ABSTRACT

Robin Webb Corbett. INVESTIGATION OF PICA HISTORY AND TRACE ELEMENTS IN PICA SUBSTANCES INGESTED BY PREGNANT FEMALES IN EASTERN NORTH CAROLINA (under the direction of Dr. Mary Ann Rose) Department of Nursing, December 1985.

The harmful effects of pica eating during pregnancy and a possible link with trace elements is suggested. This descriptive investigated:

1. the pica histories of 20 pregnant females in eastern North Carolina;
2. the trace element levels of both the pica substances and the dried packed red cells of the pregnant pica practitioners;
3. the relationship between the level of trace metal ingested and factors or symptoms related to pica.

The trace elements available from the pica substances to the pica practitioner were estimated by using an extraction procedure designed to model, to a first approximation the digestive process.

Large amounts of trace minerals were found in the pica substances and the levels exceeded recommended dietary allowances specific to the trace metal. The subjects reportedly ingested the pica substances in response to a "taste" for the pica. In addition the trace mineral levels of the dried packed red cells were low when compared with the normal dried red cell levels. It was also noted that 75% of the subjects in the study had hematocrit levels below the minimum normal level for pregnant females.

These findings suggest that pica ingestion in pregnant black females may be the result of trace mineral deficiency. Recommendations are made for further study.

INVESTIGATION OF PICA HISTORY
AND TRACE ELEMENTS IN PICA SUBSTANCES
INGESTED BY PREGNANT FEMALES IN EASTERN NORTH CAROLINA

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by

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Investigation of Pica History and Trace Elements

in Pica Substances Ingested by

Pregnant Females in Eastern North Carolina

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CHAPTER ONE

STATEMENT OF THE PROBLEM

Introduction and Background of the Problem

The high incidence of problems associated with childbearing is a major health concern, particularly in the eastern North Carolina region. North Carolina ranked 45th in the United States in 1979 in infant mortality. North Carolina's infant death rate per 1,000 live births in 1979 was 15.3% compared with the national rate of 13.0% (North Carolina Health Statistics Pocket Guide, 1982).

Within North Carolina, the eastern region is particularly problematic. The area is primarily agricultural and has a low ratio of health professionals to the total population in the region. Compared to standard measures, the overall health status of the population is not good. Fetal deaths and neonatal deaths are at least 25% higher in the eastern part of the state than in the state as a whole (Northeastern North Carolina Professional Standards Review Organization, 1983, p. 3). The infant mortality rate of eastern North Carolina in 1980 was 15.2%. Infant mortality rates in North Carolina counties range from no reported deaths in Dare County to 36.5% in Ashe County (North Carolina Health Statistics Pocket Guide, 1982).

Etiological factors of infant mortality that have been identified include low birth weight, prematurity, birth injuries, respiratory distress syndrome, asphyxia, atelectasis, and congenital malformations (Reeder, Mastroianni, and Martin, 1983, pp. 26-27). A relationship has been demonstrated between maternal nutrition and prematurity and low birth weight (Williams, 1981, p. 377).

One nutritional factor associated with these problems is pica, the craving for and ingestion of non-food or food materials. Items selected by the pica eater have included ice, clay, cornstarch, burnt match heads, toilet paper, pebbles, and tire innertubes. Normal foodstuffs, such as potatoes, carrots, ice and lettuce, may also be considered the object of pica if they are eaten in excessive quantities.

Pica is harmful. It has been associated with parotid gland hypertrophy, (Merkatz, 1961; Silverman and Perkins, 1966) and hyperkalemia with dialysis patients (Gelfand, Zarate, and Knepshield, 1975). Coltman (1969) demonstrated ice eating's association with iron lack, though not specifically with iron lack anemia. Numerous studies and case study reports have implicated pica with iron deficiency anemia (Edwards, et al., 1964; Crosby, 1971; Johnson and Stephens, 1982; Bronstein and Dollar, 1974; Moss, Nissenblatt, and Inui, 1974; Perry, 1977).

Other studies and case study reports have linked dwarfism (Prasad, Halsted, and Nadima, 1961; Prasad et al., 1963), hypokalemia (Mengel, Carter, and Horton, 1964) and hypozincemia (Cavdar and Arcasoy, 1972; Karayalcin and Lanzkowsky, 1976) with the practice of pica.

For a number of reasons, pica is particularly harmful in pregnancy. O'Rourke, Quinn, Nicholson, and Gibson (1967) found an almost double incidence of toxemia in dirt or clay eaters. Ferguson and Keaton (1950), in a study of pregnant women ingesting clay in rural Mississippi, noted a high incidence of toxemia in the population. Edwards et al. (1964) found an increased incidence of stillbirths, hypertension, and inadequate prenatal diet among pica eaters. A study by Bronstein and Dollar (1974) demonstrated that pica can result in a low-serum iron and total iron binding capacity, an indicator of iron deficiency though not specifically iron deficiency anemia. They also found low-serum albumin levels for the pregnant women, which may be indicative of inadequate protein intake and prenatal diet. Macgregor reports that maternal anemia has been implicated in perinatal mortality and prematurity (cited in Patterson and Staszak, 1977, p. 2020). Mansfield (1977, p. 29) found a significant incidence of pregnancy termination due to spontaneous abortion, abortion, neonatal/prenatal death and stillbirth among low income women practicing pica in Pitt County.

Pearl and Boxt (1970) reported congenital lead poisoning secondary to maternal ingestion of wall plaster. Holt and Hendricks (1969) reported a case of dystocia resulting from a fecal impaction due to daily ingestion of clay. Gudson and Tunca (1974) reported a partial bowel obstruction due to a geophagia that first appeared to be abruptio placenta.

Although harmful, pica is common in pregnant women. The National Academy of Sciences Committee on Nutrition of the Mother and Preschool Child (Lackey, 1982) reported that pica was "not an uncommon practice among pregnant women, particularly low-income black women of a southern rural background." Ferguson and Keaton (1950), in a study of pregnant Mississippi blacks, found that 44% of their sample were practicing pica. The study by Payton et al. (1960) reported that 17% of the pregnant women in Tennessee were eating cornstarch. The study by O"Rourke et al. (1967) determined that 55% of their pregnant clients were ingesting clay. Bruhn and Pangborn (1971) reported the practice of pica in 38% of the Spanish-American pregnant women in a California study, compared with 15% for Spanish-American nonpregnant women in the state. Bruhn and Pangborn also determined that 19% of the Anglo women in the state were practicing pica.

The etiology of pica remains obscure; however, hypothesized causes include psychological, cultural and physiological factors. The psychological hypotheses include the theory that the persistence of oral behaviors in individuals practicing pica and pica eating are a response to stress. Parents with "oral habits" (alcoholism, smoking, and pica) are more likely to have children who engage in pica (Millican, Layman, Lourie,and Takahash, 1965, p. 104). Psychosocial stress was also found to be associated with pica (S. Singhi, P. Singhi, and Adwani, 1981). Stress factors that were signficantly associated with pica included maternal deprivation, caretaking by an individual other than the mother, parental separation, parental attitude of neglect, child abuse, and inadequate maternal and/or paternal-child interaction. Millican et al. (1956) report an association of maternal and/or paternal deprivation with the practice of pica. A lump of clay or a handful of starch may be used by some pica practitioners as a pacifer for children and adults.

Since antiquity, pica has been linked with cultural factors. Thompson (cited in Danford, 1982) reported that in approximately 40 B. C. clay was removed from specific caves on the Greek islands, mixed with other substances, and ingested to ward off diseases. Southern black females are associated with earth eating, and Lackey (1983), in her review of pica during pregnancy, suggests that pica may be a continuation of a behavior among African blacks who wished to avoid becoming slaves, as earth eaters were perceived as unhealthy.

Physiological factors have long been associated with pica. One subject of consideration is that the body, in an attempt to obtain necessary nutrients, instinctively will crave a substance or food containing the salient nutrient (Danford, 1982). In countries with scarce food supplies, dirt ingestion may assauge the hunger pangs (Halsted, 1968). During pregnancy, increased salivation and changes in taste and smell may result in pica (Dicken and Trethowan, 1971). Clay eating may produce a change in the intestinal pH, enhancing the development of microorganisms (Lackey, 1983).

Existing evidence points strongly to the trace elements as a major physiological factor in the etiology of pica. More than 50 trace elements, of which only 15 to 20 are known to be required by man and also known as trace metals and trace minerals, occur in minute quantities in the body. The human tissue requires amounts of 0.01 gm. or less daily of the trace elements. These trace elements comprise no more than 0.01% of the body weight but influence many physiological processes. The best known trace minerals are iron, iodine and zinc (Whitney and Cataldo, 1983, p. 409). Lack of the trace elements, iron and zinc, has been suggested as the physiological cause of pica. Also, trace element abnormalities have been implicated in the childbearing problems resulting from pica. For example, numerous investigations have suggested that pica eaters ingest these substances in response to iron deficiency (Keith, Evenhouse, and Webster, 1968). Other studies support trace metal replacement at least partially effective in stopping the pica eater's abnormal behavior (Coltman, 1969).

There exists only limited knowledge, however, of the trace metal content of pica substances. Smith and Halsted (1970) investigated the effects of clay ingestion on zinc metabolism. A chemical analysis of clay from southern Iran revealed an available zinc level of 13% from zinc carbonate. "Available" refers to the amount of a mineral that can be absorbed and utilized by the body. Smith and Halsted's study (1970) suggested that leached clay may be beneficial to someone with zinc deficiency. Edwards et al. (1964) performed chemical analyses of clay and cornstarch and found the total iron content of the clay was 20.8 mg. per 100 gm., with 0.03 mg. per 100 gm. available. Iron, magnesium, potassium and aluminum were the most important mineral substances found in the clay. The cornstarch contained 5.6 mg. per 100 gm. of iron, of which none was available.

Mengel, Carter, and Horton (1964) reported that clay prevented absorption of potassium because of clay's cation exchange capacity. Minnich et al. (1968) reported decreased iron absorption for the same reason and Halsted (1968) speculated that this mechanism may also affect zinc absorption. This inhibited absorption would result in deficiencies of these trace elements.

Pica is a common practice in eastern North Carolina. Among 1,200 respondents in a 20-county region, Furuseth (1973, p. 33) reported that 25% of the overall population practiced earth eating, 14.8% practiced cornstarch ingestion, and 7.2% ate earth and starch concurrently. Mansfield (1977) determined that 26.6% of the low-income women in Pitt County who either were pregnant or had been pregnant within the preceding five years were practicing pica.

Thus, in summary, the eastern region of North Carolina has a significant rate of perinatal and infant mortality and morbidity. An associated problem is pica. Harmful effects of pica that have been demonstrated include toxemia, hypertension, inadequate prenatal diet, stillbirths, iron deficiency anemia, and congenital lead poisoning. Trace elements have been implicated as both an etiological factor for pica and suggested as a subsequent treatment modality.

Purpose of Study

This study had four purposes. They were as follows:

1. To identify factors which precede and/or initiate pica ingestion.
2. To identify the trace element composition of pica substances ingested by pregnant eastern North Carolina women.
3. To identify the trace element composition of blood samples from these same prenatal clients.

4. To determine whether a relationship exists between the level of trace metal ingestion and factors or symptoms related to pica.

<u>Assumptions</u>

The study acknowledges the following assumptions:

1. The practice of pica ingestion exists in eastern North Carolina.
2. The subjects will admit to practicing pica.
3. The subjects will be willing to allow samples of their pica substances to be collected and analyzed.

<u>Limitations</u>

The limitations of this study include:

1. The sample is limited to pregnant women seeking care from two health departments in eastern North Carolina, therefore generalizations to a larger population may not be made.
2. The sample size is small.
3. The model used to predict the availability of trace elements is unable to accurately replicate human digestion of pica substances.

<u>Definition of Terms</u>

Available - the amount of a trace mineral that can be absorbed and utilized by the body

Pica - the ingestion of any non-food substance during pregnancy

Prenatal - a medical diagnosis of pregnancy and/or the presence of the presumptive signs of pregnancy and/or a positive urine or serum pregnancy test

Trace Elements - (also trace metals and trace minerals) essential minerals which occur in amounts of 0.01 gram or less in the body and which comprise 0.01% or less of the body weight; specifically, iron, copper, iodine, manganese, cobalt, zinc, molybdenum, selenium, chromium, fluorine, silicon, vanadium, nickel and tin.

Significance of the Study

Given the limited research in this area, it would be useful to have additional data concerning the trace metal content of the substances that pregnant women ingest. More specifically, it would be beneficial to have pregnant women identify the factors that led to their pica and the cravings or symptoms that prompted this practice. The literature does not address the incidence of pica as it relates to the number of pregnancies experienced. Nursing currently lacks this information. The results of this investigation may be useful not only in determining the nature of the phenomenon, but also in finding a way to prevent it. If specific symptoms initiate pica, measures could be taken to counsel women to either discontinue or avoid the practice. Replacement therapy to alleviate trace element deficiency could be initiated. This investigation will set the stage for later, more rigorous research by nurses.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND REVIEW OF THE LITERATURE

Conceptual Model

Physiological changes and the nutritional needs of the mother during pregnancy provide the conceptual framework for this study. The nutritional needs of the pregnant woman differ markedly from those of the nonpregnant woman. Pregnancy requires increased energy needs for fetal growth and maternal development. Protein and fat supply the energy cost associated with pregnancy. To supply this energy cost, the dietary allowance recommends an additional intake of 300 Kcal/day throughout pregnancy. Maternal factors such as, expanded blood volume, storage of fat and uterine and breast growth usurp the energy needs of the second trimester. During the third trimester energy is expended for fetal and placental growth (Pitkin, 1976, p. 490).

It is important that these additional calories be nutritional foods that contribute the necessary dietary nutrients. To meet these energy needs the food guide for the pregnant female recommends a specific number of servings from six food groups daily. Daily ingestion of these servings will provide a well balanced diet to satisfy the energy demands of pregnancy. These six food groups are protein foods, milk and milk products, breads and cereals, vitamin C- rich fruits and vegetables, dark green vegetables and other fruits and vegetables. Four daily servings of the protein foods, milk and milk products and breads and cereals are recommended, while one serving is recommended for the remaining food groups. Protein, comprised of nitrogen is necessary for the growth and maintenance of maternal and fetal tissues. Protein also provides for maternal storage necessary for the 300 to 500 ml. of blood loss associated with delivery.

It is recommended that pregnant women have an additional dietary allowance of 30 g. of protein, a 66% increase for pregnant women(Pitkin, 1976).

Another of the food groups, milk and milk products is increased during pregnancy. This food group provides the mineral calcium, whose recommended dietary intake is increased by 0.4 g., a 50% increase when compared to the nonpregnant woman's calcium need. Calcium is a constituent of the blood clotting mechanism, initiates muscle contraction, is required for transmission of nerve impulses and builds and maintains fetal and maternal skeletal tissue (Williams, 1981, p. 384).

Vitamins, supplied by a variety of food sources, are necessary to satisfy the developmental demands of pregnancy. The daily recommended requirements for vitamins A, B, C, and D are increased in pregnancy. Vitamin A is found primarily in vitamin C type fruits and vegetables and in dark green vegetables. In the body, vitamin A has a role in the visual adaptation to light and dark and assists in the formation and maintenance of epithelial tissue and tooth formation. An increase of approximately 25% is necessary during gestation to meet these developmental activities (Williams, 1981).

A well balanced diet of all six food groups will meet the increased needs for the B complex vitamins. The B complex vitamins work as coenzyme factors in energy metabolism, important in view of the increased metabolism of pregnancy associated with maternal and fetal tissue development (Williams, 1981).

The vitamin C-rich fruits and vegetables supply ascorbic acid. During gestation an additional 20 mg., a 25% increase for the pregnant woman is recommended for its intercellular cementing ability of connective and vascular tissue and its enhancement of iron absorption (Williams, 1981).

Sunlight and fortified milk and milk products provide vitamin D. But during gestation, due to the increased needs for calcium and phosphorus for fetal skeletal tissue development an additional 5 ug. is recommended for the daily allowance of vitamin D during pregnancy (Williams, 1981).

Another mineral, iron, is supplied by the dark green vegetables, breads and cereals and protein food groups. Its absorption is enhanced by vitamin C foods. Iron, also classified as a trace element, is necessary for the formation of hemoglobin which transports oxygen to cells. An inadequate supply results in iron deficiency anemia. Iron is needed for fetal development and storage in the fetal liver because breast milk and infant formula do not supply this element. The increased maternal blood volume of pregnancy results in the need for increased hemoglobin and thus the need for more iron. Animal and human studies have demonstrated that newborns of mildly anemic mothers exhibit normal hemoglobin content but reduced iron stores. The severity of the maternal anemia may be correlated with newborn anemia or newborn anemia susceptibility (Hurley, 1980). Problems may result with the increased iron needs of gestation (30 to 60 mg. daily) and an inadequate maternal dietary iron intake. This "iron deficit" may be met with iron supplementation (Williams, 1981).

Another trace mineral involved in hemoglobin formation is copper. In utero, copper deficiency results in ataxia manifested by spastic paralysis of the hind limbs, anemia, incoordination and brain abnormalities (Hurley, 1980).

Other trace minerals necessary in fetal development include iodine, manganese and zinc. Iodine functions in the synthesis and metabolism of thyroxine. Deficiency states during gestation in humans results in hypothyroidism and cretinism. Cretins are usually physically and mentally retarded, have thick, coarse skin and a dull expression. Gestational manganese deficiency has been demonstrated to result in chrondrodystrophy (abnormal skeletal growth proportions), neonatal ataxia and abnormal brain development and function (Hurley, 1980). Zinc deficient diets during pregnancy resulted in resorbtion of approximately 50% of the conceptus, decreased birthweight and congenital abnormalities. These congenital malformations in order of frequency were: curly or stubby tail, syndactly, small or missing lung lobes, brain and eye abnormalities (Hurley, 1980). A depleted zinc leukocyte level and subsequent fetal growth retardation has also been observed (Meadows, et al., 1981).

Thus the fetal and maternal development of pregnancy requires energy which is supplied by the daily ingestion of the recommended servings of the six food groups. These food groups supply the necessary nutrients, vitamins, and minerals, particularly trace minerals needed for the myriad of activities involved in fetal and maternal tissue development.

The pregnant clients may not satisfy the nutritional needs of gestation necessary to meet the pregnancy energy cost. The ingestion of cornstarch and laundry starch while providing excess calories does not supply nutrients and minerals and may displace food ingestion by virtue of its satiety factors. Clay and dirt ingestion may "bind" iron, preventing its absorption by the body and resulting in iron deficiency.

There is considerable evidence that pica ingestion is harmful to the fetus. Documentation of lower birth weights, fetal deaths, and stillbirths and toxemia associated with pica ingestion exists but its mechanism is unknown.

This study is an attempt to approach the physiological implications of pica ingestion by investigating the trace elements available to the fetus via pica.

By assessing carefully what factors precede pica and examining the trace element composition of both the pica substances and blood samples of pica practitioners, nursing interventions may be devised to modify pica behavior.

Review of the Literature

Pica ingestion has occurred for centuries. Ingestion of clay lozenges to treat illness and poisoning was documented as early as 40 B. C. in Greece and an association between pica and pregnancy was observed by the royal physician to Justinian I in the sixth century.

Estimates of the prevalence of pica vary widely. The most conservative estimate (16%) was reported by Bronstein and Dollar's (1974) study of 410 pregnant, low income blacks. At the other extreme, Ferguson and Keaton (1950) in a study of 331 pregnant black women reported an incidence of 68%. Other studies (Bruhn and Pangborn, 1971; Edwards, et al., 1959; O'Rourke et al., 1967; Mansfield, 1977; and Keith, Evenhouse and Webster, 1968) report the prevalence of pica between these two extremes.

Some of the variance may be explained by cultural or socioeconomic factors. For example, Bruhn and Pangborn (1971) interviewed 65 migrant families of Mexican heritage and 26 migrant families of "Anglo" heritage and determined that 38% of the pregnant women of Mexican descent compared to 19% of the "Anglo" pregnant women were reported to be practicing pica. Edwards et al. (1959) also examined the socioeconomic background of 86 pica eaters and found that 76% of the pregnant clay-eaters were homemakers and 18% farmed. In comparison, 8% of the pregnant cornstarch eaters were homemakers and 15% farmed. The mean educational level was 8 and 9 years for clay and cornstarch eaters respectively.

A variety of substances is ingested; however the predominant pica substances appear to be clay, cornstarch, and other forms of dirt. O'Rourke et al. (1967) interviewed 200 Georgia women and found that 55% of the women ingested clay, cornstarch, or both. Edwards et al. (1959) reported similar findings with 44% of their 86 subjects ingesting clay and 23% ingesting cornstarch. In addition, 7% of their subjects ingested both clay and cornstarch. Vermeer and Frate, (1979) in their study of blacks in rural Mississippi reported that 28% of the pregnant and postpartum women ingested clay and 19% ingested other pica substances.

An association between pica and various complications of pregnangy, labor and delivery has been demonstrated. The complications include toxemia, colon malfunctions, and nonsurvival of infants. Concerning toxemia, Edwards et al. (1959) demonstrated that women ingesting clay and cornstarch had an 8% incidence of pre-eclampsia and an 8% incidence of toxemia, compared to 7% for pre-eclampsia, hypertension, and edema in controls. O'Rourke et al. (1967) also reported that toxemia was more than twice as prevalent in the cornstarch and clay eaters (30.9%) than the nonpica controls (12.2%).

Colon dysfunction has also been associated with pica. In 1969, Holt and Hendricks reported the case of an adolescent approximately 36 weeks gestation with dysfunctional labor whose fecal impaction dystocia was secondary to the ingestion of clay in amounts greater than one quart/day. Also, Gudson and Tunca (1974) reported a case of a woman who presented at 33 weeks of gestation with acute abdominal pain resulting from a colon obstruction secondary to clay ingestion.

There is also an apparent association between pica and various abnormalities in the infant. The study by Edwards et al. (1964) demonstrated 33% of the infants of cornstarch ingesting mothers and 23% of the infants of clay ingesting mothers were rated as "poor" or "very poor" i. e., babies who usually died within two to four days. In contrast the control group of this study had only 11% of the infants rated as "poor" or "very poor." Finally, they reported that 17% of the infants of mothers ingesting cornstarch were stillbirths as compared to 3.5% of the nonpica controls. Similar results were reported by Mansfield. Twenty-six percent of her pica eating subjects had lost a child at birth compared to 19.6% of nonpica eaters. These associations were also demonstrated in animals by Patterson and Staszak (1977) whose clay ingesting pregnant rats produced lower birth weight offspring than the controls.

Trace elements, particularly iron and zinc have been studied in relation to pica. These studies have focused primarily on maternal anemia secondary to pica ingestion, treatment of pica through iron replacement, pica associated with zinc deficiency and with multiple trace element deficiencies. Maternal anemia has been associated with pica ingestion in numerous investigations. Edwards et al. (1959) determined that the average daily intake of iron for the pregnant pica client was deficient, 8 mg. for women ingesting clay and 7 mg. for women ingesting cornstarch as compared to 10 mg. for the pregnant nonpica eating women. They also determined that the mean hemoglobin concentration for the pregnant clay eaters was 8.7 gm./100 ml and 10.1 gm./100 ml. for pregnant cornstarch eaters. In contrast, the nonpica pregnant women had a mean hemoglobin concentration of 10.1 gm./100 ml. (Edwards et al., 1964). Subsequently, nutritional anemia was found in 27% of the clay eaters and 17% of the cornstarch eaters as compared to 7% of the pregnant controls. Similar results were reported by Keith et al. (1968). This study found that severe anemia was increased in pregnant women ingesting cornstarch (13.2%) over the controls (8.1%). They also found that the degree of anemia was positively correlated with the amount of cornstarch ingestion. Pregnant women eating a one pound box of starch daily had a lower hemoglobin concentration than those women who ate only eight ounces of starch daily. Hemolytic anemia was also reported by Campbell and Davidson (1970) of a pregnant woman ingesting toilet bowl freshener. Cessation of the pica resulted in the hemoglobin rising from the 7.2 gm./100 ml. found initially. Similarly, Bronstein and Dollar (1974) found iron deficiency anemia in their study of 410 pregnant, low income blacks. This study demonstrated that 61% of the pregnant women practicing pica were anemic as compared to 21% of the nonpica pregnant women. Maternal anemia was also found by Patterson and Staszak (1977) investigating pregnant rats eating clay.

There is some evidence that iron replacement therapy results in the cessation of pica. McDonald and Marshall (1964) studied 28 children with pica who were randomly assigned to two groups, one receiving parenteral iron and the second group receiving parenteral normal saline. Their study demonstrated that at 3 to 4 months, 11 of the 13 children receiving the iron replacement had ceased their pica ingestion, in contrast to the 3 of the 12 children receiving normal saline. Iron therapy was also used by Reynolds, Binder, Miller, Chang, and Horam (1968) in their investigation of 38 patients with iron deficiency associated with chronic blood loss, who were also pica eaters. They found that as the serum iron levels with iron therapy rose to above 70 ug./100 ml. (normal 87-279 ug./100 ml.), ice ingestion ceased.

Iron lack was measured by Coltman (1969) who found that initiation of iron replacement was associated with ice ingestion. Cosby (1971) also reported four case studies involving pica eaters whose ingestion ceased after administration of iron.

Another trace element, zinc has also been linked with pica. Karayalcin and Lanzkowsky (1976, p. 687) reported a case study of a ten year old pica eater whose plasma zinc was only 17.3 ug./dl. (normal 100-37 ug./dl.). With oral zinc therapy and the return of his serum zinc to the normal range the boy discontinued his pica. Johnson and Tenuta (1979) also studying pica in children, found an association between pica and zinc. They found that the average dietary zinc intake of the pica eaters was 63% of the recommended dietary allowance (R.D.A.). Smith and Halsted (1970) ascertained the effects of clay ingestion on zinc metabolism by feeding leached clay to experimental animals. They determined that the clay provided a dietary source of zinc, of which 13% was available for absorption and metabolic needs.

Some studies have investigated more than one trace element and pica. Cavdar and Arcasoy (1972) found that children with pica and growth retardation were zinc deficient. They also had decreased magnesium and copper levels, and two children were deficient in iron, zinc, copper, and magnesium. Snowdon (1977) also investigated multiple trace elements and their association with pica. His study investigated animals with diets deficient in calcium, magnesium, iron and zinc and their ingestion of lead. He demonstrated a positive correlation between quinine sulfate ingestion and diets deficient in calcium, iron, and zinc. Finally, both zinc and iron deficiency was demonstrated in a case study by Chisholm and Martin (1981). Treatment with elemental zinc and ferrous sulfate resulted in the discontinuation of the pica.

Limited knowledge of the trace metal content of pica substances is available. The trace element zinc, of which 13% was available, was found by Smith and Halsted (1970) in a chemical analysis of clay. Another trace element, iron was found in chemical analyses of clay and cornstarch by Edwards et al. (1964). They found a total iron content of 20.8 mg. per 100 gm. with 0.03 mg. per 100 gm. available in the clay. The cornstarch had 5.6 mg. per 100 gm. of total iron, with none available for the body.

An association between cravings and nutrient deficiency has been investigated with conflicting results. Lusk (1982, cited in Harris, Clay, Hargreaves and Ward, 1983, p. 161), described a "triumph of instinct" as the ability of animals to distinguish between foods containing necessary nutrients and those nutrient deficient. Nutrient deficiency resulting in cravings has also been supported by Bolt, Denton, Goding and Sabine (1964, cited in Danford, 1982) in their discussion of the "salt lick" of wild animals. Other deficiencies, phosphorus, potassium, thiamin and iron have been associated with licking or selective ingestion of items supplying this nutrient. These studies lack replication. In the case of pica, the substances craved and ingested by man are rarely good nutrient sources.

The investigator, to date, has found no research investigations of pica in pregnancy reported in the nursing literature. However, Luke (1977) testifies to the importance of an understanding of pica by nurses, particularly concerning pica's detection, its treatment, and education about it for prenatal women.

Studies demonstrate clearly that pica exists in a variety of populations. Its particularly detrimental effects are clearly evident in pregnancy where it is associated with toxemia, hypertension, dystocia, stillbirths, and zinc and iron deficiencies. Numerous studies have implicated the trace elements, particularly zinc and iron, in this practice. It is not clear, however, whether the deficiency in iron or zinc is the cause of the pica or its result. Although there are other trace metals, (iodine, selenium, manganese, cobalt, molybdenum, chromium, fluorine, vanadium, nickel and tin) which may be associated with pica, no studies have been found that explore possible relationships between deficiencies in these metals and pica eating.

CHAPTER THREE

METHODOLOGY

Design

This study was a descriptive study investigating:

a. the pica histories of 211 pregnant females in eastern North Carolina;

b. the trace element composition of the pica substances and their availability;

c. the trace element composition of dried packed red cell samples of the pregnant pica practitioners;

d. the relationship between the level of trace metal ingestion and factors or symptoms related to pica.

Sample Group

Low income pregnant women who were non-food pica eating females living in eastern North Carolina and obtaining prenatal care from the maternity clinics of two health departments, one each in Halifax and Edgecombe county comprised the sample group. Two hundred eleven patients were approached for possible inclusion in the investigation and histories were obtained to identify pica practitioners. For inclusion in the investigation the following criteria were set:

1. patient must be pregnant;
2. patient must admit to the practice of current pica eating;
3. the pica must be a non-food substance, e. g., ice, clay, cornstarch.

Twenty-two patients met the criteria for study and all consented in writing to participate in the investigation. Two of these subjects were subsequently excluded, one because her delivery preceded the obtaining of her blood sample, and the second because of the invalidation of her written informed consent due to mental retardation.

Research Setting

The two health departments from which the sample was drawn were located in rural counties. Both counties are primarily agricultural, have a population of approximately 55,000 each and have a 50/50 black/white population. The health departments each provide comprehensive health services for the citizens of these counties, including environmental health, nutritional and speech therapy, home health, child health and adult health. The maternity clinic is one of the adult health programs of these health departments. Although any citizens of these counties are free to use the services of the health departments, they are used primarily by individuals with low incomes.

Data Collection

Every patient who was treated in the maternity clinic during a selected six week period, from May 22, 1985 until June 26, 1985 was approached for inclusion in this study. The purpose and the nature of the study were explained to every patient interviewed and the patient's written consent (Appendix A) was obtained. The initial interviews were conducted by the investigator according to the pica history interview schedule (Appendix B) developed by the investigator. To assure confidentiality each patient was assigned an interview number. All patients were interviewed by the investigator according to the pica history interview schedule up to question number 17. For those patients admitting the practice of pica, the questionnaire was completed. Upon completion of the pica history interview, the investigator made an appointment with the pica ingesting pregnant subjects, to go to the individual's residence and collect a sample of the pica substance.

At the clinic, the lab personnel of the health departments saved the blood samples collected in capillary tubes used for required health department procedures. These tubes were labeled with the subjects' initials, hematocrit and date of birth. Upon completion of the clinic visit, the investigator obtained the blood samples of the subjects admitting to the practice of pica. The capillary tubes of the pica ingesting subjects were relabeled by the investigator with a number corresponding to the subject's interview number. These tubes had a storing time from one to six weeks in a refrigerator until they were transported to the Shared Research Resource Laboratory of the School of Medicine at East Carolina University for analysis.

The pica substances were obtained by the investigator and were collected in plastic specimen containers. The investigator labeled each specimen container with a number corresponding to the subject's interview number. The corresponding number was recorded along with the type of pica substance on the pica substances and interview number recorder form (Appendix C). The recorder form, the blood capillary tubes, and the pica samples were taken to the Shared Research Resource Laboratory for analysis of the total and available trace elements in the pica substance and the total trace element concentration in the dried packed red cells.

Instrumentation

For subject interviews, a pica history interview schedule (Appendix B) was administered to consenting maternity patients by the investigator. The development of the pica history interview schedule was based on pertinent aspects determined from a review of literature. The interview schedule was pretested with five pregnant clients for ease of administration and content. Modification of the pica history interview schedule was made after the pretest in accordance with the client's recommendations and the investigator's observations. The pica history interview schedule has four separate components; demographic information, pregnancy cravings, non-food pica ingestion, and symptoms or factors assocaited with pica ingestion.

Analysis of Data

Pica histories obtained via the pica history interview schedule were examined to determine the types of non-food ingestion, frequency, etc. Data were subjected to chi square analysis to look at the relationship of the level of trace metal ingestion and factors or symptoms related to pica.

Trace element composition of pica substances was analyzed utilizing procedures to identify specific trace elements. The laboratory analysis was based upon a previous study of Edwards et al. (1959) with the exception of the pica substance to the extractant ratio. The laboratory analysis determined the trace element composition in the total pica substance and trace elements available from the pica substance using the extraction analysis mode (Appendix E). Extractable trace element analysis, considered more relevant to the investigation was done in conjunction with the total trace element composition for each pica substance. The analyses of the trace element composition of the dried packed red cell samples and the pica substances analyses were perforemd in the Shared Research Resource Laboratory of the East Carolina University School of Medicine. Analyses were performed using an energy dispersive x-ray induced x-ray fluorescence spectrometer (EDXRF), (Appendix E).

Data concerning the cravings or other factors associated with the pica ingestion were analyzed to determine whether a relationship existed between these data and the trace element levels using chi square analysis.

CHAPTER FOUR

FINDINGS

Characteristics of Study Subjects

Two hundred eleven pregnant women were interviewed for possible inclusion in the study. Of these women, twenty-two (10.4%) reported consumption of non-food substances since becoming pregnant. Two of the 22 were excluded from the study; one due to an inability to obtain a blood sample prior to delivery and the other, due to inability to obtain an informed consent because of mental retardation. The twenty remaining subjects comprised the sample.

Data were collected from these 20 subjects. Their ages ranged from 14 to 34 years with a mean of 23 years. The mean gestational weeks at the time of the interview was 30.35 with a range of 11 to 36 weeks. The number of pregnancies ranged from 1 to 8. Twenty-five percent of the subjects reported that the current pregnancy was their first. For another 20%, it was their second pregnancy and 30% reported it was their third pregnancy. For 15% it was the fourth pregnancy. While no subjects reported that this pregnancy was their fifth, sixth, or seventh pregnancy, two subjects (10%) reported that the current pregnancy was their eighth.

Of the 15 who had previous pregnancies, five of these women admitted to pica ingestion during these preceding pregnancies. During the first pregnancy one woman reported eating clay dirt and one reported eating refrigerator frost. Another reported eating refrigerator frost, and she also consumed that substance during her second and third pregnancies. One subject reported consuming refrigerator frost during her second and laundry starch during her third pregnancy. The fourth subject reported eating sweet grass during the second and third pregnancy. Finally, the fifth subject reported eating crushed ice and refrigerator frost during her second pregnancy.

Pica Substances Ingested

The substances consumed during this pregnancy by the subjects included refrigerator frost, clay dirt, cornstarch, laundry starch, baked clay dirt, sweet grass, field dirt, and baking soda (Table 1). Three subjects reported eating more than one substance.

Table 1

Pica Substances Consumed by Pregnant Subjects

Substance	Number Reporting Ingestion
Refrigerator Frost	8 (34.78%)
Clay Dirt	4 (17.39%)
Cornstarch	4 (17.39%)
Laundry Starch	3 (13.0%)
Baked Clay Dirt (350° x 10 min.)	1 (4.34%)
Sweet Grass	1 (4.34%)
Field Dirt	1 (4.34%)
Baking Soda	1 (4.34%)

<u>Frequency of Pica Ingestion</u>

Over half (52%) of the subjects reported pica eating once per week or more. The frequency for 48% of the pica subjects was less, i.e. "at intervals" to several times a pregnancy (Table 2).

Table 2

Frequency of Pica Ingestion
by Pregnant Subjects

Frequency	Number
Twice a day	1 (4%)
Once a day	6 (26%)
2-3 times/week	4 (18%)
1 time/week	1 (4%)
1-2 times/month	2 (8%)
Every month	1 (4%)
Every 3 months	2 (8%)
2-3 times during the entire pregnancy	2 (8%)
Every 6 months	1 (4%)
Intervals	2 (8%)
One time	1 (4%)

Last Time of Pica Ingestion

When questioned regarding the last time of pica consumption, 48% of the subjects reported ingestion within the last three days. The remainder of the women reported pica ingestion ranging from one week ago to six months ago (Table 3).

Table 3

Last Time of Pica Ingestion
by Pregnant Subjects

Last Pica Ingestion	Number
Yesterday	8 (34.78%)
Two days ago	1 (4.34%)
Three days ago	1 (4.34%)
Last week	2 (8.69%)
Two weeks ago	2 (8.69%)
One month ago	3 (13.0%)
Three months ago	1 (4.34%)
Six months ago	5 (21.73%)

Age at Which Pica Ingestion Began

Subjects were also questioned as to when they began eating the particular pica substance. Eleven subjects (55%) reported that they began their pica eating as a child, aged from 4 to 12 years. Four of these 11 women reported that they had ceased their pica ingestion, but began again during pregnancy. Eight women (40%) reported initiation of pica ingestion during pregnancy. Only one woman began ingesting pica substances as an adult not during pregnancy, but she reported continuing during pregnancy.

Reasons Identified Prompting Pica Ingestion

The majority of the women (58%) identified the reasons prompting pica ingestion as a "taste" for the pica substance or the pica having a good taste. Other reasons reported included they "wanted it," "liked it," "it smelled good," or they "craved it" (Table 4). Some subjects gave more than one reason.

Table 4

Reasons Identified Prompting Pica Ingestion by Pregnant Subjects

Reason	Number
Taste for it	6 (27.2%)
Taste	4 (18.1%)
Good taste	3 (13.6%)
Dirt taste	2 (9.0%)
Wanted it	2 (9.0%)
Like it	1 (4.5%)
Mouth has funny taste	1 (4.5%)
Smells good	1 (4.5%)
Craved it	1 (4.5%)
Don't know	1 (4.5%)

Hematocrit

A mean hematocrit level of 34.79 gm./100 ml was detected in the pica eating pregnant women with a range of 27 to 48 gm./100 ml. (The normal hematocrit, a measurement of the percentage by volume of packed red blood cells in a whole blood sample, for pregnant women ranges from 37 to 47 gm./100 ml.) Fifteen subjects (75%) had hematocrits below the minimum of 37 gm./100 ml., thus indicating maternal anemia.

Trace Element Composition of Pica Substances

Pica substances collected from respondents were analyzed for total trace elements extractable from each pica substance. Data for the available trace elements, more relevant to the investigation than the total analysis are presented here for each pica substance. Appendices I, J, K, and L present a breakdown of these data by individual samples.

A. Refrigerator Frost

The trace minerals silicon, iron, nickel, copper, zinc and selenium were extractable from the refrigerator frost. Silicon was present in each refrigerator frost sample (Table 5).

Table 5

Mean and Range of Available

Trace Element Levels in Refrigerator Frost

N = 8

Trace Element	Mean Available Trace Element (mg/g)	Range of Available Trace Element (mg/g)
Silicon	.0013	.0002-.0028
Vanadium	-	-
Chromium	-	-
Manganese	-	-
Iron	•.0000069	.0000007-.000032
Cobalt	-	-
Nickel	x.0000018	.0000007-.000003
Copper	ⓧ.0000047	.0000002-.000021
Zinc	ⓧ.000080	.0000003-.00052
Selenium	x.0000007	-
Molybedenum	-	-

\+ detected in one sample
x detected in two samples
• detected in six samples
ⓧ detected in seven samples

B. Clay

Five clay samples, one of which was baked at 350° for 10 minutes, were analyzed. The trace minerals, silicon, vanadium, chromium, iron, nickel, copper, zinc and selenium were extractable from the pica substance (Table 6).

Table 6

Mean and Range of Available

Trace Element Levels in Clay

N = 5

Trace Element	Mean Available Trace Element (mg/g)	Range of Available Trace Element (mg/g)
Silicon	.607	.35-.89
Vanadium	.011	.0037-.033
Chromium	.0014	.00055-.0024
Manganese	-	-
Iron	.09	.015-.34
Cobalt	-	-
Nickel	ǀ .012	.00029-.048
Copper	.0011	.00051-.0019
Zinc	.0017	.0002-.016
Selenium	+ .00004	-
Molybedenum	-	-

+ detected in one sample
ǀ detected in four samples

C. Cornstarch

Cornstarch was analyzed from four of the subjects. Five trace minerals, iron, copper, zinc, selenium and silicon were detected in analysis of the extractable elements (Table 7).

Table 7

Mean and Range of Available

Trace Element Levels in Cornstarch

N = 4

Trace Element	Mean Available Trace Element (mg/g)	Range of Available Trace Element (mg/g)
Silicon	.045	.015-.076
Vanadium	-	-
Chromium	-	-
Manganese	-	-
Iron	.0003775	.00011-.00078
Cobalt	-	-
Nickel	x.000063	.000026-.0001
Copper	.063	.000048-.25
Zinc	.00037	.00004-.00098
Selenium	+.00002	-
Molybedenum	-	-

\+ detected in one sample
x detected in two samples

D. Laundry Starch

Three samples of laundry starch were analyzed and the available trace elements were silicon, iron, nickel, copper and zinc (Table 8).

Table 8

Mean and Range of Available

Trace Element Levels in Laundry Starch

N = 3

Trace Element	Mean Available Trace Element (mg/g)	Range of Available Trace Element (mg/g)
Silicon	.059	.039-.093
Vanadium	-	-
Chromium	-	-
Manganese	-	-
Iron	.00060	.00025-.0012
Cobalt	-	-
Nickel	[x].000034	.000017-.00005
Copper	.000068	.00006-.000075
Zinc	.0002	.00012-.00024
Selenium	-	-
Molybedenum	-	-

x detected in two samples

E. Baking Soda

One specimen of baking soda was collected and analyzed; silicon and copper were detected.

F. Sweet Grass

The analysis of sweet grass detected the trace minerals of silicon, manganese, iron, copper and zinc (Table 9).

Table 9

Available Trace Element Levels in Sweet Grass

N = 1

Trace Element	Available Trace Element (mg/g)
Silicon	6.2
Vanadium	-
Chromium	-
Manganese	.32
Iron	.036
Cobalt	-
Nickel	-
Copper	.012
Zinc	.046
Selenium	-
Molybedenum	-

G. Field Dirt

A multitude of trace metals were detected in the analysis of field dirt. Trace minerals detected were silicon, vanadium, chromium, manganese, iron, nickel, copper and zinc (Table 10).

Table 10

Available Trace Element Levels in Field Dirt

N = 1

Trace Element	Available Trace Element (mg/g)
Silicon	.51
Vanadium	.0056
Chromium	.0021
Manganese	.0025
Iron	.028
Cobalt	-
Nickel	.0006
Copper	.0015
Zinc	.0018
Selenium	-
Molybedenum	-

The subjects' reported pica consumptions were analyzed to determine the approximate individual consumption of each specific trace element. The concentration available was multiplied by the number of grams the individuals reportedly consumed per day to obtain the approximate individual consumption. The reported consumption is compared with the known recommended dietary ingestion and a high dietary source (Table 11). High dietary sources are food sources with higher levels of specific trace elements than average food sources. High dietary source levels were used for comparison due to the reported high individual consumption levels. The consumption level of each trace metal detected generally exceeded the recommended dietary ingestion. A wide range of variation exists for individual consumption of the specific trace minerals.

Table 11

Recommended Dietary Ingestion, High Dietary Source Levels and the Mean and Range of Daily Individual Consumption of Trace Metals of Study Subjects

Trace Element	Recommended Dietary Ingestion (mg)*	High Dietary Source (mg/g) **	Daily Individual Consumption Mean (mg)	Daily Individual Consumption Range (mg)
Silicon	unknown	-	7600	.00089-49000
Vanadium	unknown	-	800	73-510
Chromium	.05-.02 (estimated)	.3-2.0	5800	.39-35000
Manganese	2.5-5 (estimated)	.01-.1	110	4.8-250
Iron	18	.05-.18	460	.0050-3300
Cobalt	unknown	.22-1.0	-	-
Nickel	less than .0006 (estimated)	-	57000	.0017-620000
Copper	2-2.5	.001-.1	400	.0051-8100
Zinc	20	.04-.1	36	.0021-190
Selenium	.05-.2 (esimated)	.3-1.0	.13	.28
Molybedenum	.15-0.5 (estimated)	1.0-4.0	-	-
Iodine	.175	.3-50	-	-
Fluorine	1-3 (estimated)	10-100	-	-
Tin	less than 1.0	-	-	-

*Nutrition and Diet Therapy, (pp. 163-165) by S. R. Williams, 1981, St. Louis: C. V. Mosby Co.

**Handbook of Vitamins, Minerals and Hormones, (pp. 66-177) by R. J. Kutsky, 1981, New York: Von Nostrand Reinhold Co.

Number of Dried Packed Red Cell Samples in Which Specific Trace Elements Were Detected

Blood samples were collected from 20 subjects during their prenatal visit. Iron and copper were detected in the dried packed red cells of each subject. Zinc was detected in nineteen of the blood samples and selenium in one sample (Table 12).

Table 12

Number of Dried Packed Red Cell Samples of Pregnant Subjects in Which Specific Trace Elements Were Detected

Trace Element	Number of Dried Packed Red Cell Samples
Silicon	0
Vanadium	0
Chromium	0
Manganese	0
Iron	20
Cobalt	0
Nickel	0
Copper	20
Zinc	19
Selenium	1
Molybedenum	0
Iodine	0
Fluorine	0
Tin	0

Trace Element Levels in Dried Packed Red Cells

The packed red cell portion of these blood samples, taken for hematocrit determination, were also used for trace element analysis. The analysis presents the trace mineral concentration ddetermined in the dried packed red cells, not a normal sample type (Table 13). The investigator, to date, was unable to find existing information regarding the trace element content in dried packed red cells, but limited informationwas available for packed red cells. A blood sample from a healthy, non-pica eating female of childbearing age was obtained and analyzed to determine a conversion factor (.386 g/ml) to convert from dried packed red cells to packed red cells. The mean and range for the specific trace element levels of the pregnant subjects were less than the normal levels in dried packed red cells (Table 13).

Table 13

Mean and Range of Trace Element Levels in Dried Packed Red Cells of Pregnant Subjects Compared to Normal Dried Red Cell Levels

Trace Element	Normal Dried Red Cell *	Mean (mg/g)	Range (mg/g)
Silicon	-	-	-
Vanadium	-	-	-
Chromium	-	-	-
Manganese	.015	-	-
Iron	-	1.7	.9-2.4
Cobalt	-	-	-
Nickel	-	-	-
Copper	.730	.0096	.006-.023
Zinc	11	.076	.013-.11
Selenium	.15	.001	-
Molybedenum	-	-	-
Iodine	-	-	-
Fluorine	-	-	-
Tin	-	-	-

* Adapted from Neutron Activation Analysis for Clinical Trace Element Research, p. 74) by K. Heydorn, 1984, Boca Raton, Florida: CRC Press, Inc.

CHAPTER FIVE

Discussion and Recommendations

Summary

Two hundred eleven pregnant women seeking prenatal care in Edgecombe and Halifax counties health department were screened using the pica history interview schedule to elicit a sample of non-food pica eaters. Twenty-two (10.4%) of these women admitted to the practice of pica ingestion during their courrent pregnancy. Two women were subsequently excluded from this number.

These remaining 20 subjects comprised the sample. Data were collected concerning their pica history and reasons for the pica ingestion; the trace element composition of the pica substances and the trace elements in their blood.

Discussion

All subjects identified as practicing pica were black. This finding is consistent with the report of the National Academy of Sciences Committee on Nutrition of the Mother and Preschool Child (Lackey, 1982) in which pica was cited as a not uncommon practice among southern, rural, black women.

However, this 10.4% reported incidence is lower than other reports in the literature, ranging from 16% to 68%. The 10.4% incidence of this study may be due to a better nutritionally educated and nutritionally advantaged population. Many southern rural patients in health departments are participants in the WIC Program, a federally subsidized program of nutrition education and food vouchers for milk, cheese products, etc. We do not know which of the study subjects were participants in this program; however, such participation would lead to an enhanced level of nutritional status and, possibly, a decreased incidence of pica. The onset of the pica ingestion is worthy of note. Over half of the subjects reportedly began their pica eating as a child and only 4% began their pica ingestion during pregnancy. While pica is generally a problem associated with pregnancy, it is obviously not limited to this phase of life and efforts to find its cause should be directed elsewhere, rather than the pregnancy alone.

It is evident from Table 11 that the subjects ingested extremely high levels of trace elements. Although samples varied in their composition, the mean levels of consumption of the various trace metals are high, relative to a dietary source. At the same time, the data indicate that the level of trace elements in the blood, measured through dried packed cells, were nowhere near this high. One might conclude that pica ingestion occurs as a physiological response to trace metal deficiencies occurring both during pregnancy and during childhood, both periods of increased demand due to growth of the individual or fetus.

We do not know the reason why these trace elements are not available to the body. It may be that there are physiological factors which inhibit their absorption, such as chelating substances which bind the trace elements and prohibit their absorption. Such chelating "phytates" are found in beans, peanuts or collards (Minnich et al., 1968). In a low income rural population, these substances may form the backbone of the diet, rather than meats and other proteins. Therefore, such dietary practices might be understandable, and, simultaneously, harmful to mother and child. The inavailability of the trace elements by the body may result in trace element deficiences and subsequently the practice of pica.

The increased incidence of birth anomalies and complicated pregnancies has been well documented among indigent black women. Since even mild trace element deficiencies can produce significant birth defects in rats, mice, poultry, cattle and sheep, it is likely that the trace element deficiencies seen in these patients may be a major contributing cause of obstetric and neonatal problems seen in this population. If this is true, these serious health problems are preventable by simple dietary and public health measures.

The pica substances and percentages reported ingested by the subjects in this investigation were similar to the substances and percentages reported in the literature. Percentages of the reported clay ingestion from previous studies ranged from 25% to 55%. Clay was the reported pica substance of choice for 21% of the subjects in this investigation and one subject preferred clay dirt baked for ten minutes at 350°.

The subjects also reported cornstarch ingestion, 13.5%, while previous studies ranged from 14.8% to 23%. In contrast to previous investigations where refrigerator frost was not reported as ingested, 34.8% of these subjects reported refrigerator frost ingestion. While collecting the refrigerator frost, the investigator noted the scant amount of frost in the freezer due to frequent ingestion. Its preference for the pica practitioners may be related to accessibility, cleanliness and acceptance of the substance. Refrigerator frost ingestion does not have the negative stigma associated with clay ingestion.

Frequent ingestion of the pica substance, within a three day period was reported by 48% of the subjects. Thus nearly one half of the pica practitioners are ingesting their pica frequently, possibly as a result of a physiological need for deficient trace minerals.

Pica practitioners identified taste as the reason prompting pica ingestion. This finding is in contrast to some of the literature which reports that pica ingestion may be in response to increased salivation, hunger, nausea and changes in taste and smell during pregnancy. Pica ingestion in response to a craving or a taste for the pica substances provides additional support for the practice of pica as a physiological response to a single or multiple trace metal deficiency(ies).

An important point to be made from this study is that comparison of the total trace element levels with the available or extractable trace element level demonstrates the inadequacy of looking only at total trace element levels to evaluate trace elements in humans. There is a wide variation between the two (Tables 6-10). Evaluating the trace element levels in dried packed red cells is difficult due to the sparseness of research in this area and the unknown trace element contributions by normal foodstuffs and dietary supplementation. The trace element, silicon was detected in each pica sample although it was not detected in the dried packed red cell samples. This finding is due to the limitation of the EDXRF process with the very low atomic weight elements. Iron was found in the samples of clay, sweet grass and field dirt at the same level (1.9 mg/g) though this information must be qualified by the fact that only one sample of sweet grass and field dirt were analyzed.

Recommendations

Based upon the findings of this study the following recommendations were made pertinent to nursing practice and future research.

Pica ingestion, a phenomenon of pregnant women and children; rapid growth and development periods with increased trace element demands should be investigated as a statistically signficant source of the dietary needs of trace minerals. The role of trace mineral supplementation in regard to pica cessation requires further investigation. Pica investigations should be a standard component of prenatal assessments and as this investigation demonstrates, also part of the assessment for sick and well child visits. Questions regarding pica ingestion should be direct, "do you eat clay, cornstarch, ice, refrigerator frost, or any other non-food substance?" Questioning should also be nonthreatening, non-judgemental, and allow the patient adequate response time.

As an association between pica ingestion and a below normal hematocrit for the pregnant pica eating females in this study exists, the admission of pica by prenatal and pediatric clients should alert health care providers to investigate the existence of maternal anemia, its potential etiology and compliance with iron supplementation therapy. The existence of maternal or pediatric anemia should alert health professionals to question clients regarding the practice of pica. Since 58% of the subjects identified taste as prompting pica ingestion, health care providers should determine whether food substances or trace element supplementation will satisfy the cravings for specific pica substances.

A stigma is related to the social unacceptability of the ingestion of non-food substances as clay dirt, laundry starch, etc. If indeed pica results from single or multiple microelement deficiencies then the negative stigma held by health care professionals, i.e., nursing, has no basis. Nursing educators, obstetrical, pediatric, and community health nurses currently lack this knowledge.

It is further proposed that this study be repeated with a larger number of subjects, including subjects seeking prenatal care from private obstetricians, pediatric subjects and middle socioeconomic subjects. A replication of this investigation could include non-pica practicing pregnant females matched for age, race, location, and socioeconomic status.

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APPENDICES

Appendix A

CLIENT CONSENT FORM

This study is a study on eating likes and dislikes of pregnant women. Women in the maternity clinic are being asked about what they like to eat. Whether or not you are willing to help is your decision. Your name and answers are confidential. The interview will take about five minutes. Your responses may indicate a need for a home visit by me. Would you be willing to participate in the study?

____________________ Date

____________________ Client Signature

APPENDIX B

____
Interview Number

Pica History Interview Schedule

Hello, my name is Robin Webb Corbett. I am a student nurse doing a study on what pregnant women like to eat and do not like to eat. I am asking women in the clinic about what they like to eat and I'd like to ask you my questions. Whether or not you are willing to answer is your decision. This study involves me asking you questions about what you like to eat. Your name and your answers are confidential. It will take about five minutes.

I. Demographic

Initials:	Gestational Weeks:
Date of birth:	Race:
Hematocrit:	Parity:

II. Some people experience cravings or a strong desire for a particular food or substance.

1. Have you ever craved or had a very strong urge to eat a particular food or substance, at any time, not just now during this pregnancy?

   Yes_____ No_____

   if yes go to question 2

   if no go to question 4

2. What were they? ____
3. Anything else? ____
4. Have you had cravings or strong urges to eat something since you've been pregnant? Yes_____ No_____

   if yes go to question 5

   if no go to question 7

5. What were they? ____________________

6. Anything else? ____________________

7. Have you had cravings or strong urges to eat something with your other pregnancies? Yes_____ No_____

   if yes go to question 8

   if no go to question 11

8. What were they? ____________________

9. Anything else? ____________________

10. Which pregnancy?

    ___1 ___2 ___3 ___4 ___5 ___other

III. 11. Since you became pregnant have you eaten any particular things. . .

   a. to relieve nausea or feeling sick at your stomach?

      Yes_____ No_____

      if yes go to question i

      if no go to question b

      i) what are they? ____________________

      ii) anything else? ____________________

   b. to relieve excess salivation or a lot of water in your mouth?

      Yes_____ No_____

      if yes go to question i

      if no go to question c

      i) what were they? ____________________

      ii) anything else? ____________________

   c. to relieve hunger pangs? Yes_____ No_____

      if yes go to question i

      if no go to question d

i) what are they? ______________________________

ii) anything else? ______________________________

d. because of changes in your sense of smell? Yes_____ No_____

if yes go to question i

if no go to question e

i) how do things smell differently? ____________________

ii) what do you eat? ______________________________

iii) anything else? ______________________________

e. because of changes in your sense of taste? Yes_____ No_____

if yes go to question i

if no go to question 15

i) what do you eat? ______________________________

ii) anything else? ______________________________

15. Some women have reported that they eat clay for its salty taste and others for its sweet taste. Have you ever eaten food or other things for their sweet or salty taste? Yes_____ No_____

if yes go to questions a and b

if no go to question 16

a. sweet ____________________

b. salty ____________________

Some women during pregnancy eat a particular food or other substance. Some substances that other women report eating are things like clay, cornstarch, and cleaning products.

16. Have you ever eaten any of those products? Yes_____ No_____

if yes go to question 17

if no to all of the above questions conclude the interview schedule with:

Thank you for your cooperation. I appreciate your help and I wish you well with your pregnancy.

17. What have you eaten? ______________________________

18. When did you first start eating ______________? ______________
    pica substance

19. How long have you been eating ______________?
    pica substance

    _____ days _____ weeks _____ months _____ years

20. Approximately how much ______________ do you eat at a time? (show me)
    pica substance

    ________ tablespoon(s)

    ________ cup(s)

    ________ handful(s)

    ________ other

21. When did you last eat ______________? ______________
    pica substance

22. What other reasons can you think of to tell my why you eat ________ pica ________ substance? ______________________________

    ____

Thank you for your cooperation. I would like to arrange a time to obtain a small sample of your ______________ (pica substance). (Show her specimen container) May I take you home after maternity clinic? Yes_____ No_____

May I stop by your home this afternoon? Yes_____ No_____

if no

When would it be convenient for me to visit you today or tomorrow?

____
Appointment date and time

Thank you again and I look forward to seeing you on ______________ appointment date and time.

Appendix C

PICA SUBSTANCE AND INTERVIEW NUMBER RECORDER FORM

Sample Number	Interview Number	Pica Substance

Appendix D

AGENCY AGREEMENT FORM

Investigation of Pica History and Trace Elements in

Pica Substances Ingested by Pregnant Females

in Eastern North Carolina

I, ______________________________ understand the proposed research, an
Health Department Director
investigation of pica history and trace elements in pica substances ingested by pregnant females in eastern North Carolina to be conducted by Robin Webb Corbett, R. N. I approve the study and consent to the inclusion of ______________ County Health Department maternity patients if the patient consents.

________________	____________________________________
Date	County Health Department Director

Appendix E

Trace Element Extraction Procedure

The extractions were performed as follows. Two grams of the pica substance was freeze dried and powdered with a mortar and pestal and weighed into plastic 50 ml. centrifuge tubes. Forty ml. of .1 N HCl was added to the centrifuge tubes and capped. The tubes sat for 2 hours 15 minutes, placed in a horizontal position and then shaken (60-80 excrusions/second) for 1 hour. Removed from the shaker, the tubes were put in the centrifuge for 30 minutes to spin down the solids. Samples for analysis were drawn off the top.

Analyses were performed using a Kevex model 0600 Ultra Trace energy dispersive x-ray induced x-ray fluorescence spectrometer (EDXRF). Ultra thin techniques were used in accordance with the manufacter's instructions. The samples were mounted on Formvar films, irridated with silver filtered tungsten x-radiation. The tungsten tube was operated at 31 Kv and at an appropriate current to yield 50% dead-time to the counting mechanism. The system was calibrated for each matrix with appropriate matrix match or simulated standards.

This data was graphically represented for trace elements in each pica substance sample, each sample of extractable elements and each sample of dried packed red cells. Samples of each of these graphs are included for a laundry starch sample in Appendix F.

Appendix F
Graphic Representation of Available Trace Element Concentration

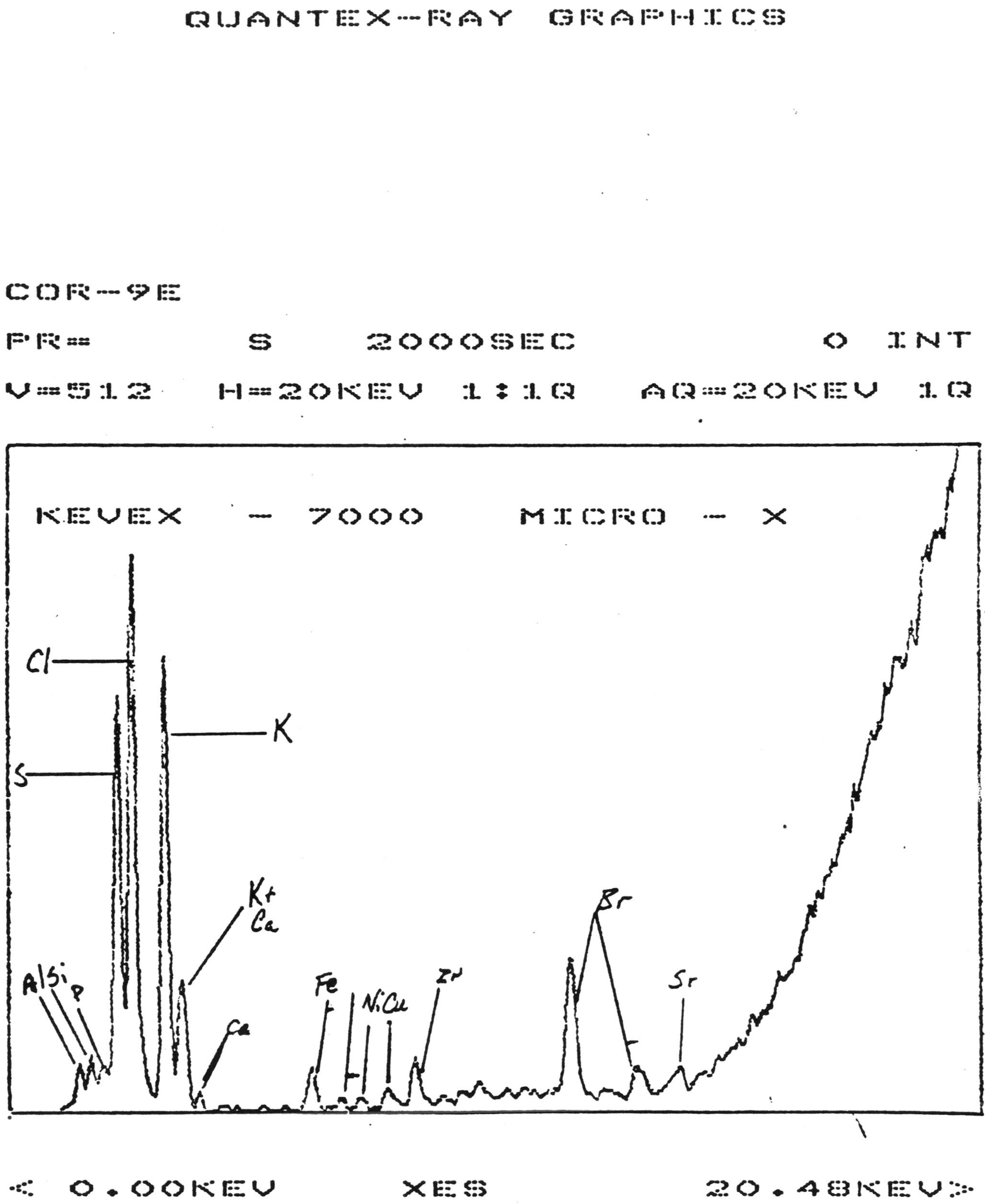

Figure 2 Example of EDXRF graphical output for extractable elements; example is that of extractables from laundry starch

Appendix F

Graphic Representation of Trace Element Concentration

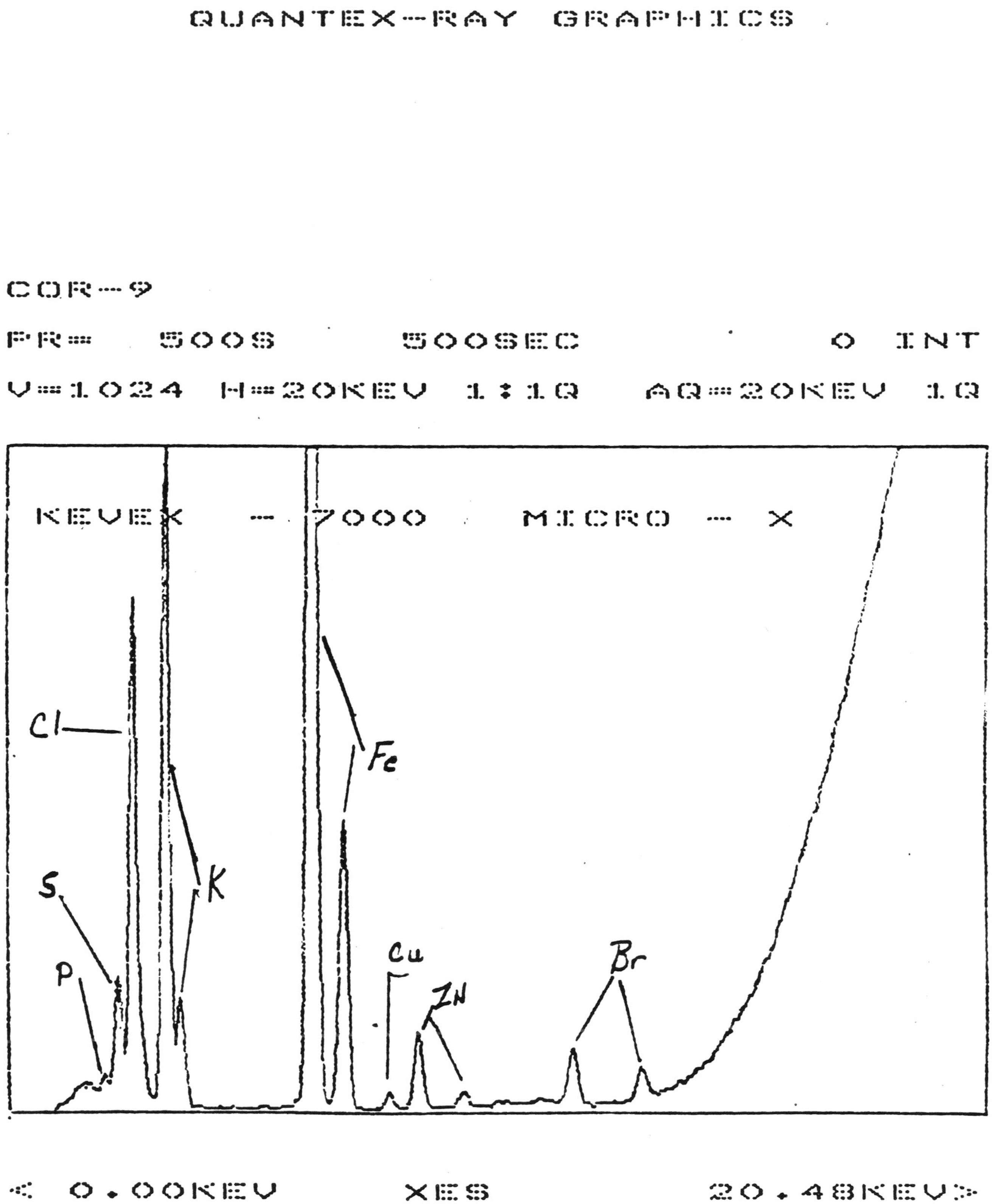

Figure 3 Example of EDXRF graphical output for dried packed red cells

Graphic Representation of Trace Element Concentration

QUANTEX-RAY GRAPHICS

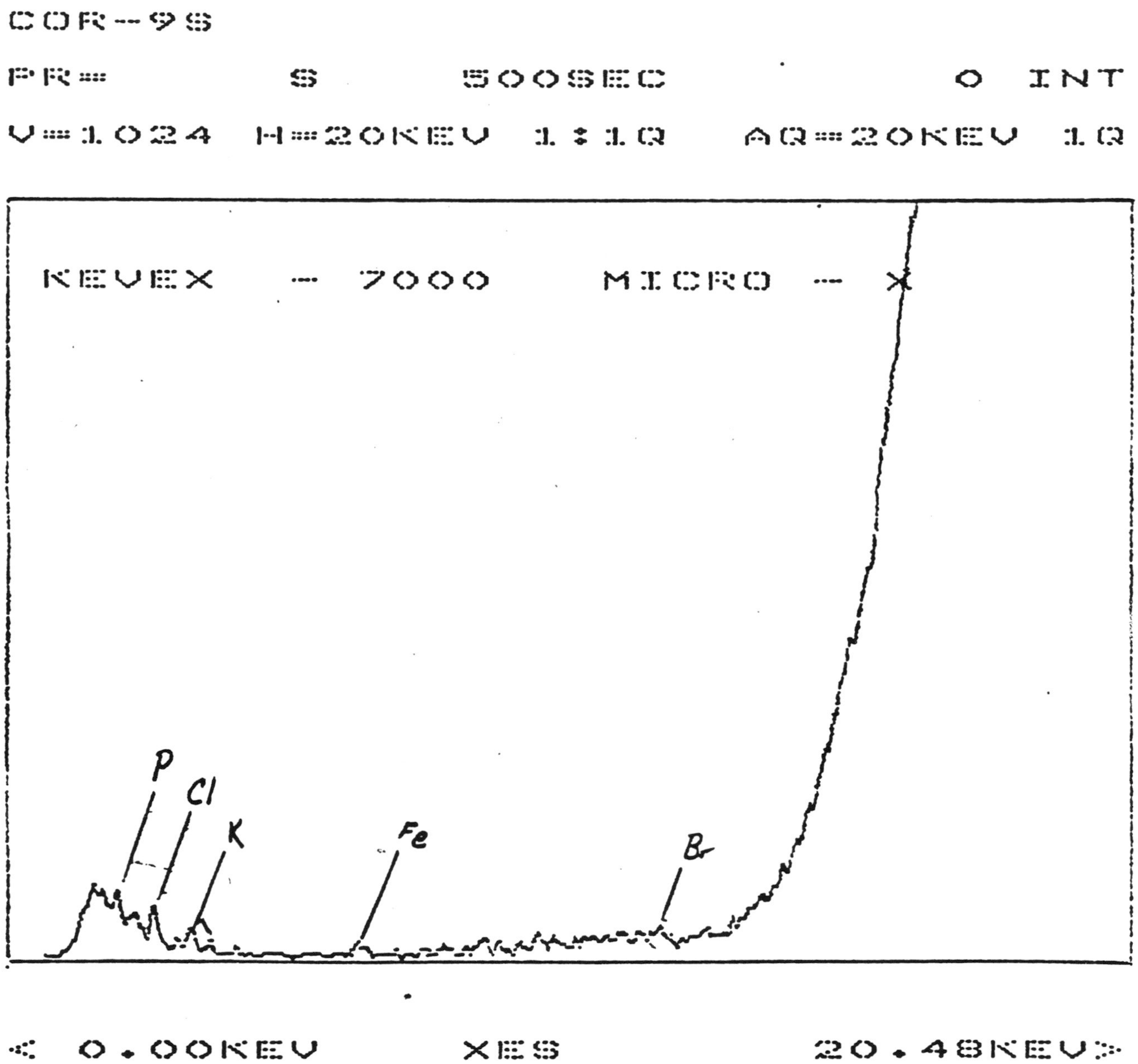

Figure 1 Example of EDXRF graphical output for solids; example is that of laundry starch.

Appendix G

Total Trace Elements Concentration in Pica Material
(mg/g)

Trace Element																							
Silicon			170	160	4.7	220		140				160				130							
Vanadium				.1				.15				.1				.1							
Chromium			.036	.071		.13		.061				.092				.048							
Manganese			.045	.063	.063	.09		.063								.17							
Iron			16	210	.21	43		20				46											
Cobalt				.011				.016								.011							
Nickel			.001	.017		.02		.01				.021				.00095							
Copper			.007	.009	.011	.019		.007				.0057				.00095							
Zinc			.016	.031	.03	.036		.02				.013				.017							
Selenium																							
Molybdenum			.025	.014		.005		.007				.014				.02							
Iodine																							
Fluorine																							
Tin																							
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Cornstarch	Refrigerator Frost	Clay	Baked Clay	Sweet Grass	Field Dirt	Cornstarch	Clay	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Clay	Cornstarch	Refrigerator Frost	Cornstarch	Clay	Laundry Starch	Baking Soda	Refrigerator Frost	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Refrigerator Frost

Appendix H

Available Trace Elements Extractable from Pica Material (mg/g)

Trace Element																							
Silicon	.046	.0002	.35	.38	.62	.51	.015	.71	.039	.0007	.00012	.71	.076	.0027	.043	.39	.044	2.2	.0019	.093	.0016	.00034	.0028
Vanadium			.0039	.0037		.0056		.033				.0043			.012								
Chromium			.0008	.00095		.0021		.0023				.00055			.0024								
Manganese					.32	.0025																	
Iron	.00034		.015	.025	.036	.028	.00011	.033	.00025	.0000032	.0000007	.038	.00078	.000011	.00028	.34	.00034			.0012	.0000034	.0000013	.0000022
Cobalt																							
Nickel			.048		.00044	.0006		.00029	.00005	.0000007		.001	.0001		.000026	.00038	.000017						.000003
Copper	.000048		.00051	.00055	.012	.0015	.25	.0014	.00006	.0000013	.0000002	.0019	.00018	.0000032	.000065	.0013	.00007	.0032	.0000026	.000075	.000004	.0000007	.000021
Zinc	.00098		.0002	.0015	.046	.0018	.00004	.00037	.00012	.0000017	.0000003	.0008	.0032	.00052	.00014	.0057	.00024		.0000048	.00024	.000012	.0000006	.000024
Selenium	.00002									.0000007		.00004											
Molybedenum																							
Iodine																							
Fluorine																							
Tin																							
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Cornstarch	Refrigerator Frost	Clay	Baked Clay	Sweet Grass	Field Dirt	Cornstarch	Clay	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Clay	Cornstarch	Refrigerator Frost	Cornstarch	Clay	Laundry Starch	Baking Soda	Refrigerator Frost	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Refrigerator Frost

Appendix I

Individual Consumption of Specific Trace Elements (mg/day)

Trace Element																							
Silicon	650	45	45000	49000	470	17000	490	10731.4	13000	79	.98	500	460	610	3.4	.00025	6.9	16000	431	21000	19	77	65
Vanadium			505	480		181		500				3050				73							
Chromium			104	120		68		35000				.39				15							
Manganese	4.8178				245.29	80.97																	
Iron			1900	3300	27	907	3.6	499	.09	.37	.0050	27	4.7	2.5	.022	2070	.054			.97	.04	.30	2.5
Cobalt																							
Nickel			620000		.33	19		4.4	.0017	.08		.71	.61		.0020	23	.0026						
Copper	.680		66	71	9.1	49	8100	21	20	.15	.0014	1.3	1.09	.73	.0051	7.9	.011	1.5	.59	.06	1.049	.16	2.4
Zinc	14		26	190	35	58	1.3	5.6	40	190	.0021	.57	1.9	118	.011	35	38		1.09	.19	.15	.14	2.7
Selenium	.28									.08		.028											
Molybedenum																							
Iodine																							
Fluorine																							
Tin																							
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Cornstarch	Refrigerator Frost	Clay	Baked Clay	Sweet Grass	Field Dirt	Cornstarch	Clay	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Clay	Cornstarch	Refrigerator Frost	Cornstarch	Clay	Laundry Starch	Baking Soda	Refrigerator Frost	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Refrigerator Frost

Appendix J

Trace Element Concentration in Dried Packed Red Cells of Pregnant Pica Practitioners (mg/g)

Trace Element																							
Silicon																							
Vanadium																							
Chromium																							
Manganese																							
Iron	1.6	1.5	1.6	1.6	1.9	1.9	1.2	2.0	·2.2	1.7	2.1	2.2	1.9	1.8	1.8	2.2	2.4	1.5	.96	.9	.89	.97	2.2
Cobalt																							
Nickel																							
Copper	.015	.015	.015	.015	.01	.01	.018	.0075	.006	.012	.0065	.0092	.0083	.008	.0088	.0073	.0038	.012	.022	.023	.013	.019	.0064
Zinc	.033	.024	.19	.19	.042	.042	.032	.022	.038	.037	.026	.11	.022	.028	.02	.023	.027	.022	.013	.013	.021	.017	.024
Selenium	.001																						
Molybedenum																							
Iodine																							
Fluorine																							
Tin																							
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Cornstarch	Refrigerator Frost	Clay	Baked Clay	Sweet Grass	Field Dirt	Cornstarch	Clay	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Clay	Cornstarch	Refrigerator Frost	Cornstarch	Clay	Laundry Starch	Baking Soda	Refrigerator Frost	Laundry Starch	Refrigerator Frost	Refrigerator Frost	Refrigerator Frost