



# Pica is prevalent and strongly associated with iron deficiency among Hispanic pregnant women living in the United States



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## ABSTRACT

**Introduction:** Anecdotal evidence suggests that pica occurs among Hispanic women in the United States, especially during pregnancy. However, the prevalence and socio-demographic and biological factors associated with pica in this population have not been adequately identified.

**Methods:** Trained, bilingual study personnel conducted structured interviews at public health clinics in Salinas Valley, California with 187 pregnant Hispanic women in their 2nd or 3rd trimesters of pregnancy. Hemoglobin was measured using Hemocue; concentrations of transferrin receptor (TfR) and alpha-1 acid glycoprotein (AGP) were measured in dried blood spots. Multivariable stepwise regression analyses were conducted with pica during pregnancy as the dependent variable and individual- and family-level factors as independent variables to identify significant associations. Additionally, multivariable models were built to explore the associations between pica and iron status (iron deficiency and anemia).

**Results:** Half of all participants (51.3%) had ever engaged in pica, and 37.6% had done so during the current pregnancy. Pica substances included large quantities of ice, frost, raw starches, and various earthen items. Pica during the current pregnancy was significantly associated with higher TfR concentrations [OR: 1.29; 95% CI: 1.11, 1.51] indicative of low iron stores and greater food insecurity [OR: 1.20, 95% CI: 1.03, 1.40]. Women who engaged in pica during the current pregnancy were more likely to be iron deficient [adjusted OR: 2.58; 95% CI: 1.19, 5.60], but not anemic [adjusted OR: 1.40; 0.60, 3.23].

**Conclusions:** Among pregnant Hispanic women, pica was prevalent and strongly associated with iron deficiency and food insecurity. Clinicians should screen for pica during pregnancy in Hispanic populations, and future studies should elucidate the underlying etiology and consequences of engaging in pica during pregnancy.

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## 1. Introduction

Pica, the craving and purposive consumption of substances that the consumer does not define as food, is an enigmatic behavior found around the world, especially among pregnant women (Cooksey, 1995; Corbett, Ryan, & Weinrich, 2003; Ezzeddin,

Zavoshy, Noroozi, Jahanihashemi, & Riseh, 2015; Fawcett, Fawcett, & Mazmanian, 2016; Lumish et al., 2014; Saathoff, Olsen, Kvalsvig, & Geissler, 2002; Young, Sherman, Lucks, & Pelto, 2011). Substances that are commonly consumed by people engaged in pica can be broadly categorized as geophagic (e.g. earth, clay), amylophagic (e.g. raw corn starch, uncooked rice), and pagophagic (e.g. ice, frost) (Young, 2011). Other non-food substances, such as charcoal, chalk, ash, paper, baby powder, paint chips, coffee grounds, and eggshells are less commonly reported pica items (Cooksey, 1995; Corbett et al., 2003; Edwards et al., 1994).

Although pica has been described for centuries (Hippocrates, 1849), the causes of this behavior have not been fully elucidated.

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Hypotheses such as cultural beliefs, hunger, gastro-intestinal distress, micronutrient deficiencies (especially iron, zinc, and calcium), emotional stress, and protection against toxins and pathogens have been postulated; each potential hypothesis has merits and limitations (Young, 2010; Young, Wilson, Miller, & Hillier, 2008) but none has been definitively proven. Moreover, pica has been associated with harmful and potentially healthful consequences. Negative health conditions possibly attributable to pica include micronutrient deficiencies (Bhalla, Khanna, Srivastava, Sur, & Bhalla, 1983; Cavdar, Arcasoy, Cin, Babacan, & Gozdasoglu, 1983; Chisholm and Martin, 1981; Hooda, Henry, Seyoum, Armstrong, & Fowler, 2004; Chisholm and Martin, 1981; Minnich et al., 1968; Patterson and Staszak, 1977; Seim et al., 2013; Patterson and Staszak, 1977; Thomas, Falko, & Zuckerman, 1976), particularly iron-deficiency anemia (Miao, Young, & Golden, 2015; Young, 2010), heavy metal exposure (Bakhireva et al., 2013; Lowry et al., 2004; Mathee et al., 2014; Rothenberg et al., 1999; Shannon, 2003), and intestinal damage (Anderson, Akmal, & Kittur, 1991). On the other hand, some pica items, e.g. clay-rich earth may have positive health effects, such as relief from gastrointestinal distresses (Dominy, Davoust, & Minekus, 2004; Young et al., 2010), preventing exposures to harmful toxins and pathogens (Dominy et al., 2004; Johns and Duquette, 1991), and being a source of micronutrients (Hooda et al., 2004; Yanai et al., 2009).

In the United States, pica has been reported by pregnant women from all ethnic groups, but a higher proportion of minority women report pica than white women (Bakhireva et al., 2013; Cooksey, 1995; Corbett et al., 2003; Edwards et al., 1994; Rainville, 1998; Simpson, Mull, Longley, & East, 2000). While Hispanics constitute the largest ethnic minority group in the United States (17% of the total population), our understanding of pica among them is limited. Only four studies have analyzed pica among Hispanics in the U.S., focusing primarily on Mexican women (Bakhireva et al., 2013; Bruhn and Pangborn, 1971; Lin et al., 2014; Simpson et al., 2000). Each of these have limitations.

Data on the prevalence of pica among Mexicans in Mexico is even more scant. There are a handful of older ethnographic studies focused on geophagy (Castillo, 1912; Joyce, 1914), including religious geophagy (Bourke, 1894; Hunter and DeKleine, 1984). There are also a small number of more recent case reports of acute lead poisoning among pregnant Mexican women and their newborns due to ingestion of lead-laden items during pregnancy, mostly glazed pottery (Fuertes and Bauer, 2000; Lowry et al., 2004; Mycyk and Leikin, 2004; Shannon, 2003; Thihalolipavan, Candalla, & Ehrlich, 2013). Despite a lack of rigorous quantitative studies, there is reason to believe that the practice of pica is common among Mexican-origin Hispanics. In the sole study of the prevalence among Mexican women, conducted in Enseñada, Mexico, the prevalence of pica among 75 pregnant or post-partum women was 44%; earth, bean stones, magnesium carbonate and ashes were commonly reported pica items (Simpson et al., 2000).

Because there are limited data about pica practices among Hispanic women, and because some pica substances can be deleterious to both women and infants, our first objective was to assess the frequency of and different types of pica items consumed by Hispanic women before and during pregnancy. Second, we identified the socio-demographic and physiological correlates of pica using multivariable logistic models. Third, because the directionality of the associations between pica and iron deficiency is not clear, we modeled iron deficiency and anemia during pregnancy, to understand the role of pica in these potentially dangerous conditions.

## 2. Materials and methods

### 2.1. Study setting & participant recruitment

This cross-sectional study was conducted in the Salinas Valley of California, which is located about 100 miles south of San Francisco and home to large community of Mexican immigrants who are primarily engaged in agricultural work. Pregnant Hispanic women in their second or third trimester of pregnancy who attended prenatal clinics and community organizations were invited to participate in the study. Informational flyers were posted in six public health clinics and staff members who worked in the clinic and study personnel recruited participants. A sample size of 155 was calculated based on a minimum detectable difference of 0.6 g/dL and an SD of 1 for hemoglobin (Hb) with 90% power and 1.5 mg/L difference in transferrin receptors (TfR) with 99% power for a 30% prevalence of pica, at 5% significance level. In total, 187 pregnant women were recruited between June 2009 and March 2010. The study was approved by the Institutional Review Board at the University of California, Berkeley.

### 2.2. Survey data collection

Surveys were administered by six trained, bilingual study staff in private rooms within each clinic [cf. Survey Instrument, online [supplementary material 1 \(Spanish\)](#) and [supplementary material 2 \(English\)](#)]. To assess pica, participants were asked about their cravings for and consumption of a list of items that was developed during the formative phase of the research study (Lin et al., 2014). Participants were also encouraged to describe other substances that they had craved or consumed at any point in their lives. For the items that were craved, participants were asked about the timing, duration, motivation, and sensory appeal, amongst others.

During the study interview, each woman was asked her age, education, country of birth, time spent in the U.S., acculturation (language preference and proficiency), marital status, past and current tobacco and drug use, family income, and crowding at home. Women were also asked about obstetric history, health conditions, particularly blood disorders, diabetes, anemia, celiac disease, and urinary tract or other infections during pregnancy. To assess pregnancy-related complications and possible risk factors for pica, we also during which trimester/s women had experienced a range of symptoms of gastrointestinal distress. Lastly, we asked women to report how frequently they consumed iron-rich foods and whether they had experienced household food insecurity during the previous 12 months (USDA, 2012).

### 2.3. Blood collection

Immediately after the study interview, we obtained a sample of whole blood via finger prick, using a portable HemoCue hemoglobinometer (HemoCue, Lake Forest, CA, USA). We also collected dried blood spots on Whatman filter paper for later assessment of transferrin receptor (TfR) and alpha-1 acid glycoprotein (AGP) concentrations, using standard methods (McDade and Shell-Duncan, 2002).

### 2.4. Biochemical analyses

The dried blood spots were processed by Craft Technologies (Craft Technologies Inc., Wilson, NC). The assessment of TfR and AGP in dried blood spots was performed employing a sandwich ELISA technique that was developed and validated at Craft Technologies (Shell-Duncan and McDade, 2004). Transferrin receptor

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