kidney, lima and lentils; and broccoli were the good sources of folate consumed by this sample of women of childbearing age. Some of these foods were found to be good sources of folate in other studies (Gates and Holmes, 1999; Schaller and Olson, 1996; Tucker et al., 1996; Subar et al., 1989).

Orange juice is not an excellent source of folate because of its partial availability due to the presence of organic acids and anions that act as inhibitors to folate absorption (Wei et al., 1996). However, in several studies (Gates and Holmes, 1999; Schaller and Olson, 1996; Subar et al., 1989), orange juice constituted one of the main sources of folate in women's diets because of its high consumption. Russell (1999) found that women of childbearing age were willing to include orange juice in their diets because it is very convenient.

Many neural tube defects due to folate deficiency can be prevented by providing the appropriate amounts of folate in the diets of women of childbearing age. To prevent these birth defects, women should consume 400 μg of folic acid per day from fortified foods and/or supplements, in addition to the amounts provided by the diet (Food and Nutrition Board, 1998). Fortified grain products were very good sources of folic acid.

Breads, cereals, rice, pasta, and mixtures of grains constitute some of the most important grain products in the American diet. These fortified foods have been found in other studies to provide significant amounts of folate in the diet (Albertson and Marquart, 1999; Gates and Holmes, 1999; Schaller and Olson, 1996; Subar et al., 1989). Albertson and Marquart (1999) support the idea that fortified foods are better sources of folate than the natural folate sources because they are convenient and have a better taste. However, fortification of grain products will influence folate intake only in people who consume these products (Crane et al., 1995). Women who consume few grain products will probably have a low intake of folate. Because most of the good sources of folate contain significant amounts of carbohydrates, if women follow a high protein or high fat diet they will probably not be able to meet their folate needs without a supplement. Women's perception of grain products as fattening or promoting weight gain may limit consumption of these foods (Cypel and Prather, 1993; Russell, 1999).

Legumes are naturally good sources of folate. A ½ cup serving of legumes provides from 20 to 128 μg of folate (USDA Nutrient Database for Standard Reference, 1999). This population consumed legumes about 0.16 times per day. If women were willing to increase their consumption of legumes, it would produce an increase in folate intake. A half of a cup of black beans provides about 128 μg of folate, or more than 25% of the 400 μg/day required. Russell (1999) found that women were also willing to include beans in their diets to enhance folate intake.

Limitations

One of the main limitations of this study was the use of a convenience sample, which restricts the generalizability of the conclusions. Conducting the focus group interviews about folate intake before collecting the data could have modified dietary reports of the subjects. Although the subjects were trained to accurately record the foods eaten with specific portion size and description about the method of preparation, including brand names, dietary reports could be influenced by how accurately they could describe their diet, and the respondent's ability to keep records. Generalization of some items (for example, using a generic biscuit instead of a Pillsburry biscuit) was necessary when coding the foods for data entry due to missing folate values in the nutrient analysis program used to evaluate nutrient intake.

Conclusion

This study showed the relationship among three different dietary assessment tools that were used to estimate folate intake. Significant correlations were found between the assessment tools. The 24-hour recall was a better predictor of folate intake as estimated by the food record than the food frequency questionnaire. Mean estimates of folate intake for two of the three diet assessment tools did not meet the RDA for folate. Core foods did not provide enough folate in the diet of this sample. Orange juice and breads were the only good sources of folate included in the core foods. Most of the good sources of folate were included in the secondary core. Fortified foods provided significant amounts of folic acid in this study, but not enough to meet the amount recommended to prevent neural tube defects.

Implications

Most women of childbearing age are not consuming enough folate to decrease the incidence of neural tube defects. If health professionals and nutrition education providers understand the food preferences of these young women, more effective strategies for diet change could be suggested to introduce good folate sources into their diets. Based on the food patterning theory, it is easier to move foods from the secondary core to the core, than from the peripheral foods to the core (Jerome, 1976). Therefore, nutrition educators should suggest that women move foods that are good sources of folate in their secondary core to their core foods.

When trying to enhance folate intake in women of childbearing age, it is necessary to know which good sources of folate are consumed most often. Once we know the main providers of folate, more effective nutrition education for this population can be developed and implemented, giving them acceptable food choices to enhance their diet.

If women learn about the health benefits of folate intake, and know foods in their diet that are good folate sources, this may influence their ability to increase folate intake by introducing some of these foods into their core diet. Nutrition professionals should be encouraged to use this information on food patterns to develop nutrition education programs that enhance women's food choices for the prevention of neural tube defects.

Future Research

Once we determine the folate content of the foods and which methods can be used to best assess folate intake, other studies can be conducted to establish educational strategies to enhance folate intake in women of childbearing age in Oklahoma. Studies to determine food patterns in this population should be conducted with a larger sample size. Development of simpler research tools to evaluate folate intake is desirable to more easily determine folate intake in this population. Further studies should include biochemical measures of folate to determine a better relationship between estimated amounts of folate from dietary assessment tools and biochemical parameters in women of childbearing age. In addition, researchers should consider assessing the effect of nutrition education on folate intake to promote the prevention of neural tube defects.

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APPENDICES

APPENDIX A

IRB Approval

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 09-11-97 **IRB#:** HE-98-007

Proposal Title: IMPROVING FOLATE INTAKE IN YOUNG WOMEN

Principal Investigator(s): Gail Gates, Kathy Keim

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:

Signature: [signature]
Chair of Institutional Review Board

Date: September 16, 1997

APPENDIX B

Flyer

How Women Choose Food

Women Needed For Oklahoma State University Research Project

Would you like to tell us why you choose the foods you do?

If so, you will receive $25.00 and information about the foods you eat.

If you are a woman between the ages of 18 and 44, you can participate in research about food choices conducted at Oklahoma State University. To participate, you cannot be pregnant or have a disease that affects what you eat. We want to know what you think about food, and we need you to participate in focus group interviews. The reason that we are doing this study is to find out why women choose the foods they do. We also want to know how women wish to receive information about healthy eating. The group interview is simple and easy and takes about 1-½ hours of your time. We have babysitters if you need one. Appointments for interviews are being made for the next few weeks.

Volunteers will receive $10.00 for finishing the group interview and completing a food frequency questionnaire. Refreshments will be served after the interview. You will receive $15.00 more when you finish a food diary. You will also receive nutrient information about the foods you eat.

The group interview will be videotaped. The information that you give us will be confidential. This study has been approved by the Institutional Review Board for Protection of Human Subjects at Oklahoma State University.

Thank you for interest. For more information or to volunteer for the project, please call someone below.

Gail E. Gates, Ph.D., RD
Principal Investigator
Department of Nutritional Sciences
Oklahoma State University
(405) 744-5032

Christy Russell
Research Assistant

APPENDIX C

Consent form

Consent to Participate in Research

Factors Influencing Folate Intake in Women

I ________________________, voluntarily agree to participate in the above titled research. The Oklahoma Center for the Advancement of Science and Technology and the College of Human Environmental Sciences at Oklahoma State University sponsor this research.

I understand that:

(1) The purpose of the study is to find out what influences the food intake of women.

(2) I will participate in a focus group interview about influences on my food preferences and choices.

(a) The interview will take about 1 to 1 1/2 hours.
(b) I will allow the researcher to videotape my interview.
(c) The tape of the interview may be transcribed.

(3) I will complete a food frequency questionnaire at the beginning of the study that will ask me to recall my typical food choices;

(4) I will receive $10.00 for finishing the focus group interview and completing the food frequency questionnaire.

(5) I will record my daily food intake for four days

(6) I will receive $15.00 for completing the four day food record.

(7) All records are confidential. My name will not be used in any reports or data records at the end of the study. All information obtained about me as an individual will be considered privileged and held in confidence.
(a) Videotapes of the interviews will be viewed by the project director or her authorized representatives. Tapes will be filed in the project directors office until completion of the study when they will be destroyed.

(8) I volunteer to take part in this study.
(a) I have the right to withdraw from this study at any time by contacting the researchers.
(b) I may stop participating in the study at any time without penalty or loss of benefits that I am otherwise entitled to receive.

(9) This research is beneficial in that it provides information about the effects of nutrition education on food habits of women; and
(a) the information gained from this study may provide information useful in helping women choose nutritionally adequate diets;

(10) If I need more facts about the study I may contact Dr. Gail Gates at (405) 744-5032. I may also contact Gay Clarkson at the office of University Research Services, 305 Whitehurst, Oklahoma State University, Stillwater, OK 74078 at (405) 744-5700.

I have read and fully understand the consent form. I sign freely and voluntarily. A copy has been given to me.

Date_______________________________
Time_______________________________

Subject Name (please print) ____

Signed ____

Permanent Address ____

____

____

I certify that I have personally explained all parts of this form to the subject before requesting the subject to sign it.

Signed____
(project director or her authorized representative)

Printed name____
(project director or her authorized representative)

APPENDIX D

Food Frequency Questionnaire

Name ______________________________

Food Frequency Questionnaire

Subject Number ______________________________ Date ______________

The following section is about your usual eating habits. Think back over the **past year**. How often do you usually eat the foods listed?

First: Mark (√) the column to show how often, on the average, you ate the food during the past year.
Please BE CAREFUL which column you put your answer in. It will make a big difference if you say "Hamburger once a day" when you mean "Hamburger once a week"!
For example, if you eat bananas twice a week put a √ in the "2 per week" column.

Second: Mark (√) whether your usual serving size is small, medium, or large.
Please DO NOT OMIT serving size.

Additional comments:

A small serving is about one-half the medium serving size shown, or less
A large serving is about one-an-a-half times as much, or more.
Please DO NOT SKIP any foods. If you never eat a food, mark "Never or less than once a month."

FOOD FREQUENCY

EXAMPLE: This person ate a medium serving of rice about twice per month and never ate squash.

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per mon	2-3 per mon	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	Medium Serving	Your Serving Size		
											S	M	L
Rice			√							3/4 cup		√	
Winter squash, baked squash	√									1/2 cup			
FRUITS AND JUICES													
Example: Apples, etc.				√						1 medium or 1/2 cup		√	
Apples, applesauce, pears										1 medium or 1/2 cup			
Bananas										1 medium			
Peaches, apricots, (fresh or canned)										1 medium or 1/2 cup			
Cantaloupe (in season)										1/4 medium			
Cantaloupe (rest of year)										1/4 medium			
Watermelon (in season)										1 slice			
Strawberries (in season)										1/2 cup			
Oranges										1 medium			
Grapefruit										1/2 medium			
Orange juice or grapefruit juice										6 ounce glass			
Fruit drinks with added vitamin C, such as Hi-C										6 ounce glass			
Any other fruit, including berries, fruit cocktail, grapes										1/2 cup			

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per mon	2-3 per mon	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	Medium Serving	Your Serving Size		
											S	M	L
BREAKFAST FOODS													
High fiber, bran or granola cereals, shredded wheat										1 medium bowl			
Highly fortified cereals, such as Total, Just Right or Product 19										1 medium bowl			
Other cold cereals, such as corn flakes, Rice Krispies										1 medium bowl			
Cooked cereal, or grits										1 medium bowl			
Milk on cereal										1/2 cup			
Sugar added to cereal										2 teasp.			
Eggs										1 egg=sml 2 eggs=med			
Bacon										2 slices			
Sausage										2 patties or links			
VEGETABLES													
String beans, green beans										½ cup			
Peas										½ cup			
Chili with beans										¾ cup			
Other beans such as baked beans, pintos, kidney, limas, and lentils										¾ cup			
Corn										½ cup			
Winter squash/baked squash										½ cup			
Tomatoes, tomato juice										1 medium or 6 oz. glass			
Red chili sauce, taco sauce, salsa picante										2 tablesp.			
Broccoli										½ cup			
Califlower or brussels sprouts										½ cup			

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per mon	2-3 per mon	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	Medium Serving	Your Serving Size		
											S	M	L
Spinach (raw)										¾ cup			
Spinach (cooked)										½ cup			
Mustard greens, turnip greens, collards										½ cup			
Cole slaw, cabbage, sauerkraut										½ cup			
Carrots, or mixed vegetables containing carrots										½ cup			
Green salad										1 medium bowl			
Regular salad dressing & mayonnaise, including on sandwiches or on potato salad, etc.										2 tablesp.			
French fries and fried potatoes										¾ cup			
Sweet potatoes, yams										½ cup			
Other potatoes, including boiled, baked, mashed & potato salad										1 medium or ½ cup			
Rice										¾ cup			
Any other vegetable, including cooked onions, summer squash										½ cup			
Butter, margarine or other fat added to veg., potatoes, etc.										2 pats			

MEAT, FISH, POULTRY, LUNCH ITEMS													
TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per mon	2-3 per mon	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	Medium Serving	Your Serving Size		
											S	M	L
Hamburgers, cheeseburgers, meatloaf, beef burritos, tacos										1 med. or 4 ounces			
Beef, (steaks, roasts, etc., including sandwiches)										4 ounces			
Beef stew or pot pie with carrots or other vegetables										1 cup			
Liver, including chicken livers										4 ounces			
Pork, including chops, roasts										2 chops or 4 ounces			
Fried chicken										2 small or 1 large pce			
Chicken or turkey (roasted, stewed or broiled, including on sandwiches)										2 small or 1 large pce			
Fried fish or fish sandwich										4 oz. or 1 sandwich			
Tuna, tuna salad, tuna casserole										½ cup			
Oysters										5 pieces, ¼ cup, or 3 oz.			
Shell fish, (shrimp, crab, lobster, etc.)										5 pieces, ¼ cup, or 3 oz.			
Other fish (broiled or baked)										2 pieces or 4 ounces			
Spaghetti, lasagna, other pasta with tomato sauce										1 cup			
Pizza										2 slices			
Mixed dishes with cheese (such as macaroni and cheese)										1 cup			
Liverwurst										2 slices			

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per mon	2-3 per mon	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	Medium Serving	Your Serving size		
											S	M	L
Hot dogs										2 hot dogs			
Ham, bologna, salami, and other lunch meats										2 slices or 2 ounces			
Vegetable and tomato soups, including vegetable beef, minestrone										1 medium bowl			
Other soups										1 medium bowl			
BREADS, SNACKS, SPREADS													
Biscuits, muffins, (including fast foods)										1 medium piece			
White bread (including sandwiches, bagels, burger rolls, French or Italian bread)										2 slices			
Dark bread, such as wheat, rye, pumpernickel, (including sandwiches)										2 slices			
Corn bread, corn muffins, corn *tortillas*										1 medium piece			
Salty snacks, such as potato chips, corn chips, popcorn										2 handfuls or 1 cup			
Peanuts, peanut butter										2 tablesp			
Margarine on bread or rolls										2 pats			
Butter on bread or rolls										2 pats			
Gravies made with meat drippings, or white sauce										2 tablesp			

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1 per mon	2-3 per mon	1 per week	2 per week	3-4 per week	5-6 per week	1 per day	2+ per day	Medium Serving	Your Serving size		
											S	M	L
DAIRY PRODUCTS													
Cottage cheese										½ cup			
Other cheeses and cheese spreads										2 slices or 2 ounces			
Flavored yogurt, frozen yogurt										1 cup			
SWEETS													
Ice cream										1 scoop or ½ cup			
Doughnuts, cookies, cake, pastry										1 piece or 3 cookies			
Pumpkin pie, sweet potato pie										1 medium slice			
Other pies										1 medium slice			
Chocolate candy										1 small bar or 1 oz.			
Other candy, jelly, honey, brown sugar										3 pieces or 1 tblsp.			
BEVERAGES (Please note that the categories for these columns are different.)													
	Never or less than once per month	1-3 per mon	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-5 per day	6+ per day	Medium Serving	Your Serving Size		
											S	M	L
Whole milk and beverages with whole milk (not incl. on cereal)										8 oz. glass			
2% milk and beverages with 2% milk (not incl. on cereal)										8 oz. glass			
Skim milk, 1% milk or buttermilk (not incl. on cereal)										8 oz. glass			

TYPE OF FOOD	HOW OFTEN									HOW MUCH			
	Never or less than once per month	1-3 per mon	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-5 per day	6+ per day	Medium Serving	Your Serving Size		
											S	M	L
Regular soft drinks (not diet soda)										12 oz. can or bottle			
Beer										12 oz. can or bottle			
Wine or wine coolers										1 medium glass			
Liquor										1 shot			
Coffee, regular or decaf										1 medium cup			
Tea (hot or iced)										1 medium cup			
Lemon in tea										1 teasp.			
Non-dairy creamer in coffee or tea										1 tablesp.			
Cream (real) or Half-and-Half in coffee or tea										1 tablesp.			
Milk in coffee or tea										1 tablesp.			
Sugar in coffee or tea										2 teaspoon s			
Glasses of water										8 oz. glass			

SUMMARY QUESTIONS	AVERAGE USE LAST YEAR								
	Less than once per week	1-2 per week	3-4 per week	5-6 per week	1 per day	1 ½ per day	2 per day	3 per day	4+ per day
a. How often do you use fat or oil in cooking?									
b. About how many servings of vegetables do you eat, not counting salad or potatoes?									
c. About how many servings of fruit do you eat, not counting juices?									
d. About how many servings of cold cereal do you eat?									

Demographic Information

1. During the past year, have you taken any vitamin or mineral supplements? (circle number)

   1 NO
   2 Yes, fairly regularly
   3 Yes, but not fairly regularly

2. If yes, circle the supplement that best describes what you take. (circle number)

   1 Multivitamin
   2 Vitamin C
   3 Vitamin E
   4 Folic Acid
   5 Other, specify ____________________________

3. ____________ft __________in Current height in feet and inches

4. ___ _________ Current weight in pounds

5. ____________ Age in years

6. How satisfied are you with your current weight? (Circle number)

1 VERY SATISFIED   2 SATISFIED   3 UNSATISFIED   4 VERY UNSATISFIED

7. Which of the following describes your current diet? (Circle number)

   1 Normal/General
   2 Weight reduction
   3 Weight gaining
   4 Low fat/Low cholesterol
   5 Low salt/Low sodium
   6 High Fiber
   7 Diabetic
   8 Vegetarian
   9 Other, specify __________________

8. List the people who lives in your household.

Relationship   Age

____

____

____

____

9. Which of the following describes your current student status? (Circle number)

   1 Full-time student
   2 Part-time student
   3 Not a student

10. What is the highest level of education that you have <u>completed</u>? (Circle number)

1 Elementary School (grades 1-6)
2 Some High School
3 High School Graduate /GED
4 Some Technical School/Some College
5 Technical School Degree
6 College Graduate
7 Graduate School

11 Which of the following describes your current work status? (Circle number)

1 Employed full-time
2 Employed part
3 Homemaker
4 Unemployed

12. What is your race? (Circle number)

5 White
6 Black
7 Asian/Pacific Islander
8 American Indian/Alaska Native
9 Other

13 Are you of Hispanic Origin? (Circle number)

1 Yes
2 NO

14. Which represents your income from all sources over the past year? (Circle number)

1 Under $10,000
2 $10,000 – 14,999
3 $15,000 – 19,999
4 $20,000 – 24,999
5 $25,000 - $29,000
6 $30,000 – 34,999
7 $35,000 – 49,999
8 $50,000 and over

15. Which of the categories comes closest to describing the paid work that you do?

1 Professional or Technical
2 Manager, officer or proprietor
3 Clerical or sales worker
4 Service worker or other similar job
Other, specify ____________________

APPENDIX E

24-Hour Recall

Name________________

Identification #________________________________ Date____________

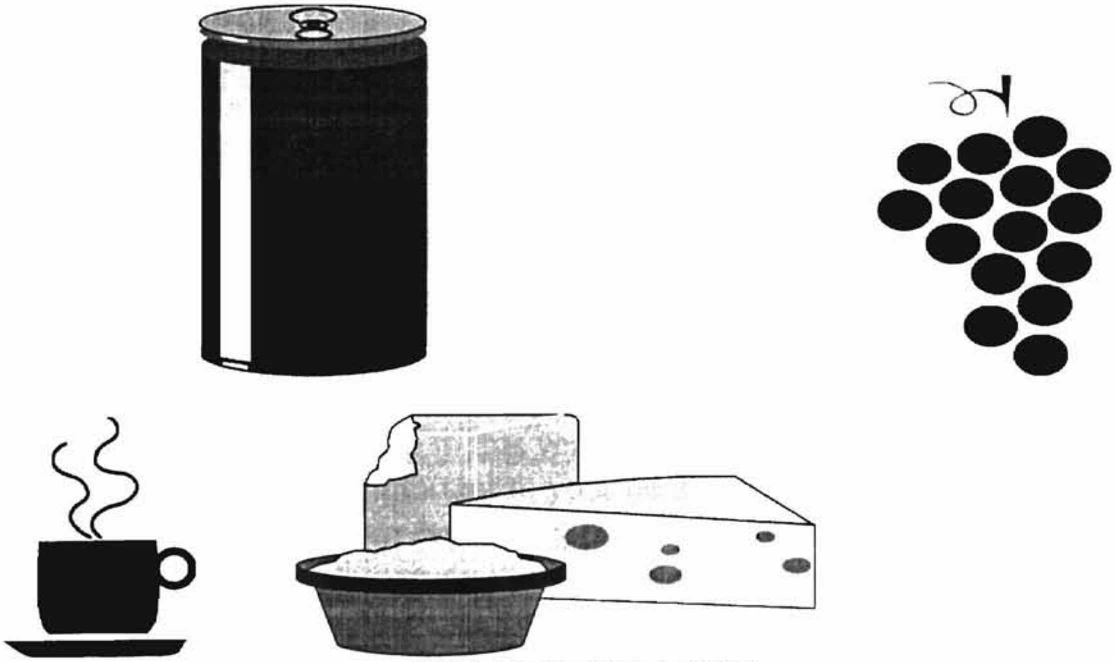
M=morning
MM=midmorning
N=noon

AN=afternoon
E=evening
LE=late evening

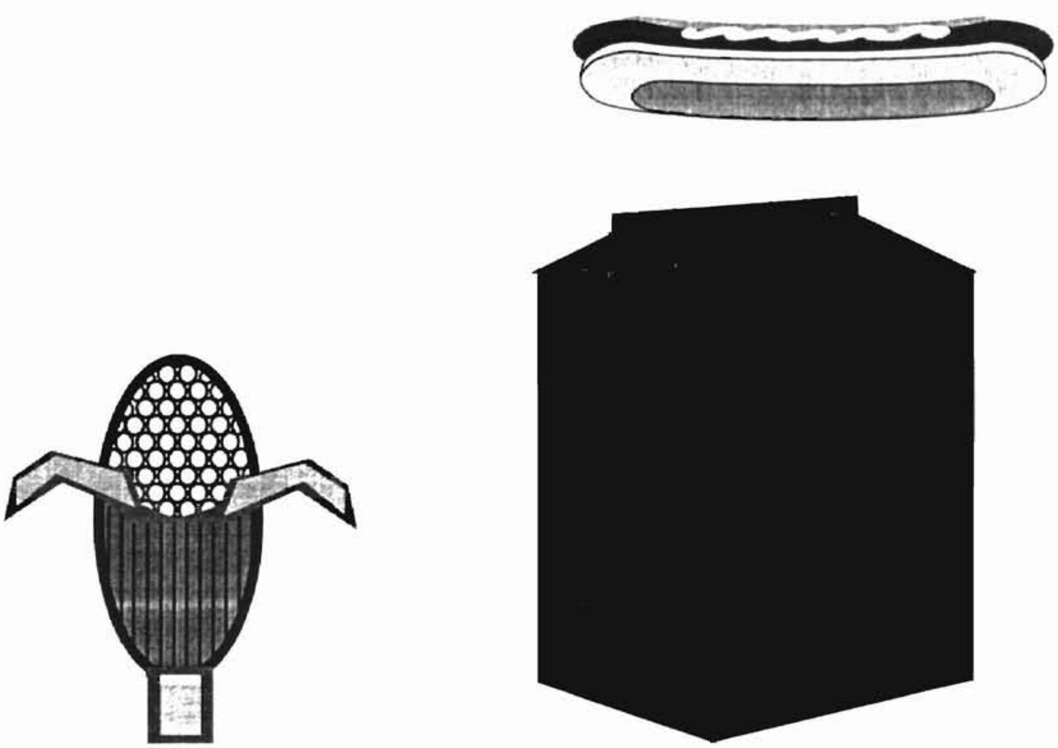
Time of day	Food Item and Method of Preparation	Amount Eaten

APPENDIX F

Food Diary



FOOD DIARY



Department of Nutritional Sciences
425 Human Environmental Sciences
Stillwater, Oklahoma 74078-6141
(405) 744-5040, Fax (405) 744-7113
E-mail: ggates@okstate.edu

Dear ______________________

Thank you for participating in this very important study. Everything that goes into your body is important to your health. For this reason, we would like for you to write down everything that you eat and drink for the next three days. We hope this study will help us make recommendations for improving your health based on what you eat. If you have any questions at any time, feel free to ask. Do not change your eating habits during the time that you keep this diary. This is very important since we must know exactly what you eat.

Thank you !

Gail E. Gates, PhD., RD
Principal Investigator

Directions for Using the Food Diary

1. Write down **everything** that you put into your mouth for the next three days. This includes foods, candies, drinks (including alcohol beverages), and anything that you swallow. Everything that goes into your body is important.

2. On the pages given to you, please list the food immediately after each meal or snack. Also list the time and amount that you ate. Use these codes to indicate the time of day:

M=morning	**AN=afternoon**
MM=midmorning	**E=evening**
N=noon	**LE=late evening**

3. Describe every item that you record, include details such as how it was prepared, size or amount and condiments that you use. For example:

   a) Write "fried chicken wing" if it is fried, not just chicken
   b) Write milk, whole milk, 2% milk, or skim milk. Do not just write milk.
   c) Write white bread, wheat bread, do not just write bread.
   d) Record the name brands when you know it. For example "Kellogg's Frosted Flakes", "Campbell's chicken soup", or "Ramen noodles".
   e) Include everything that you add to your food or drinks (jellies, sugar, salad dressings, mustard, ketchup, mayonnaise, butter, sauces, etc.).

For example:

Time of day	Food Item and Method of Preparation	Amount Eaten
E	Canned green beans with	½ cup
	Margarine	2 tsp
E	French fries (Burger King) with	1 small order
	Ketchup	2 TB
E	Iced tea with	16 oz
	Sugar	2 tsp
E	Fried chicken thigh	1 whole

4. Estimate what you ate in household measures (tablespoons, cups, slices, etc.). Your nutrition educator will show some examples. List the amount that you ate in the column marked amount eaten.

5. Please write as neatly as possible. Use as many pages as you need to record what you ate.

6. If anything is not clear to you, be sure to ask the nutrition educator any questions that you have before you leave today.

You may need some help in trying to decide how much you ate. Use this guide to help you.

Drinks: cups or fluid ounces. For example: pepsi 20 oz.

Grains: slices, cups. For example: white bread 1 slice.

1. An average size bagel is the size of a hockey puck.
2. A medium size pancake is the size of a CD.
3. 1 cup of rice or pasta would be about the size of a walkman.
4. 1/2 cup of rice or pasta would fill a cupcake wrapper.
5. 1 cup of dried breakfast cereal would be a large handful.

Fruits: pieces, portions of pieces, or cups. For example: red apple 1 medium.

1. A fruit that is considered to be medium sized is the size of a tennis ball.
2. 1 cup of chopped fruit is about the size of a baseball.
3. 1/2 cup of fruit looks like a pile of 15 marbles.

Vegetables: cups. For example: french fries 10 units.

1. 1 cup of lettuce is 4 large leaves.
2. 1 cup of chopped vegetables is the size of a fist.
3. 1/2 cup of chopped vegetables is the size of a light bulb.

Meat: ounces or cups. For example: fried chicken legs 2, refried beans 1 ½ cup.

1. 3 ounces of cooked meat is the size of a deck of cards or a cassette tape.
2. 1 ounce of meat is the size of a matchbook or 1 domino.

Milk Items: cups or ounces. For example: whole milk 1 cup or 8 oz.

1. 1 1/2 ounces of cheese looks like 3 dominoes or a 9-volt battery.
2. 1 ounce of cheese is the size of 4 dice.

Fats, oils, sweets/others:

1. 1/2 cup of ice cream is the size of a tennis ball.
2. 2 tablespoons of butter, salad dressing, peanut butter, or mayonnaise is the size of 1 dice.
3. 1 ounce of small snack foods like hard candy or nuts is a handful.
4. 1 ounce of larger snack foods like pretzels, cornchips, or potato chips is a large handful.

For your information:

1. 1 cup is the size of a baseball.
2. 1 tablespoon is 3 teaspoons.

Remember to write down these items:
- Crackers, breads, rolls, tortillas.
- Hot or cold cereals.
- Cheese added as topping on vegetables or on a sandwich.
- Chips, candy, nuts, seeds.
- Fruit eaten with meals or as snack.
- Coffee, tea, soft drinks, juices.
- Beer, wine, cocktails, brandies, any other drinks made with liquor.

VITA

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