THE RELATIONSHIP OF PAGOPHAGIA AND IRON-DEFICIENCY ANEMIA IN PREGNANT WOMEN

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INTRODUCTION

The word pica is derived from the Latin word for magpie, a bird known for its unselective appetite. Pica is a perversion of appetite characterized by the compulsive consumption of a substance, usually a single item. The most extensively reported types of pica are geophagia (dirt, clay, and ash-eating) and anylophagia (starch-eating). The purposeful ingestion of ice is a form of pica termed pagophagia by Coltman in 1966(1).

In the past 40 years, several studies have documented a relationship between pica and anemia, particularly iron-deficiency anemia (2,3,4,5,6). Although some investigators claim that pica is a certain sign of iron-deficiency (4,7,8), others write that the association between nutrition and pica is still unclear (3,9,10). There are some conflicting reports on the efficacy of iron supplementation in the treatment of pica (11,12). Geophagia has been reported in association with zinc and copper deficiencies as well as iron deficiency (10,13). The question of whether geophagia and amylophagia are the cause or the effect of deficiency states is still debated (6). It seems that pica is not a single entity, but a set of related behaviors with varying causes and several effects (10,14,15). The etiologies of pica have been attributed to cultural, psychological, social, instinctual, and physical mechanisms (1,2,3,11,13).

Although pica is reported to occur at all ages and in either sex, it is usually manifested by children and pregnant women. The possibility of a direct association between pica and a specific nutrient deficiency makes the investigation of pica intriguing. The association of this unusual eating habit with the intense growth and increased vulnerability to malnutrition during childhood and pregnancy makes the investigation of pica compelling.

Iron-deficiency anemia is the most common complication of pregnancy (17). Between 10-60% of pregnant women are reported anemic (18), with an estimated 90% caused by iron deficiency (19,20). Holly states that without facilities for serum iron studies, iron deficiency may be assumed the cause of anemia in pregnancy until proven otherwise by therapeutic trial (21).

In recent years, pagophagia has become one of the most common forms of pica in the U. S. (8). If this prevalent form of pica can indeed be shown to be a reliable indicator of iron-deficiency anemia, it would be a most helpful adjunct to the clinical care of pregnant women. This is especially true in the public clinics where often the first, and possibly most influential meeting with the nutritionists is conducted before the results of biochemical studies are available.

STATEMENT OF THE PROBLEM

Maternal response to anemia during pregnancy can range anywhere from an exaggerated heart response during exercise to tissue hypoxia and anemic heart failure. Hematocrit values of 30% or less cause fetal hypoxia that may affect intrauterine growth. Infants from mothers with untreated anemia show decreased viability at birth. Profound maternal anemia is associated with perinatal mortality (22).

Pritchard and Scott showed that one-third of a large group of apparently healthy young women had negligible iron stores. Another third had iron stores equal only to the iron content of one unit of donated blood (23). In view of these findings it is not surprising that iron-deficiency anemia is the most common complication of pregnancy.

The purpose of this research was to study pregnant women claiming pagophagia to determine if there was any association between the incidence of pagophagia and the incidence of iron-deficiency anemia.

Is pagophagia a reliable indicator of iron-deficiency anemia in pregnant women? Is the frequency of anemia among ice-eaters significantly greater than the frequency of anemia among non-ice-eaters?

HISTORICAL PERSPECTIVE

The practice of pica has been known since the fifth century B.C. Recorded in the Hippocratic collection may be the first reference to pica in surviving literature:

> Such women as cannot conceive, but appear green, without fever, and the viscera are not at fault; these will say that the head is pained and that the menstrual discharge is vitiated and scanty.
>
> Both men and women who have long had a bad color, but not in the form of jaundice . . . eat stones and earth and have piles (24).

Although almost all authors report pica as occurring in both sexes and at all ages, the earliest writers centered their attention on the condition as it affects women, and in particular, pregnant women (25). Aetius, the Royal Physician to Justinian I during the sixth century A.D. presented the first documented description of pica associated with pregnancy (1). Aetius believed that the suppression of the menstrual flow gave rise to "bloody humors" that attacked the stomach causing the pregnant woman to desire improper materials (25).

Almost a thousand years later, Greek and Roman medical knowledge passed virtually intact through the Arabic civilization to Renaissance Europe. The early European authors, therefore, also subscribed to the theory that fermental humors and foul vapors attacked the stomach causing a perversion of the appetite resulting in pica (25).

These authors found pica in both sexes, but noted an increased incidence among women, attributable to their weaker spirit and inability to resist sensuous pleasures (25). The even greater incidence of pica in pregnant women was easily explained because pregnant women obviously "are accustomed to yield to the affections and not suppress the cogitations of the mind" (26).

Many writers in this period also expressed the belief that women who practice pica produce more beautifully formed children, and that frustration of the urge may mark the fetus (25). Similar thoughts are expressed by women who practice pica today. It is interesting to note that in a period when diets were often severely restricted, cravings for a varied diet and fresh foods may have been labeled pica. Authors included as forms of pica foods we now recognize as having significant nutritive value, such as raw cabbage, clabbered milk, and yeast (25).

The earliest of the Renaissance authors offers the first description of pagophagia. Hubrighkt, in 1562, defines pica as "a longing for food strange by reason of place, of time, of nourishment, and custom. . . . (27). He gives as examples the craving for snow in summer, strawberries and asparagus in autumn, etc.

Over a hundred years later, Christiani also references what may be pagophagia (28). He differentiates, like

many authors of his day, between pica and malacia, the latter being less intractable than pica and caused by a weakness of the mind. He gives the examples of cravings for common foods, condiments, salt, wind, and even human flesh--also unusual drinks such as excessive amounts of water and iced drinks.

Among the early European writers is also found the first references to the specific use of iron in the treatment of pica. Boezo is the first to mention iron, prescribing "1-1½ scruples of iron dross every day or iron steeped in fine wine and strained through Hippocrates sleeve" (29). Dehne prescribes medications, venesection, diversion, persuasion, good nutrition, and a healthy regimen in the treatment of pica, but adds "above all, iron, lemons and a variety of fresh fruit" (26).

Lazarus Riverius, physician to the court of Louis XIV of France, in providing a systematic account of chlorosis (anemia), clearly describes pica and pagophagia:

> . . . They have in this Disease a loathing of meat, because the Stomach is filled with crude Excrements by reaction of its evil Concoction and distribution: which excrements having gotten an evil quality by a particular kind of corruption, cause a desire of evil meats, and things not ordained for nourishment, as Salt, Spices, Chalk, Coals, Ashes, and the like, which Disease is called Pica Malacia, or strange Longing. . .

> The Causes of the Obstruction in the Veins of the Womb, and the Hypochondria, are thick, slimy, and crude Humors, coming commonly from evil Diet: for these Virgins drink great draughts of Water at bed-time, or in the morning fasting; or eat Vinegar, Herbs, unripe Fruits, Snow, or Ice. . . . (30).

In the treatment of chlorosis, Riverius prescribed purging, bleeding, and bathing, and among other medication, iron:

> After you have bled sufficiently you must give an ordinary purge. . . . The ordinary Pils mentioned in the Cure of the stoppage of the Liver are most excellent; to which you may add the Medicines there mentioned, of Tartar, Vitriol, and Steel (30).

Although the apparent symptoms of anemia are often mentioned in association with pica, a cause and effect relationship was not conceived by these early writers. No specific remedy for pica was consistently mentioned in the literature of the early pica investigators. Most authors stressed the imperative of good nutrition and prescribed a variety of fresh foods, especially lemons, vegetables, meat, and fish in the treatment of pica. Among some of the more picturesque remedies, such as ashes of fossil unicorn, one occasionally finds iron in some form, sometimes prescribed incidentally as a component of a purgative (25).

In the next 200 years references to pica are found in the works of explorers, anthropologists, and the colonial physicians. This group focuses almost exclusively on

geophagia, or dirt-eating, and associates pica increasingly with the symptoms of anemia. A good example is an account by the famous explorer David Livingstone. He describes the haggard appearance, shortness of breath, progressive weakness, and bloodlessness of habitual clay-eaters in Africa (25).

Geophagia was a great concern to plantation owners and managers in the West Indies and southern United States. They observed the habit almost exclusively in negro slaves and termed the syndrome 'cachexia africanus' or 'mal d'estomac' (25). The symptoms of advanced anemia are apparent in Craigin's detail of this syndrome: extreme sluggishness, great edema, pallor of the mucous membranes, great susceptibility to cold, diminished secretions, and thin, watery blood with a livid purple hue. The leading and essential symptom of cachexia africanus, though, was an ungovernable desire to eat dirt (31). Apparent believers of the hypothesized etiology of emotional weakness or the influence of lower culture, advocated as a treatment for pica restraint in stocks and manacles, or metallic masks and mouthpieces. As several writers observed, however, this did not atler the course of the disease which eventually led to death with an abundance of fluid in the lungs (25).

Most colonial writers attributed pica to a diet inadequate in quantity and quality and to filthy living

conditions. They prescribed a plentiful and varied diet, healthy living conditions, and like earlier European writers, several note the efficacy of iron (25).

Early reports of pica in the twentieth century contain greater clinical detail, but these also point to anemia and malnutrition as underlying etiology. They also report an association between pica and parasitic infestation, a new note (25). A survey of geophagy by Lauffer in 1930 contradicts the then popular notion that pica occurs only among those of 'lower culture.' Lauffer finds that pica is not a universal phenomenon, but occurs sporadically anywhere. He reports that it has nothing to do with race, creed, cultural area, or a higher or lesser degree of culture (32).

Reports in the modern literature show pica is still prevalent among the commonly surveyed populations of pregnant women and chilren. Table 1 summarizes recent reports on the incidence of pica among pregnant and postpartum women. The majority of surveys reported investigations of predominantly black populations in the southern U. S. One study reporting frequencies by race found a significantly greater frequency of pica among the blacks. Of the black group, 41% ate clay and 25% ate starch, compared with 10% clay-eating and 7% starch-eating among the whites (33). A report of the frequency of pica among a predominantly

TABLE 1

SUMMARY OF REPORTS ON THE INCIDENCE OF PICA IN PRE- AND POSTNATAL WOMEN AND THE RELATION OF PICA TO ANEMIA

Reference	Population	Location	Form	Anemia
Fergusen, 1950 (33).	N=361 92% Black	Miss.	Clay--39% Starch--25%	Non-sig.*
Posner, 1957 (36)	N=600	Harlem, N.Y.	Starch--17% Ice--5% Clay--1%	
Payton, 1960 (37)	N=571 Black	Nashville, Tenn.	Laundry Starch--17%	
Edwards, 1959 (38)	N=86	Tuskegee, Ala.	Clay--50% Starch--20%	Non-sig.
O'Rourke, 1967 (39)	N=210 Black, Rur.	Augusta, Ga.	Clay &/or Starch--55%	Non-sig.
Keith, 1964 (40)	N=987 Predom. Blk.	Chicago, Ill.	Laundry Starch--34.6%	Sig.**
Keith, 1969 (35)	N=500 Black, His.,	Chicago, Ill.	Laundry Starch--23.8%	Non-sig.
Bruhn, 1971 (34)	N=91 His. & Wh.	Calif.	Clay & Ashes--19%	
Kitay, 1971 (41)	N=527 18% White 82% Black	Atlanta, Ga.	Clay, starch, chalk, ice, ashes--10.2%	Sig.
Bronstein, 1974 (4)	N=410 Urb. & Rur. Predom. Blk.	Georgia	Starch, chalk, clay--16%	Sig.
Vermeer, 1979 (42)	N=142 Bl., Rur.	Miss.	Chalk & Clay--28% Other--19%	Non-sig.

Abbreviations: Bl & Blk: Black, W & Wh: White, His: Hispanic, Urb: Urban, Rur: Rural

*Non-sig.: Indicates where analysis done, there was no significant association between the incidence of pica and anemia.

**Sig.: Indicates a significant association found between pica and anemia.

Mexican group (34) was comparable to the occurrence of pica elsewhere during the same time period (4,35).

The predominantly forms of pica studied are starch, clay, and chalk-eating (4,33-42). Only one study in the modern literature reports on pagophagia among pregnant women (36). This is surprising in view of Crosby's statement in 1966 that over 50% of patients with iron-deficiency anemia claim pica. Of these, one-half eat ice and one-half eat "something else" (8). Considering the high iron demands of pregnancy, pagophagia should be found among the pica practices of pregnant women. The paucity of information most likely results from the failure of researchers to question a subject specifically about ice consumption.

The hypothesized etiologies for pica remain the same as those proposed in earlier literature: cultural influences, psychological aberrations, and physiological need or abnormality (1,2,3,11,13). While cultural and social environment must surely play a role in the choice of material to be consumed, studies and observations of laboratory and domestic animals seem to negate a purely cultural or psychological etiology for pica. Pigs eat sod, usually in association with copper and iron deficiencies (2,14,43). Cattle and sheep will exhibit pica, particularly osteophagia, when consuming phophorus deficient diets(14). Rats have been found to consume a significant amount of water as ice when iron-deficient (44).

Of the physiological causes of pica, several authors throughout time have noted the association of pica with decreased socioeconomic status and generalized malnutrition (25,45). Some suggest that pica results simply from hunger and the inability to allay hunger pangs with a meager supply of food (2,4,25,40,45). Others suggest that pica results from an instinctive search for a lacking nutrient (4,25,45,46). Anemia has been associated with pica from antiquity (24). Several modern researchers have also found an increased incidence of anemia in groups practicing pica.

In 1964, Edwards et al., found a significantly increased percentage of anemics among women claiming geo- and amylophagia (46). Twenty-seven percent of the clay-eaters, and 17% of the cornstarch-eaters were anemic. Only 7% of the control group was found to have a hemoglobin of less than 10 gm/dl.

Bronstein and Dollar reported similar findings in Georgia among pregnant women who ate starch, chalk, or clay (4). Defining anemia as a hemoglobin value of less than 10 gm/dl or a hematocrit of less than 30%, 29% of the pica group were anemic. The control group showed a 13% anemia rate. A serum iron to total iron binding capacity

ratio of less than 16, showing iron depletion, was found in 55.5% of the pica subjects and only 13.6¢ of the controls.

Kitay reported that 24.5% of iron-deficient pregnant women practiced pica (19). The incidence of pica among iron-sufficient women was only 10.7%.

In contrast, O'Rourke et al. studying pica (clay and starch) among pregnant women in Georgia, reported a 1 gm decrease in mean hemoglobin value for 110 pica patients as compared to 200 nonpica patients (39). But, defining anemia as a hemoglobin value of less than 12 gm/dl, no significant association was found between the practice of pica and the occurrence of anemia. The incidence of toxemia was found to be 2 times more prevalent in the pica group, however. Vermeer, also working with pregnant and postpartum women in Georgia, found an incidence of pica in 47% of the women studied, but failed to correlate the incidence of pica with hunger, anemia, or helminthic problems (42).

Sayer et al., in Johannesburg, Africa, surveyed geophagia in black adults. They concluded that consuming the local earth and ashes cannot have a deleterious effect on iron nutrition in the vast majority of individuals (6). The mean hemoglobin in this group was 14.6 gm/dl with no increased incidence of iron-lack or anemia.

Although some studies fail to associate anemia and pica, the relationship between pica and iron appears undeniable in some cases. The first study undertaken to define the pica/iron relationship was the work of Lanzkowsky in 1959 (5). In 12 children, pica was found in association with anemia and parasitic infestation. All the children were cured of the pica and the anemia with intramuscular injections of iron dextran.

Carlander also found that iron readily cured pica, even in some patients with normal hemoglobin levels (47). Catzel found that sand-eating in 36 children aged 1-2 years was cured without exception by iron given orally or by injection. The pica was usually cured within a week using a dose less than that necessary to cure anemia (48).

In a group of 25 children claiming geophagia, MacDonald and Marshall found a mean hemoglobin of 10.4 gm/dl (12). The children were divided into 2 groups. The experimental group was treated with intramuscular iron and the control group was given saline injections. At the end of 3-4 months nearly all the treated group had ceased their pica behavior. Pica still persisted in 3/4 of the control group. As the hemoglobin levels rose, the incidence of pica decreased. Conversely, as the hemoglobins fell in some cases after the initial study period, there was a relapse of pica. MacDonald and Marshall concluded that

"pica can be cured by iron in nearly all cases, but permanent cure is dependent on the maintenance of adequate hemoglobin levels."

However, Gutelius et al. could not prove by means of 2 double-blind studies that it was the iron therapy that caused an improvement in eating behaviors. In one study, 16 children were given saline and 16 children were given iron injections. The cure rate for pica was 75% in both groups at the end of 5-6 months (11). In another study, placebo and multi-vitamin and mineral supplements proved equally effective in curing pica (49).

Opposing the theory of malnutrition as the cause of pica is a strong contention that nutrient deficiencies are actually the result of pica. This theory arises from the possible mineral-binding capacity of clays and starch. Minnich et al. demonstrated that clay adsorbed dietary iron and rendered it unavailable for adsorption (51). This could be shown *in vitro* and while some clays had limited binding capacities, others possessed powerful adsorptive properties. Potassium deficiency with hypokalemia and muscle weakness has been ascribed to clay-eating (2). Zinc deficiency seems to be one component in a complex syndrome of dwarfism, hypogonadism, hepatosplenomegaly, and iron-deficiency seen in Iranian (52) and Turkish villagers (3) who eat excessive amounts of clay. Copper deficiency has

also been cited (53). Theoretically the iron-binding capacity of clays and starch might also be extended to any cation, such as zinc, copper, and potassium, although it has not been demonstrated (53).

In contrast, Talkington et al. showed that the ingestion of 30-60 grams of starch, or relatively large amounts of clay, prior to iron ingestion did not appreciably alter the absorption of iron in iron deficient or normal subjects (54). They suggested that starch might lead to iron-deficiency by means of dietary replacement of foodstuffs which contain iron, while the ability of clay to inhibit iron absorption might vary with different clays.

In Johannesburg, black adults consuming clay and ashes showed no decrease in iron nutrition (6). There was no convincing evidence that ash diminished the absorption of radio-iron to any significant extent, and some of the particular earths studied released significant quantities of soluble iron when incubated with hydrochloric acid. The observance that clays may actually add nutrients to the diet is supported by several animal studies showing that animals fed mineral-deficient diets were able to survive when supplemented with clays (13,43).

Perhaps the most convincing evidence that pica may be the result, rather than the cause, of iron deficiency are the two studies on pagophagia (1,16). Reynolds found

that 23 of 38 consecutive patients (men and nonpregnant women) with iron-deficiency anemia from chronic blood loss, claimed pagophagia (16). The mean hemoglobin was 8.1 gm/dl, hematocrit 26%, and serum iron ranged between 0-53 ug/dl. Twenty-two of the 23 patients resolved their craving for ice following treatment with oral iron supplements alone. The correlation of serum iron levels with symptoms of pagophagia was best demonstrated by the disappearance of symptoms as serum iron levels rose above 70 ug/dl, before the hemoglobin had reached maximum levels. Symptoms recurred in 3 patients with recurrent anemia. Reynolds concluded that "the finding of pagophagia should alert the physician to possible iron-deficiency states," but "preliminary studies suggest 5-10% normal persons enjoy ice without overt anemia."

In a controlled single-blind study, Coltman also showed the resolution of pagophagia after iron therapy in amounts insufficient to cure anemia (1). Twenty-five women claiming pagophagia, with clearly documented iron lack, but not necessarily demonstrating anemia, were first given saline injections or oral ferrous sulfate. No change in the habit was observed during the baseline week, but all resolved their pagophagia within 11.6 ± 2.2 days for oral iron or 5.7 ± 3.7 days for those receiving parenteral iron. The resolution of pagophagia in such a short period of

time, and prior to a hemoglobin response, leads the authors of both studies to conclude that pagophagia is related to the influence of iron on some compound other than hemoglobin. Since it is improbable that ice either displaces foodstuffs in the diet, or interferes with iron absorption, these two studies give strong support to the contention that (at least) the ice-eating form of pica is caused by iron deficiency.

Pica has been known for at least 2500 years and is still widely practiced today (45,55). It is surprising that so little attention has been devoted to the causes and effects of this habit. The myriad of conflicting and confusing reports that do exist only serve to illustrate that pica is not a single entity but must be studied in the specific context of the material consumed, the cultural and social environment, and the age, sex, and physical condition of the subjects.

Most authors would agree that pica is most frequently, but not always, associated with lowered socioeconomic status. Cultural and psychosocial environment may play a role in the particular form and relative incidence of pica. It is commonly agreed that pica is often found in association with generalized malnutrition and may be related to specific nutritient deficiencies, iron deficiency being the

most consistent finding. But there still does not exist a specific etiology, or even a definitive classification, for pica.

HYPOTHESES

This study will explore the relationship between the incidence of pagophagia and iron-deficiency anemia in pregnant women. In order to approach the determination of a possible causal effect between iron deficiency and pagophagia, three hypotheses will be tested.

The association between iron-deficiency anemia and pagophagia will be shown by a significant difference in the incidence of anemia in a study group of claimed ice-eaters as opposed to a control group claiming no pica. Anemia will be defined as a hematocrit value equal to or less than 35% in the first trimester, or a hematocrit value equal to or less than 33% in the last two trimesters of pregnancy.

As a corollary to the relationship between the incidence of anemia and pagophagia, a significant number of the study group will cease their ice-eating behavior following a period of oral iron supplementation. The independent variable in the prospective study will be the increased consumption of iron within the testing period. The dependent variable will be the reported incidence of ice-eating.

Further support to the hypothesized association between pagophagia and iron deficiency will be demonstrated by a significant difference in the mean dietary iron intake of the ice-eating group when compared to the control group of non-ice-eaters.

LIMITATIONS

1. A lowered hematocrit value may be caused by a variety of reasons including individual variation, folate or vitamin B-12 deficiency, pernicious anemia, sickle cell disease, or chronic infection
2. The study participants may have considered pica a deviant or embarrassing behavior. Unwillingness to admit to the behavior may have injected a source of error into the data with particular impact on the selection of the experimental and control groups
3. Although the participants were encouraged to take their iron supplements no method to ensure compliance was possible
4. The validity and reliability of diet recalls are highly criticized. The situation surrounding the collection of dietary information in this study may have created an increased possibility of validity problems. Participants may have altered their true dietary pattern in an attempt to increase their eligibility for a supplemental food program related to the Nutrition Services of the City of Houston Health Department.
5. The ideal experimental design is the double-blind design. Participant interference was kept to a minimum

by obscuring the exact focus of the study. However, it was unfeasible to avoid all situations vulnerable to unconscious researcher bias.

METHODS, PROCEDURES, AND DATA GATHERING

Forty-seven subjects were selected from among 98 women accessing a City of Houston Health Department Clinic for prenatal care. Clients were interviewed to gain background information and to identify claimed ice-eaters. For the purposes of this study, pagophagia was defined as the purposeful act of obtaining and ingesting daily at least one cup of ice (or frozen water in any form) for a period of at least two consecutive weeks. Twenty-seven women claiming this behavior were selected to participate in the prospective study. A control group of 25 clients denying any form of pica was formed by the method of systematic sampling, i.e., selecting the next eligible subject to access the clinic nutritionist following an ice-eater.

Subjects were asked for a 24-hour diet recall, an intake summary, and information regarding dietary cravings. The participants' medical records were reviewed and the following information was transcribed: clinic number, age, race, height, weight, pre-pregnancy weight, estimated gestation time, frequency of pregnancies, partiy, and current and past gestational complications. All information was collected on the City of Houston Health Department's Nutrition History and Record form (Figure 1). At a later time, the information was organized and transferred to a data sheet (Figure 2).

NUTRITION HISTORY AND RECORD

e _____ Date _____ Clinic No. _____ EDC _____

_____ Ht. _____ Wt. _____ Wt. History _____ Pica _____

d Allowance/Wk. _____ No. in Home ____ Welfare _____ Food Stamps _____

ve _____ Refrigerator _____ Does Own: Cooking _____ Buying _____

ly Food Intake:

rning	Noon Meal	Evening Meal
me _____	Time _____	Time _____
acks	Snacks	Snacks

Summary of Intake	DAILY	OCCASIONAL	NEVER (D-Dislike,	NA-Not Available
Food				
Milk				
Cheese				
Eggs				
Meat, Poultry, Fish				
Dried Beans, Peas				
Vegetables				
Fruit: Citrus, Juices				
Ice Cream				
Coffee, Tea				
Soft Drinks, Kool-aide				
Potato Chips, Candy				
Beer, Alcoholic Bev.				
Cake, Pies, Cookies				
Bread and Cereals				
Starchy Vegetables				

GRESS NOTES:

Figure 1. City of Houston Health Department Nutrition History and Record Form

DATA COLLECTION FORM

Initial _____ Follow-up _____

Date _____ Patient Clinic # _____

Birth date _____ Race _____ Height _____ Weight _____

EDC _____ Wks Gestation _____ Pre-Preg Wt _____ Hct ____

Reproductive History:

DOB	BW	Outcome

Current Complications:

_____

_____

_____

Past Complications:

_____

_____

_____

Summary: _____

24 Hour Diet Recall

Item	Amount	Prep

Intake Summary

	Dly	Wkly
milk		
meat		
eggs		
legumes		
lfy greens		
citrus		
ot frts		
ot veg		
cereal		
breads		
starch veg		
sweets		
soda, kool		
other		
supplements		

Pica: _____ Form: _____

Frequency _____

_____

Duration _____

Amount _____

Address: _____

_____

m _____

Phone # _____

Additional Information:

Figure 2. Data Collection Form

Venous blood was collected by the regular clinic staff at the time of the first visit. Blood samples were analyzed at the City of Houston Health Department Central Lab by the manual graph comparison method. Hematocrit values were reported on the average of two weeks post the initial visit. Hemoglobin electrophoresis results were analyzed to detect and disqualify any participant showing sickle cell disease. Additionally, any person claiming sickle cell disease, or showing a history of refractory anemia was excluded from the study and control group.

The ice-eating group was instructed on the importance of taking their prenatal supplements. The prescription for iron supplementation was one 200 mg. tablet of ferrous sulfate taken orally three times daily. This is the equivalent of 195 mg. of elemental iron. Additionally, all clinic patients also receive a multi-vitamin and mineral tablet to be taken once daily. This tablet contains the equivalent of 60 mg. of elemental iron in the form of ferrous fumarate. The total daily iron supplementation level was 255 mg. of elemental iron.

Study subjects were not informed of the exact focus of the research in order to minimize any possible external influences. No emphasis was placed on dietary cravings, nor were subjects counseled regarding their ice-eating behavior. The study group of ice-eaters was asked to

return to the investigator at their next regular clinic visit in four weeks. The follow-up interview updated the information obtained in the initial interview. Recall evidence of compliance (or noncompliance) with the supplementation routine was noted.

Dietary recalls were collected with the aid of food replicas. The 24-hour recall was cross-checked with an intake summary. The diets were analyzed with reference to Nutritive Value of American Foods, Agricultural Handbook 456 (56); Food Values of Portions Commonly Used, Bowes and Church (57); and specific product information when available.

STATISTICAL ANALYSIS

The data obtained describing the frequency of anemia and ice-eating behavior were nominal level data. Statistical methods for the analysis of nonparametric data were used. The statistical analysis of the incidence of anemia consisted of a tabulation of frequency by group (independent samples). A chi-square calculation was performed to test the significance of the difference between the frequency of anemia in the ice-eating group and the non-ice-eating group.

The difference between reported ice-eating behaviors before and after supplementation was evaluated. A variation of the chi-square test, the MacNemar test for the significance of changes, was used to test the significance of the difference in the tabulated frequencies of ice-eating before and after the period of iron supplementation. For both tests, the chi-square value was converted to c, the coefficient of contingency, in order to describe the magnitude of the difference between the frequencies. The minimum level of significance sought to reject the null hypotheses and accept the research hypotheses was the $p \leq .05$ level.

The data obtained from the calculated mean dietary iron intakes were ratio level data on a continuous numerical scale. The statistical analysis of the variation in the

mean dietary iron intake between the ice-eating and non-ice-eating groups consisted of the *t*-Test for differences between independent means. The minimum level of significance sought to reject the null hypothesis and accept the research hypothesis was the $p \leq .05$ level.

The demographic characteristics of the population, the study, and the control groups were compiled. Analysis of the differences between the study and control group were performed using methods consistent with the level of data gathered, either nominal or ratio level.

RESULTS AND DISCUSSION

Ninety-eight pregnant women were interviewed. When asked about the development of cravings most subjects responded negatively or indicated a food item recently desired and eaten occasionally in limited quantities. When asked about the specific items of geo- and amylophagia (dirt, clay, plain flour, cornstarch, laundry starch, or ashes) most subjects registered surprise and humor at the idea. All responded readily.

Forty-two percent of the women interviewed claimed to practice pica in some form (including those with intermittent consumption patterns). Of these women, 93% ate ice alone. Only two women claimed to crave dirt but denied eating it. One subject ate plain flour and ice. Of the entire population, 25% of the blacks, 30% of the Hispanics, and 39% of the whites claimed to practice pica.

These findings are significantly different from most reports in the literature. The major forms of pica reported among pregnant women have been clay, chalk, and starch (4,33-41) and the practice is usually reported to predominate among blacks (33,35,42). In this study, there was a greater frequency of pica among whites, and no subject admitted eating Argo starch, a reputed favorite among

women with pica (38,40,58). Few subjects claimed to even crave dirt or clay, and none admitted eating these substances.

The difference in results may lie in comparing a relatively mobile, urban population with predominantly rural populations. Houston is the most rapidly growing city in the country. Although some studies found clay and starch-eating in urban and northern locations (4,35,36,40), southern cultural influences may be stronger in the rural areas and account for the larger incidence of geophagia in previous surveys. Cultural influences may also have affected the survey results through ethnic background of the population studied. Most previous reports investigated predominantly or totally black populations. This investigation studied a population almost equally divided between black, Hispanic and Anglo women, with a slight majority of black participants (see Table 4). In addition, there actually may have been a greater incidence of ice-eating in many previously studied populations but this would not have been discovered unless the researchers asked specifically about ice consumption.

Of the women claiming to practice pica, 64% (or 27.5% of the total population) fit the criteria for selection into the experimental group. All ice-eaters were questioned carefully to differentiate the casual ice-muncher

from a person with a true craving. Most women practicing pica but not selected to the experimental group were excluded because they did not eat ice every day. Ice-eaters in the experimental group stated that if ice was not available, they would make a special trip to obtain it. The investigation was conducted in February and March so the influence of hot weather was minimal.

As several investigators point out (1,7,19,55), interviewer/subject rapport is very important. Although none of the ice-eaters appeared painfully embarrassed about their craving, the differing levels of privacy in the interview situation seemed to make a difference in the incidence of pica reported. The importance of rapport may also have influenced the relative frequencies of reported pica among ethnic groups. The Anglo women may have identified most strongly with the researcher and, thus, been most willing to admit pica.

The amount of ice consumed was recorded in glass or tray measures. A common ice cube tray was found to contain 353 grams of ice, half the amount used by Coltman in his calculations (1). Most ice was eaten as cubes (chewed and swallowed in small pieces) or as crushed ice. Only one subject admitted to occasionally eating freezer frost. Ice consumption ranged from 176.5 grams to 1235.5 grams. The

mean ice consumption was 436.8 ± 298.5 grams. The mean daily ice consumption of Coltman's subjects was 2445.2 grams (1). His figures may be inflated due to the greater weight of ice per tray Coltman used in his calculations.

Racial characteristics, mean age, and maternal history were analyzed to determine the comparability of the experimental and control groups (Tables 2, 3, and 4). The ages of women selected to the experimental group ranged from 14-27 years, with a mean age of 18.77. The mean age of the control group was 21.24 years, with a range of 13-31 years.

TABLE 2

BREAKDOWN OF AGE OF STUDY AND CONTROL GROUPS

Group	Sample Size	Mean	Standard Deviation
Study	27	18.77*	3.25
Control	25	21.24	4.18
Total	52	19.96	3.89
Entire population**	96	20.61	4.91

*Statistically significant difference (p .025)
**Missing values = 2 (2%)

TABLE 3

BREAKDOWN OF MATERNAL HISTORY OF
STUDY AND CONTROL GROUPS

Group	Sample Size	Mean	Standard Deviation
Study	27	1.77	.93
Control	25	2.24	1.20
Total	52	2.00	1.08
Entire population	98	2.13	1.36

TABLE 4

TABULATION OF RACIAL CHARACTERISTICS
OF STUDY AND CONTROL GROUPS

	Black		Hispanic		White	
	No.	%	No.	%	No.	%
Study	10	37.0	8	29.6	9	33.3
Control	12	48.0	5	20.0	8	32.0
Total	22	42.0	13	25.0	17	32.7
Entire population*	39	39.8	26	26.5	24	24.5

*Missing values = 9 (9.2%)

The difference in mean age between the two groups is significant. The mean age of all women interviewed was 20.61, showing the age of the study group to be lower than the average age of the population. Since the selection of the study group was dependent on the presence of pagophagia, the difference in age may be a factor in the development of the practice of ice-eating. If pagophagia is related to nutrient deficiencies, it might follow that younger pregnant women, with their increased nutritional needs, would be more susceptible to nutritional disturbances and the development of pagophagia.

Analysis of maternal history revealed the mean number of pregnancies for the study and control groups were 1.77 and 2.24, respectively. The difference in the two frequencies is nonsignificant. The slightly lower number of pregnancies among the study group participants may reflect the decreased mean age of this group.

The ethnic backgrounds of the two groups were analogous. The control group contained slightly less Hispanics and more blacks than the experimental group, but this difference was nonsignificant.

Association with Anemia

The mean hematocrit values of the study and control groups are shown in Table 5. There was no significant

difference in the mean hematocrits of the study (35.4%) and control (36.6%) groups. There was no correlation between the amount of ice consumed and the hematocrit value (correlation coefficient=.1138, p=.316).

TABLE 5

BREAKDOWN OF HEMATOCRIT VALUES OF STUDY AND CONTROL GROUPS

Group	Sample Size	Mean	Standard Deviation
Study	20	35.4	3.20
Control	20	36.6	3.53
Total*	40	36.0	3.38
Entire population**	74	35.6	3.06

*Missing values = 12 (23.1%)
**Missing values = 24 (24.5%)

Thirty-five percent of the study group subjects were anemic compared to 20% of the control group. This difference is nonsignificant, however. Converting the chi-square value to c to describe the magnitude of the difference between the two frequencies shows no significant association between anemia and ice-eating (Table 6).

The data were divided into values for women practicing pica (including all forms and consumption patterns) and

those denying pica. Comparison of mean hematocrit values between these two groups still produces no significant difference (Table 7). Similarly there is no significant difference in the frequency of anemia when comparing the pica and non-pica subjects. The c value also shows no significant association between anemia and pica (Table 8).

TABLE 6

FREQUENCY OF ANEMIA IN STUDY AND CONTROL GROUPS

	Anemic		Non-anemic	
	No.	%	No.	%
Study	7	35.0	13	65.0
Control	4	20.0	16	80.0
Total*	11	27.5	29	72.5
Entire population**	21	28.4	53	71.6

*Missing values = 12
**Missing values = 24

TABLE 7

BREAKDOWN OF HEMATOCRIT VALUES OF PICA AND NON-PICA GROUPS

Group	Sample Size	Mean	Standard Deviation
Pica*	32	35.53	2.72
Non-pica**	42	35.80	3.33
Total population	74	35.68	3.06

*Missing values = 10 (23.8%)
**Missing values = 14 (25%)

TABLE 8

FREQUENCY OF ANEMIA IN PICA AND NON-PICA GROUPS

	Anemic		Non-anemic	
	No.	%	No.	%
Pica*	9	28.1	23	71.9
Non-pica**	12	28.6	30	71.4
Total population	21	28.4	53	71.6

*Missing values = 10
**Missing values = 14

A small majority of previous studies on pica reporting hemic data find a significant association between the incidence of anemia and pica (4,19,40,46) and/or significantly decreased hemic values when comparing pica and non-pica groups (19,33,46). Others report no significant association between pica and anemia, but note a trend of decreased hemic values (usually 1 gm/dl hemoglobin or 1-2% points hematocrit) in groups practicing pica (33,35, 38). Vermeer in 1979, however, found no association with anemia or lowered hematocrit values (42).

Although comparisons between this study and previous investigation of non-ice forms of pica are tenuous at best, the results of this study are similar to some of the previous studies. Although hematocrit values were similar and the frequency of anemia in the ice-eating group was not statistically significant, there does appear to be a somewhat decreased mean hematocrit value and a trend toward anemia in the ice-eating group.

The trend toward anemia in the study group may have become significant if it had been possible to observe the ice-eaters without iron supplementation. Iron deficiency follows three stages. The first is depletion of iron stores. The second is defective erythropoiesis. The third is continued defective red cell production resulting in lowered hemic values (59). If pagophagia is a result of

iron-deficiency and not caused by anemia specifically, the experimental group may have had exhausted iron stores. Without iron supplementation, the ice-eaters may have proceeded to develop a greater incidence of anemia than a control group of unsupplemented non-ice-eaters.

Effect of Iron Supplementation

Fifteen of 27 ice-eaters returned for follow-up 4-6 weeks after the initial visit. Compliance with the iron supplementation schedule was rated as excellent, fair, or poor, depending on an estimated weekly consumption of 80%, 60%, or less than 60% of the prescribed amount of iron tablets. All but two subjects claimed excellent compliance.

Subjects were questioned to learn if there were any social or cultural influences on the practice of ice-eating. Several subjects stated they had discussed their habit with friends or relatives. Two subjects stated they discontinued eating ice because they had been told ice-eating was harmful to the fetus. No other subjects expressed value judgments on the practice or speculated on its harmful or beneficial effects on the fetus. No subject had been told to anticipate a craving for ice during pregnancy.

The number of subjects that continued to eat ice at the end of the study period was 7, while 8 subjects claimed to have complete ceased eating ice or to only crave

ice intermittently (Table 9). The MacNemar test for significance of changes revealed there was a significant effect of iron supplementation on the practice of pagophagia ($X^2 = 6.125$, $p < .025$). These results are comparable to the two previous investigations of pagophagia (1,16) and the majority of other studies investigating the efficacy of iron supplementation in curing geophagia (5,12,48,52).

Although it is tempting to conclude that pagophagia is indeed cured by iron therapy, other dietary influences cannot be ruled out. It was impossible to hold nutrient intakes constant over the supplementation period. Neither Reynolds nor Coltman comment on this aspect of their studies (1,16). It should be noted that two recent studies have found ascorbic acid deficiency in association with geophagia, and two studies report the efficacy of zinc supplements in curing metal pica (60) and clay-eating (61).

In the previous studies on the efficacy of iron supplementation in the treatment of pica, all produced dramatic cures in nearly all patients (1,5,12,16,48,52). It is puzzling then, that nearly one-half the study group continued to eat ice following iron therapy.

Pregnancy produces a physiologic anemia due to the disproportionate increase in plasma volume compared to cellular components. The greatest increase in blood volume and therefore the greatest demand for blood-forming

TABLE 9

INFORMATION ON PREGNANT ICE-EATERS RETURNING FOR FOLLOW-UP

Case	Age	Race	Onset	Study Period	Initial Hct	F-u Hct	Supl Comp	F-u Pica	Int Ice (gms)
1	19	W	8	20-24	39	Unk	E	No	176.5
2	21	W	18	25-29	Unk	Unk	E	Yes	706.0
3	23	H	11	13-17	Unk	38	E	No	1235.5
4	16	W	8	16-20	39	Unk	E	Yes	176.5
5	18	B	14	16-20	Unk	35	E	No	176.5
6	20	W	29	34-40	34	40	E	No	1059.0
7	16	B	19	27-31	31	33	P	Yes	706.0
8	20	H	18	22-26	35	37	E	Yes	176.5
9	18	B	8	11-15	37	Unk	E	Yes	529.5
10	15	H	21	23-27	34	35	E	No	353.0
11	14	B	18	22-26	31	31	F	Yes	265.0
12	20	H	8	32-36	33	33	E	No	265.0
13	22	B	12	16-23	37	47	E	No	412.0
14	16	B	35	38-42	Unk	Unk	E	Yes	353.0
15	23	W	30	34-38	33	Unk	E	No	176.5

Abbreviations: B: black; W: white; H: Hispanic; Hct: hematocrit value; Unk: unknown; F-u: follow-up; E: excellent; F: fair; P: poor.

Note: Onset: gestation week in which craving for ice began, determined retrospectively by the subject; Study Period: gestation weeks over which subject was observed; Supl Compl: a rating of the subject's compliance to the supplementation level prescribed; F-u Pica: denial or admission of pica at follow-up interview (after iron supplementation); Int Ice: amount of ice consumed as reported by the subject at initial interview.

elements occurs in weeks 24-32 of gestation. If the majority of the subjects that continued pagophagia were observed over this period of high demand, the effect of iron supplementation may not have been obvious.

Figure 3 represents the measurable hemoglobin response in iron-deficient pregnant women initiating oral iron therapy during different trimesters (62). Although an absolute hemoglobin response is not necessarily the focus of discussion here, this figure serves to illustrate the varying internal milieu associated with different phases of gestation.

Comparing the mean gestation week for initiation of iron therapy between the continued and cured ice-eaters, the value is found to be similar for both groups (23 and 24.5, respectively). This suggests that the subjects continuing pagophagia and those that were cured were observed over similar periods during their pregnancies. This minimizes any disparate influences due to other physiological mechanisms. Greater subject noncompliance to the supplementation schedule must be considered.

Reynolds and Coltman studying pagophagia (1,16) and authors studying other picas (47,48) have reported a surprisingly short period from initiation of iron therapy to resolution of pica. These authors note pica is cured with

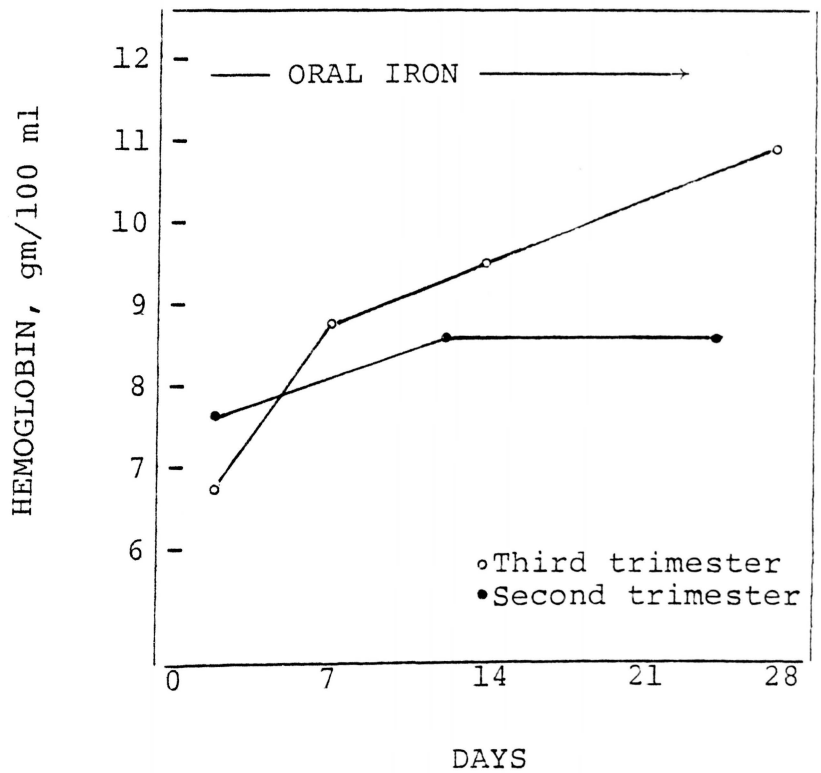

Figure 3. Response to iron therapy by two women treated with identical doses of iron (105 mg per day as ferrous gluconate) during different trimesters of pregnancy.

doses of iron too small to cause a hemoglobin response (1, 48) and cessation of pica occurs prior to resolution of the anemia (16,47). Pica may not be the result of iron-deficiency anemia but may be due to the effects of iron deficiency on some compound other than hemoglobin.

Catalase, myoglobin, and cytochrome c are heme containing compounds found to be decreased in iron-deficiency states (63,64). Cytochrome c and myoglobin in the intestinal mucosa and skeletal muscle of iron-deficient rats can be reduced by one-half of control levels (64). Cytochrome c in intestinal mucosa returns to normal levels only two days after initiation of iron replection (64). Cytochrome oxidase levels have also been demonstrated at reduced levels in human buccal epithelium (64). Reduced cytochrome oxidase levels in iron-deficient rats return to normal within 24-hours of iron therapy (64). Reduction of this and other enzymes may account for some symptoms of iron deficiency such as glossitis, chelosis, and koilonychia (5,65,66).

Fairbanks et al. state that in their experience symptoms of iron deficiency are not directly proportional in intensity to the reduction in hemoglobin (66). Although the changes in tissue enzyme levels in experimental animals and humans have not been found in association with functional disturbances which can be attributed directly to the

changes in enzymes, it is conceivable that a lack of iron could result in a disturbance of many body functions. Gastric atrophy, achlorhydria, and intestinal mucosal changes have been associated with iron deficiency (65). The nuclear mass in the hypothalmus differs from other parts of the brain by its high iron content. Bonsdorff hypothesizes that pica may be caused by a functional disturbance of the appetite center due to the effects of iron deficiency on this tissue (67).

Dietary Analysis

The reported 24-hour recalls of the ice-eaters and non-ice-eaters were analyzed for macronutrient and iron content. Additionally, an attempt was made to judge the relative quality of the diets by calculating the percent calories consumed from nonnutritive sources (Koolaid, soda, candy, etc.) and the percent iron obtained from animal sources. A few subjects reported voluntary consumption of vitamin and iron supplements. The averaged supplemental iron plus dietary iron intake is also reported (see Table 10).

A breakdown of the nutrient content of the ice-eater and non-ice-eater diets is shown in Table 10. The mean caloric, protein, and iron contents of participants' diets are similar to values reported elsewhere (see Table 11).

TABLE 10

BREAKDOWN OF DIETARY CONTENT OF STUDY AND CONTROL GROUPS

Nutrient	Group	Sample Size	Mean	Std. Dev.
Calories (kcal)	Study	26*	1607.52**	809.21
	Control	25	2181.50	840.36
Protein (gms)	Study	26	73.48	47.69
	Control	25	96.03	40.17
Carbohydrate (gms)	Study	26	181.44+	78.13
	Control	25	273.38	141.54
Fat (gms)	Study	26	63.64	36.46
	Control	25	83.30	41.18
Iron (mgs)	Study	26	11.05 (34.2)++	6.6 (55.3)
	Control	25	13.30 (39.2)	5.9 (83.1)
Cal. (Non-Nutr Source) (%)	Study	26	19.24	15.16
	Control	25	15.23	11.64
Iron (Animal Source) (%)	Study	26	38.08	21.96
	Control	25	41.84	23.42

*One recall not included due to inability to obtain adequate nutrient analysis.
**Significant difference ($p < .025$).
+Significant difference ($p < .01$).
++Mean supplemental plus dietary iron intake.

Differences appear to be the somewhat larger reported protein intake of the control group and the reduced caloric intake of the study group.

TABLE 11

REVISED 1980 RECOMMENDED DIETARY ALLOWANCES FOR PREGNANT WOMEN AGED 19-22 YEARS (68)

Energy kcal	Energy Range	Protein (gms)	Iron (mgs)
2,400	2,000-2,800	74	30-60

Mean protein intakes for both groups approach or exceed 100% of the 1980 Revised Recommended Dietary Allowances (68) for pregnant women 19-22 years old (i.e., 74 gms). It is difficult to assess iron intakes in relation to the RDA as the NRC recommends daily supplementation with 3-60 mgs elemental iron for all pregnant women. Although the averaged dietary plus supplemental iron intakes exceed the lower level RDA, most subjects in both groups were not taking iron supplements at the time of initial visit. Overall iron nutriture was judged inadequate for both groups. The mean caloric intake of the control group is adequate at greater than 2/3 the median RDA for energy intake. The study group's mean caloric intake, however, is

below adequacy levels at less than 2/3 median RDA and significantly less than the lower limit RDA for age group (see Table 11).

Comparing the diets of study and control group subjects revealed no significant difference in the mean iron or protein content, or calorie or iron source. However, the mean caloric content (and carbohydrate level) of the study group was significantly lower than control levels.

In 1959, Edwards et al. reported significantly reduced nutrient intakes of subjects claiming pica when compared to non-pica controls (Table 12). Payton et al. (37), and later Edwards et al. (46), however, reported significantly greater nutrient intakes in subjects practicing pica. In Edward's study (46), after establishing baseline nutrient consumptions, subjects were asked to cease consumption of clay and starch. It was found that the mean nutrient levels of the pica groups then feel to near mean control levels. This caused the investigators to conclude that the practice of pica has a stimulating effect on the appetite of pregnant women. The bulk and taste potentials of clay and starch are greatly different from ice. Comparisons of dietary effects between these different kinds of pica is interesting but not conclusive.

The small sample size, large standard deviations, and unreliability of the 24-hour dietary recall also limit

TABLE 12

SOME REPORTS OF NUTRIENT CONTENT OF DIETS OF PREGNANT WOMEN

Reference	Pop.	Calories (kcal)	Protein (gms)	Iron (mgs)
Ten-State 1968-70, (70).	W	2127	89.25	12.0
	B	2024	79.06	11.4
	H	2205	83.59	12.4
Van de Mark 1972, (69).	Teens (12-17) yrs.	1864	62	12
Adams 1978, (71).	Adult	2014	80	30
Edwards 1959, (38).	Clay*	1191	51	8
	Starch**	984	46	7
	Control	1291	67	10
Payton 1960, (37).	Starch	2218	65.3	11.5
	Control	1665	58.8	10.3
Edwards 1964 (46).	Clay	2013 (1410)+	41 (34)+	6.6 (6.6)+
	Starch	2525 (1962)	47 (19)	2.4 (1.4)
	Control	1390	38	4.0

Abbreviations: Pop: population studied. B: Black; W: White; H: Hispanic

*Clay-eaters.

**Starch-eaters.

+Values reported during period without practicing pica (see text)

the conclusions which can be drawn from comparisons against standards or between control and study groups. Another measure of nutritional status, or adequacy of lifelong dietary habits, in pregnant women is pre-pregnant weight status (72). Using the Metropolitan Life Insurance Tables (Appendix 12) as standards, pre-pregnant weight was rated as underweight (greater than 15% below standard) and overweight (greater than 20% above standard). A rating of normal was assigned to pre-pregnant weight for height falling in-between the two extremes.

Comparison of frequencies between study and control groups finds a significantly greater frequency of underweight in the ice-eating group (Table 13). This finding tends to support the conclusion of greater dietary inadequacy among the ice-eating group.

Although the higher frequency of underweight in the study group may reflect the younger age of this group, preceding marginal weight status, continued inadequate caloric intake during pregnancy, combined with the greater nutritional needs of the younger pregnant woman, results in significant nutritional risk.

Table 14 shows the mean nutrient intakes of the continued and cured ice-eaters at follow-up. The difference in nutrient intakes are nonsignificant. There is no

explanation for the slightly decreased mean intakes of the cured group unless one speculates, as Edwards does (46), that the practice of pica stimulates the appetite.

TABLE 13

FREQUENCY OF UNDERWEIGHT, NORMAL WEIGHT AND OVERWEIGHT IN STUDY AND CONTROL GROUPS

	Underweight		Normal		Overweight	
	No.	%	No.	%	No.	%
Study	8	29.6	17	63.0	2	7.4
Control	1	4.0	16	64.0	8	32.0
Total	9	17.3	33	63.5	10	19.2
Entire population*	10	10.2	63	64.4	22	22.4

*Missing values = 3 (3.1%)

TABLE 14

BREAKDOWN OF DIETARY CONTENT OF CONTINUED AND CURED ICE-EATERS

Nutrient	Group	Sample Size	Mean	Std. Dev.
Calories (kcal)	Cont.	7	1840.12	726.40
	Cured	8	1705.42	674.35
Protein (gms)	Cont.	7	89.87	42.20
	Cured	8	78.42	45.58
Carbohydrate (gms)	Cont.	7	217.00	92.09
	Cured	8	200.42	60.75
Fat (gms)	Cont.	7	69.87	34.56
	Cured	8	69.42	32.71
Iron (mgs)	Cont.	7	21.45	15.84
	Cured	8	25.74	27.55
Cal (Non-Nutr Source) (%)	Cont.	7	7.37	8.07
	Cured	8	5.14	3.67
Iron: Animal Source (%)	Cont.	7	36.25	25.07
	Cured	8	25.85	30.14

IMPLICATIONS AND CONCLUSIONS

The satisfaction of hunger pains in a deprived environment, a hypothesized cause of clay and starch-eating, would appear to have no bearing on the practice of pagophagia. The amounts of ice eaten daily in this study were generally too small to afford much relief from hunger pains, and the diet recalls of the ice-eating group, although not generous in calories, indicated the availability of food. Cultural and social causes of pica also appear mote where pagophagia is concerned. There was no evidence of ice-eating folklore or early childhood habits that might have induced these pregnant women to consume ice.

The studies of Reynolds (16) and Coltman (1) certainly appear to be solid ground upon which to base a theory of iron-lack as cause of pagophagia, but the condition of pregnancy may either give rise to different causes of pagophagia or demand different treatment modalities. This study finds a significant reduction in pagophagia following oral iron therapy but without the dramatic cure rate reported in the two studies above.

Because of the possible relationship between pagophagia and iron deficiency, as opposed to iron-deficiency anemia, an investigation of serum iron or serum iron/TIBC ratio would be more conclusive in determining the relationship of pagophagia and iron deficiency in pregnant women.

If pagophagia indeed results from iron deficiency at a stage before hemoglobin production is impaired as this and other studies suggest, it would make the discovery of pagophagia an even greater aid in assessing the nutritional status of pregnant women.

The reduced nutrient composition of ice-eater diets, plus the significantly higher proportion of underweight, along with the trend toward anemia in the ice-eating group, all combine to produce strong support of the age-old observation that pica is associated with a compromised nutritional status.

Fairbanks et al. consider that other nutritional deficiencies may arise as a result of changes in the gastrointestinal tract secondary to iron deficiency (66). Such a mechanism might explain the differences in the incidence of findings since changes in the dietary habits of populations studied might in this way markedly influence clinical manifestations.

Although the presence of pagophagia is not yet a proven indicator of a single nutrient deficiency in pregnant women, this study again suggests the relationship of pagophagia to iron deficiency. The discovery of pagophagia in a pregnant woman should alert the clinician to nutritional disturbances requiring investigation and treatment.

APPENDIX 1

ANALYSIS OF THE VARIANCE OF MEAN AGE OF STUDY AND CONTROL GROUPS

Source	Sum of Squares	D.F.	Mean Square	F Value	Sig.
Between groups	78.696	1	78.696	5.660	.0212
Within groups	695.227	50	13.905	--	--

APPENDIX 2

ANALYSIS OF THE VARIANCE OF MEAN PREVIOUS PREGNANCIES (MATERNAL HISTORY) OF STUDY AND CONTROL GROUPS

Source	Sum of Squares	D.F.	Mean Square	F Value	Sig.
Between groups	2.773	1	2.773	2.423	.1259
Within groups	57.227	50	1.145	--	--

APPENDIX 3

ANALYSIS OF THE FREQUENCIES OF RACIAL CHARACTERISTICS BETWEEN STUDY AND CONTROL GROUPS

RACE	Count % Row % Col % Total %	Study	Control	Row Total
	Black	10 45.5 37.0 19.2	12 54.5 48.0 23.1	22 42.3
	Hispanic	8 61.5 29.6 15.4	5 38.5 20.0 9.6	13 25.0
	White	9 52.9 33.3 17.3	8 47.1 32.0 15.4	17 32.7
	Column Total	27 51.9	25 48.1	52 100.0

Chi square = 0.85729 with 2 degrees of freedom
Significance = 0.6514
Contingency coefficient = 0.12735

APPENDIX 4

ANALYSIS OF THE VARIANCE OF MEAN HEMATOCRIT VALUE OF STUDY AND CONTROL GROUPS

Source	Sum of Squares	D.F.	Mean Square	F Value	Sig.
Between groups	14.400	1	14.400	1.268	.2672
Within groups	431.600	38	11.358	--	--

APPENDIX 5

ANALYSIS OF THE FREQUENCY OF ANEMIA BETWEEN STUDY AND CONTROL GROUPS

Count % Row % Col % Total %	Study	Control	Row Total
Non-Anemic	13 44.8 65.0 32.5	16 55.2 80.0 40.0	29 72.5
Anemic	4 63.6 35.0 17.5	4 36.4 20.0 10.0	11 27.5
Column Total	20 50.0	20 50.0	40 100.0

Corrected chi square = 0.50157 with 1 degree of freedom
Significance = 0.4788
Contingency coefficient = 0.16565
Number of missing observations = 12

APPENDIX 6

ANALYSIS OF THE VARIANCE OF MEAN HEMATOCRIT VALUE OF PICA AND NON-PICA GROUPS

Source	Sum of Squares	D.F.	Mean Square	F Value	Sig.
Between groups	1.102	1	1.102	0.004	.9469
Within groups	23769.543	96	247.600	--	--

APPENDIX 7

ANALYSIS OF THE FREQUECY OF ANEMIA BETWEEN PICA AND NON-PICA GROUPS

Count % / Row % / Col % / Total %	GP PICA	NON-PICA	Row Total
	10 41.7 23.8 10.2	14 58.3 25.0 14.3	24 24.5
	23 43.4 54.8 23.5	30 56.6 53.6 30.6	53 54.1
	9 42.9 21.4 9.2	12 57.1 21.4 12.2	21 21.4
Column Total	42 42.9	56 57.1	98 100.0

Chi square = 0.02018 with 2 degrees of freedom
Significance - 0.9900
Contingency coefficient = 0.01435

APPENDIX 8

ANALYSIS OF THE VARIANCE OF THE MEANS OF NUTRIENT INTAKES OF STUDY AND CONTROL GROUPS

Variable		Standard Error	Pooled Variance Estimate T Value	Degrees of Freedom	2-tail Prob.
CAL	GROUP 1	164,808	2.48	49	.016
	GROUP 2	161,844			
PRO	GROUP 1	7,879	1.83	49	.073
	GROUP 2	9,539			
CHO	GROUP 1	27,758	3.14	49	.003
	GROUP 2	15,627			
FAT	GROUP 1	8,076	1.80	49	.078
	GROUP 2				
FE	GROUP 1	1,157	1.28	49	.206
	GROUP 2	1,320			
TIRON	GROUP 1	16,311	0.25	49	.802
	GROUP 2	11,076			
PCAL	GROUP 1	2,285	-1.04	49	.303
	GROUP 2	3,132			
PFE	GROUP 1	4,595	0.59	49	.557
	GROUP 2	4,392			

APPENDIX 9

ANALYSIS OF THE VARIANCE OF THE MEANS OF NUTRIENT INTAKES OF CONTINUED AND CURED ICE-EATERS

		Standard Error	T Value	Degrees of Freedom	2-tail Prob.
ACAL	GROUP 1	256.822	0.37	13	.717
	GROUP 2	254.882			
APRO	GROUP 1	14,923	0.50	13	.622
	GROUP 2	17,229			
ACHO	GROUP 1	32,560	0.40	13	.693
	GROUP 2	22,962			
AFAT	GROUP 1	12,222	0.03	13	.980
	GROUP 2	12,365			
APCAL	GROUP 1	2,853	0.67	13	.514
	GROUP 2	1,388			
APFE	GROUP 1	8,864	0.73	13	.479
	GROUP 2	11,392			
FE	GROUP 1	5,600	-0.38	13	.713
	GROUP 2	10,416			

APPENDIX 10

ANALYSIS OF THE FREQUENCIES OF UNDERWEIGHT, OVERWEIGHT, AND NORMAL PRE-PREGNANT WEIGHT OF STUDY AND CONTROL GROUPS

	Count % Row % Col % Total %	TN STUDY	CONTROL	Row Total
PPWT	Underweight	8 88.9 29.6 15.4	1 11.1 4.0 1.9	9 17.3
	Normal	17 51.5 63.0 32.7	16 48.5 64.0 30.8	33 63.5
	Overweight	2 20.0 7.4 3.8	8 80.0 32.0 15.4	10 19.2
	Column Total	27 51.9	25 48.1	52 100.0

Chi square = 9.01115 with 2 degrees of freedom
Significance = 0.0110
Contingency coefficient = 0.38431

APPENDIX 11

MACNEMAR TEST FOR THE SIGNIFICANCE OF CHANGES

		AFTER	
		Non-ice-eaters	Ice-eaters
BEFORE	Ice-Eaters	0	7
	Non-ice-eaters	0	8

$$X^2 = \frac{(|a-d| - 1)^2}{a + d} = 6.125$$

APPENDIX 12

STANDARD NONPREGNANT WEIGHT FOR HEIGHT FROM THE METROPOLITAN LIFE INSURANCE ACTUARIAL TABLES 1969

Inches*	Standard Weight For Height**	15% Below Standard Weight**	20% Above Standard Weight**
4	95	81	114
5	98	83	118
6	101	86	121
7	104	88	125
8	107	91	128
9	110	93	132
0	113	96	136
1	116	99	139
2	118	100	142
3	123	105	148
4	128	109	154
5	132	112	158
6	136	116	163
7	140	119	168
8	144	122	173
9	148	126	178
0	152	129	182
1	156	133	187
2	160	136	192
3	164	139	197
4	168	143	202

* Height: Height without shoes.

** For participants under age 25, subtract one pound for each year.

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