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REVIEW ARTICLE

A meta-analysis of the worldwide prevalence of pica during pregnancy and the postpartum period

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ABSTRACT

Background: Although pica has long been associated with pregnancy, the exact prevalence in this population remains unknown. *Objectives:* To estimate the prevalence of pica during pregnancy and the postpartum period, and to explain variations in prevalence estimates by examining potential moderating variables. *Search strategy:* PsycARTICLES, PsycINFO, PubMed, and Google Scholar were searched from inception to February 2014 using the keywords pica, prevalence, and epidemiology. *Selection criteria:* Articles estimating pica prevalence during pregnancy and/or the postpartum period using a self-report questionnaire or interview were included. *Data collection and analysis:* Study characteristics, pica prevalence, and eight potential moderating variables were recorded (parity, anemia, duration of pregnancy, mean maternal age, education, sampling method employed, region, and publication date). Random-effects models were employed. *Main results:* In total, 70 studies were included, producing an aggregate prevalence estimate of 27.8% (95% confidence interval 22.8–33.3). In light of substantial heterogeneity within the study model, the primary focus was identifying moderator variables. Pica prevalence was higher in Africa compared with elsewhere in the world, increased as the prevalence of anemia increased, and decreased as educational attainment increased. *Conclusions:* Geographical region, anemia, and education were found to moderate pica prevalence, partially explaining the heterogeneity in prevalence estimates across the literature.

1. Introduction

Pica refers to the craving and purposive consumption of nonfood substances, with descriptions dating as far back as the Greek physician Hippocrates in the fifth century BC [1]. Pica has been defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [2] as the persistent eating of non-nutritive substances for a duration of at least 1-month; the eating of non-nutritive substances must be inappropriate to the individual's developmental level and must not be part a culturally supported or socially normative practice. Furthermore, if pica occurs alongside another mental disorder or medical condition, it is required to be severe enough to warrant independent clinical attention to meet the DSM-5 definition [2].

The three types of pica most commonly reported in the literature include the eating of earth, clay, chalk, mud, or soil (geophagia); starch (amylophagia); or ice/freezer frost (pagophagia) [1]. However, numerous substances have been reported as being consumed by individuals with pica, including charcoal, baking soda, ashes, and pencil erasers, to name a few [3]. A variety of possible etiological explanations of pica have been proposed, including cultural expectations, a response to stress, hunger, gastrointestinal distress, micronutrient deficiency (iron, zinc, calcium, etc.), and finally as protection from toxins and pathogens [1].

Horner and colleagues [4] were the first to systematically review the practice of pica during pregnancy. Across 16 studies from the United States, ethnicity, residence (rural or urban), and time period (1950–1990) were identified as significant risk factors for pica. A fourfold increase in pica prevalence was recorded in individuals who were African American and pregnant, making ethnicity the most significant predictor of pica during pregnancy in this study. Residents of rural (as opposed to urban) areas were more than two times more likely to report pica, and the prevalence of pica significantly decreased during the time period considered in the review.

The DSM-5 does not offer a prevalence estimate for pica, commenting that the prevalence in the general population is unclear [2]. The same is true of pregnant and postpartum populations, despite the fact that increased pica prevalence during the period surrounding childbirth is commonly reported in the literature [5]. Current prevalence estimates of pica during pregnancy vary considerably, especially for geophagia, which has been reported to range from 0.007% in Denmark [6] to 92.5% in Nigeria [7]. This variability has been attributed to multiple factors including differences in diagnostic criteria and measurement,

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underreporting of pica, regional differences, cultural practices, and differences in the populations sampled (e.g. ethnicity, socioeconomic status) [3,8–10].

The aim of the present meta-analysis was to estimate the prevalence of pica in pregnant and postpartum populations, and to characterize the apparent variation in reported prevalence estimates by identifying potential moderating variables. A secondary goal was to highlight some of the difficulties inherent in the measurement of prevalence estimates for pica, including reconsidering the present diagnostic criteria.

2. Method

2.1. Literature search

A search of the online resources PsycARTICLES, PsycINFO, PubMed, and Google Scholar was performed using the Boolean search phrase: ("pica") AND ("prevalence" OR "epidemiology"). The search was conducted from database inception until February 2014 without date or language restrictions, and was supplemented by articles referenced in the obtained sources.

Articles that estimated the prevalence of pica during pregnancy and/or the postpartum period (up to 12 months after delivery) in women of reproductive age using a self-report questionnaire or interview were included. Pica was defined as the purposeful consumption of non-food or non-nutritive substances. Studies that defined pica solely as cravings for non-food items were excluded. All instances of pica, including earth (geophagia), starch (amylophagia), ice (pagophagia), and a vast number of additional substances (e.g. baking soda) were coded. Furthermore, studies that solely measured the prevalence of pica in special populations (e.g. sickle cell disease, dialysis patients) were excluded because the intent in the present meta-analysis was to estimate pica prevalence in healthy women because they are more representative of the general population.

2.2. Data extraction

The following data were extracted from each article by the first author (E.J.F): author name, year of publication, sample size, group (pregnant, pregnant/postpartum, postpartum), point prevalence of pica, specific substances ingested, percentage of participants who were primiparous, percentage of participants who were anemic, mean duration of pregnancy among participants, mean maternal age, country, sampling method (random vs convenience), education of participants, and the assessment measure employed (interview, questionnaire).

2.3. Moderator analyses

Owing to many of the articles not reporting the necessary information to code potential moderators, each analysis was conducted using only the sub-sample of effects for which the moderator under investigation was available. The following eight variables were examined as potential moderators: percentage of participants who were primiparous, percentage of participants who were anemic, mean duration of pregnancy, mean maternal age, education, sample (random vs convenience), geographic region, and year of publication.

Education history was not reported by many of the studies and the nature of the information provided varied between studies; consequently, for each of the included studies, it was only possible to calculate the percentage of study participants that had completed Grade 12 or higher. Geographical region was coded as follows: North America, South America, Europe, Africa, Middle East, and Asia. Several of the regional designations included only a few studies (e.g. Europe and South America); to increase the power of the analysis regions were recoded in two different ways. First, as North/South America, Eurasia, and Africa; second, using the binary predictors Africa and all other regions combined. Finally, anemia was defined as the percentage of participants exhibiting hemoglobin concentrations lower than 11 g/dL [11].

2.4. Data analysis

Prevalence estimates were calculated as the percentage of pica reported within each individual study. Pica prevalence could refer to geophagia, amylophagia, pagophagia, other substances (e.g. baking powder, toothpaste, ashes, etc.), or any combination of the above, depending on what was reported by each individual study. Consequently, pica prevalence is used to refer to any type of pica unless specified otherwise (e.g. geophagia). Although geophagia was examined separately, its relation to any moderating variables did not differ from overall pica prevalence; therefore, only the latter was reported. Amylophagia or pagophagia were not examined separately owing to the small number of studies providing specific results for these, resulting in even smaller sub-samples of data for moderator analyses. Although separating pregnant and postpartum samples for each analysis was considered initially, these samples failed to differ significantly from one another (see Supplementary Material S1 for further information). Consequently, these groups were collapsed to maximize statistical power.

The framework for effect size calculation in the current meta-analysis followed the procedure used by Russell, Fawcett, and Mazmanian [12]. Logit-transformed proportions [13] were used to calculate effect sizes for the prevalence estimates, using the escalc function in the metafor package [14] of R version 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria) [15]. Following this, random-effects models were fitted to the logit-transformed proportions. These values were then back-transformed into percentages for the purpose of reporting and to aid in interpretation. Each moderator analysis began with a random-effects model of the data subset that was available for that moderating variable; this was followed by a mixed-effects model incorporating the moderator as a predictor. Moderator analyses were performed on sub-samples of the data because many studies omitted the information necessary to code for specific moderators.

Given that Horner and colleagues [4] found ethnicity to be the most significant predictor of reported pica in the United States, the present meta-analysis included a supplemental analysis examining the risk of pica in African American and non-African American individuals in a subsample of studies that provided a breakdown including relevant ethnicity data. This information was used to calculate the log-transformed relative risk of pica in individuals who were African American versus those who were non-African American individuals, which was then analyzed using a separate random-effects model.

Outliers were characterized by a studentized deleted residual of greater than two [16] and were considered influential according to several regression deletion diagnostics (e.g. Cook's distance) [17]. The I^2 index was used to calculate the level of heterogeneity between the studies analyzed, with 25%, 50%, and 75% representing low, medium, and high heterogeneity, respectively [18]. $P < 0.05$ was considered statistically significant for all analyses. Wherever appropriate, PRISMA guidelines for systematic reviews were adhered to [19].

3. Results

3.1. Description of studies

Of the 1389 studies initially identified, 71 studies were ultimately coded (Fig. 1). Countries were categorized by geographic region, including North America (33.8%), South America (5.6%), Africa (33.8%), Middle East (18.3%), Asia (4.2%), and Europe (4.2%). Mikkelsen et al. [6] was identified as an outlier, with a prevalence of 0.02%, and was removed from the subsequent analyses, resulting in 70 studies being included. Detailed study characteristics and a full reference list are provided in Supplementary Material S2.

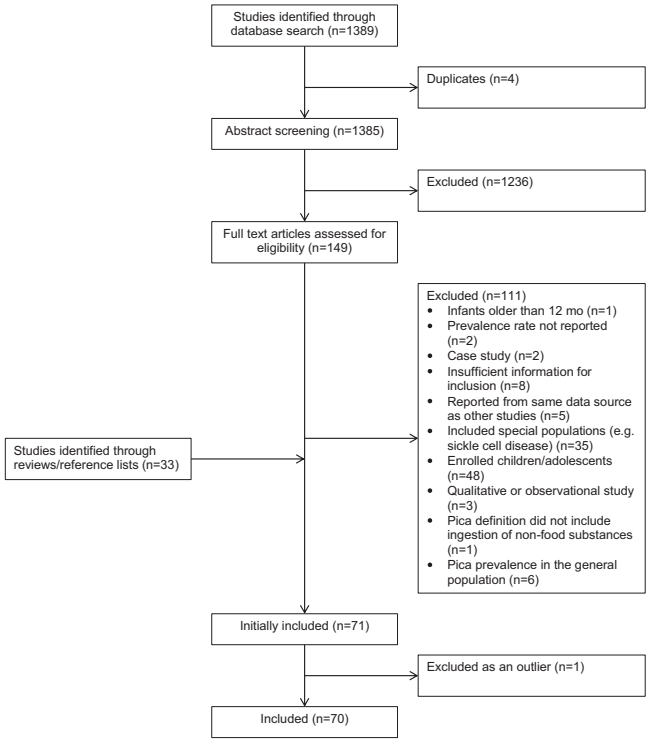

Fig. 1. Flowchart of study selection.

3.2. Pica prevalence

The final analysis included 70 studies, with 71 independent effect sizes. Although an aggregate prevalence estimate was calculated using a random-effects model, inspection of this model (Fig. 2) revealed substantial between-study heterogeneity ($P < 0.001$, $I^2 = 98.81\%$). Therefore, although the back-transformed aggregate prevalence rate was found to be 27.8% (95% confidence interval [CI] 22.8–33.3), the strict application of this point estimate is questionable. Owing to the observed heterogeneity, a 95% prediction interval was also calculated to gauge the range of credible "true" prevalence estimates predicted for a given study within the present model. This interval ranged from 4.2% to 77.3%, meaning that the "true" pica prevalence estimated by any given study was highly variable, implicating the presence of one or more moderating factors. Consequently, the subsequent meta-analyses were focused on isolating the source(s) of the observed heterogeneity in the form of potential moderators.

3.3. Moderator analyses

Of the eight potential moderating factors examined, only geographic region, anemia, and education were found to be significantly associated with pica prevalence; consequently, these models form the focus of the following discussion (further information on the non-significant moderators are included in Supplementary material S1).

3.4. Geographic region

When the study region was coded to compare North/South America, Eurasia, and Africa, the highest mean pica prevalence emerged for Africa (44.8%, 95% CI 35.5–54.6), followed by North/South America (23.0%, 95% CI 17.3–30.1), and Eurasia (17.5%, 95% CI 11.8–25.0). The mean prevalence estimates for both North/South America and Eurasia were significantly lower in comparison with Africa ($P < 0.001$ for both). The binary predictor (comparing Africa with all other regions combined) was also significant ($P < 0.001$), with higher mean pica prevalence demonstrated in Africa (44.8%, 95% CI 35.4–54.6) compared with the rest of the world (20.8%, 95% CI 16.5–25.8). Although this model accounted for 23.4% of the variability within the prevalence estimates, significant heterogeneity remained between studies ($P < 0.001$, $I^2 = 98.40\%$).

3.5. Anemia

The prevalence of anemia was reported by 31 studies. When included in a meta-regression model, the percentage of participants in each sample with anemia was found to positively predict the prevalence of pica (unstandardized regression coefficient [B] = 0.015, 95% CI 0.003–0.027), accounting for 14.8% of the total heterogeneity between the analyzed studies ($P < 0.001$, $I^2 = 97.86\%$). This relationship (Fig. 3) remained present after accounting for regional differences in prevalence (B = 0.0139, 95% CI 0.002–0.026).

Two supplementary analyses were conducted to further investigate the relationship between pica and anemia. Log-transformed relative risk ratios were calculated for each study that included the risk of pica in individuals with and without anemia. Nineteen studies provided sufficient information to calculate the necessary risk ratios. Women with anemia were over one and a half times more likely to report pica compared with women without anemia (log-risk ratio 0.47, 95% CI 0.38–0.56; back-transformed risk ratio 1.60, 95% CI 1.46–1.75); further, there was minimal evidence of heterogeneity within this model ($P = 0.71$, $I^2 < 0.01\%$) (Supplementary material S3). A trim and fill procedure suggested two studies were missing to the left of the aggregate effect, although the corrected aggregate risk ratio remained largely unchanged and was estimated to be 1.58 (95% CI 1.45–1.73).

Following this, a meta-analysis of mean hemoglobin levels in study participants with and without pica was performed. The information for this analysis was present in 11 studies. This model demonstrated substantial heterogeneity, largely attributable to a single study [20] that was identified as an outlier. Consequently, the analysis was repeated excluding this outlier, demonstrating that hemoglobin levels were on average 0.55 g/dL lower (95% CI 0.43–0.66) in participants with pica. Although moderate heterogeneity was still present between the studies analyzed ($P = 0.005$, $I^2 = 57.69\%$), when considered individually, each of the included studies supported the conclusion that individuals with pica have lower hemoglobin levels–demonstrated by positive difference scores. These data are depicted in Supplementary material S3. A trim and fill procedure was applied to correct for publication bias, which suggested four missing studies to the left of the mean. The corrected unstandardized mean difference was 0.48 g/dL (95% CI 0.33–0.63).

3.6. Education

The information necessary to code for education status was included in 29 studies. When education was included in an initial meta-regression model, a non-significant ($P = 0.145$) negative trend was observed, suggesting that a study population having a higher percentage of educated individuals was associated with a lower estimate of pica prevalence (B = −0.012, 95% CI −0.028 to 0.004). However, it was suspected that the relationship might be masked by regional differences in overall prevalence; consequently, a model that accounted for both education and geographic region concurrently was produced. This model demonstrated that education had a significant negative association with pica prevalence (B = −0.017, 95% CI −0.027 to −0.006; $P = 0.002$) (Fig. 4). This combined model accounted for 62.9% of the variability within the prevalence estimates, although further between-study heterogeneity remained ($P < 0.001$, $I^2 = 98.01\%$).

3.7. Ethnicity

A breakdown of participants' ethnicity was included by nine studies that were conducted in the USA. An analysis of the log-risk ratios comparing the risk of experiencing pica between study participants who

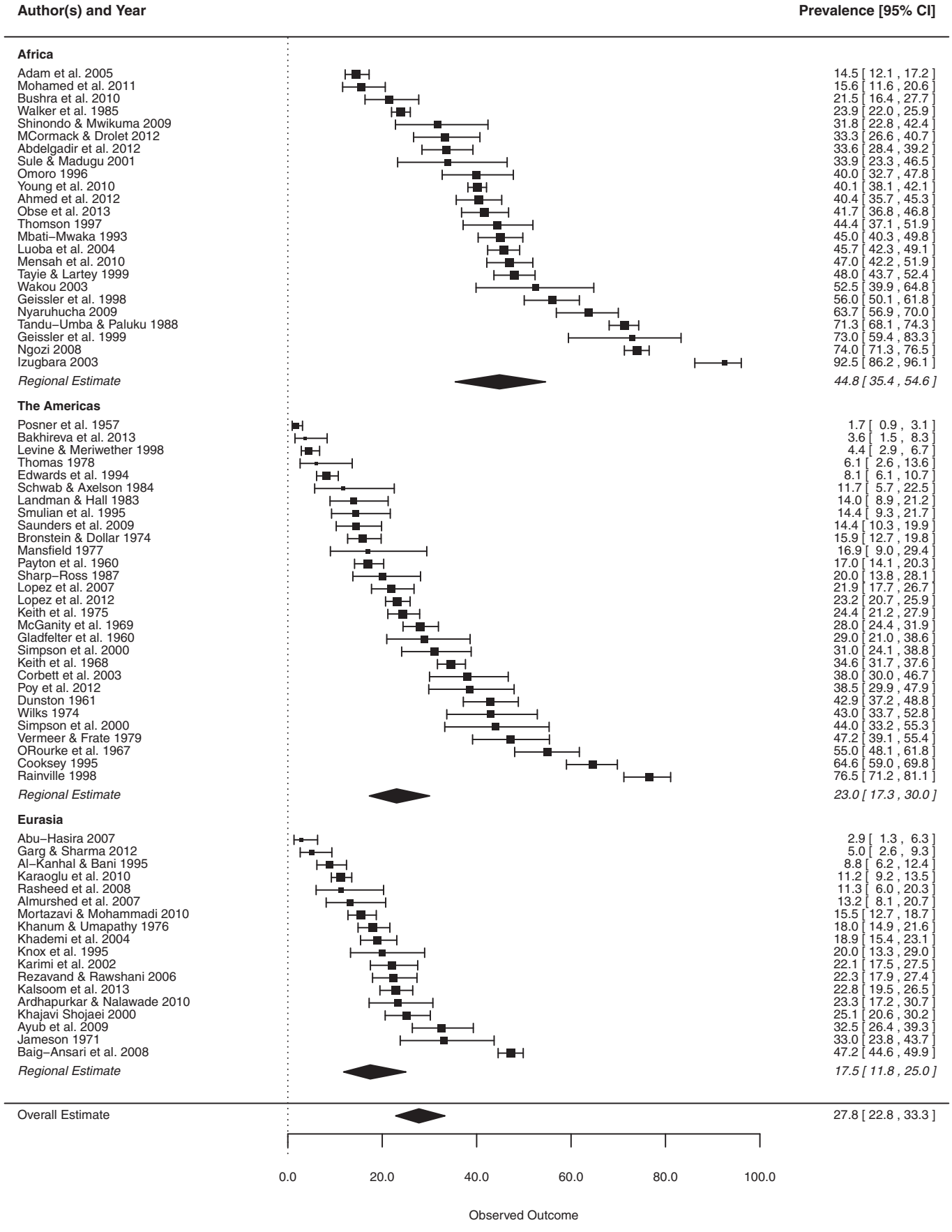

Fig. 2. Forest plot of back-transformed aggregate prevalence rates for each region. Marker size represents weight within the model. Abbreviation: CI, confidence interval.

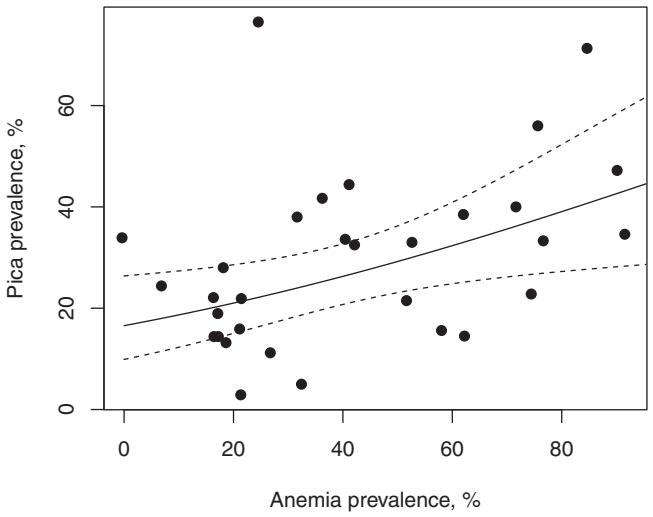

Fig. 3. Scatterplot of association between anemia and the prevalence of pica.

were African American or non-African American produced a log risk ratio of 0.80 (95% CI 0.35–1.25) (Fig. 5) and the aggregate back-transformed risk ratio was 2.22 (95% CI 1.42–3.48), demonstrating that participants who were African American were 2.22 times more likely to experience pica compared with individuals who were not African American. Although there was moderate between-study heterogeneity within this analysis ($P = 0.002$, $I^2 = 55.97\%$), each of the studies included in the analysis demonstrated an increased risk of experiencing pica among participants who were African American–as demonstrated by positive log-risk ratios. A trim and fill procedure was applied to test and correct for publication bias [21], which suggested two studies were missing to the left of the aggregate effect. Nonetheless, the corrected aggregate risk ratio was still 1.98 (95% CI 1.27–3.10).

An apparent positive trend between log-risk ratio and the year of study publication was demonstrated (Fig. 5); the largest log-risk ratios were recorded for older studies, whereas more recent studies tended to have relatively smaller log-risk ratios. When incorporated into an exploratory model, the year of study publication was found to be significantly associated with the magnitude of the association between ethnicity and pica prevalence ($P = 0.009$), accounting for 79.9% of the study heterogeneity ($P = 0.19$, $I^2 = 16.41\%$). Consequently, in this analysis, participants who were African American were at higher risk of experiencing pica in earlier decades in comparison with more recent studies.

4. Discussion

According to the results of the present study, the aggregate pica prevalence in pregnant and postpartum populations was estimated to be 27.8%; however, owing to substantial heterogeneity across the studies analyzed, it is suggested that this represents a poor indicator of the prevalence of reported pica in the general population of pregnant and postpartum individuals. The corresponding prediction interval demonstrated a wide range of probable "true" prevalence estimates that varied according to the specific features of the study population in question. Consequently, the analyses were focused on isolating the sources(s) of the observed heterogeneity to help improve understanding of the factors associated with the development of pica.

Pica was found to be more prevalent in Africa compared with elsewhere in the world. Higher educational attainment was associated with lower pica prevalence. The rate of anemia in a study population was also positively associated with the prevalence of pica. The supplementary analyses supported this finding, revealing that women with anemia were 1.6 times more likely to have pica compared with women without anemia; additionally, participants with pica demonstrated significantly lower hemoglobin levels (0.55 g/dL lower) compared with women who were not experiencing pica. Finally, participants of African American ethnicity were 2.2 times more likely to have pica compared with other ethnic groups–although the size of this difference appears to have decreased over time.

Pica prevalence has long been thought to be highest in individuals of lower socioeconomic status [5]. The present meta-analysis found that pica prevalence within a sample decreased as educational attainment increased. It has been reported that education and socioeconomic status are also associated with anemia, with increased anemia prevalence in low-income countries and among individuals with limited education [22]. Additionally, individuals who were socioeconomically disadvantaged were found to be more likely to be exposed to conditions that increased their risk of anemia (e.g. inadequate nutrition, lack of prenatal care, etc.) [22]. Therefore, it is possible that anemia is driving the association between pica prevalence and education; unfortunately, too few studies report information pertaining to both anemia and education to facilitate an analysis of this in the present study. Another possibility is that these findings reflect reporting bias, where, as education increases, individuals are more likely to view pica as "bad" or "abnormal" and, consequently, are less inclined to disclose if they practice pica. Therefore, the prevalence of pica could be much higher than reported in high-income countries owing to increased stigma surrounding the practice [23]. Increased awareness, validated assessment tools, and normalization of the practice could benefit individuals who are otherwise reluctant to freely discuss pica behavior.

Previous literature supports the hypothesis of a strong association between pica and anemia. Consistent with the present findings, another recent meta-analysis [24] independently reported that pregnant individuals practicing pica were 1.92 times more likely to be anemic and had significantly lower hemoglobin levels compared with individuals who did not report pica. Furthermore, this analysis found that pica was a marker for micronutrient deficiencies across several populations (e.g. children, adults, individuals who were pregnant) [24]. However, the direction of the relationship between pica and anemia remains

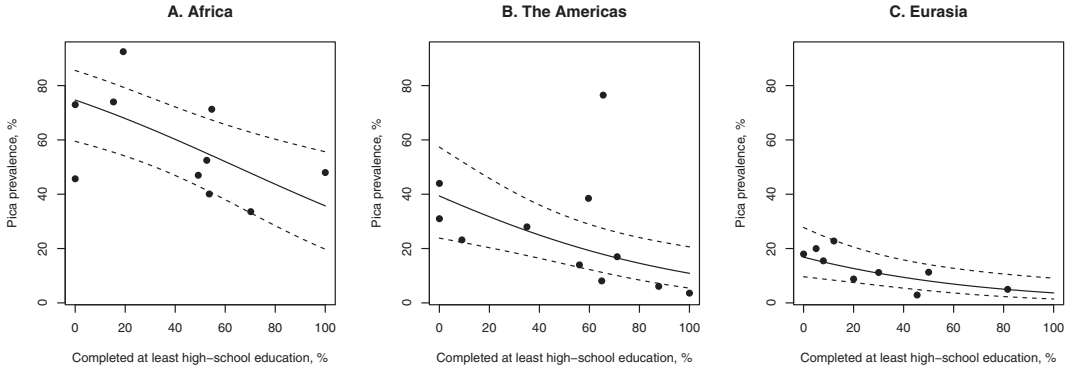

Fig. 4. Scatterplot of association between having completed at least high-school education and pica prevalence in (A) Africa, (B) the Americas, and (C) Eurasia.

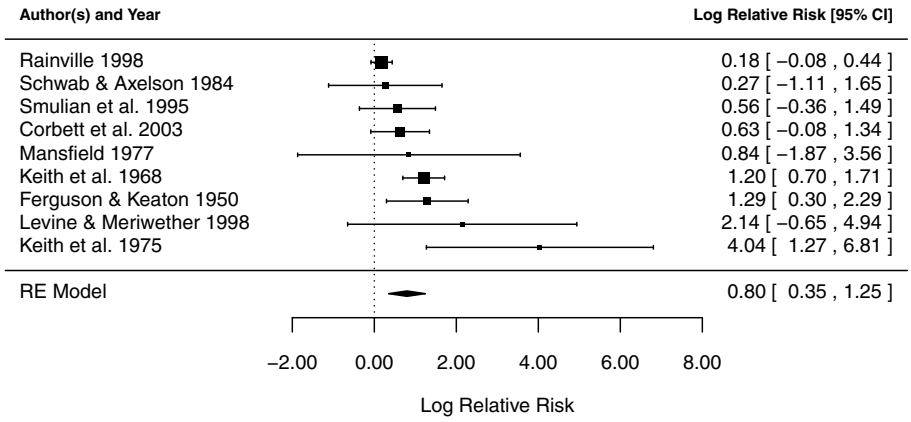

Fig. 5. Forest plot of the log-risk ratio of reporting pica in women who were African American compared with women who were not. Marker size represents weight within the model. Abbreviation: CI, confidence interval; RE, random effects.

unclear. Case reports have found a cessation in pica following iron administration [25,26]; however, iron treatment did not successfully reduce pica in two randomized, double-blind studies that enrolled children [27,28]. There are several additional problems with the theory of iron deficiency being a cause of pica. Humans practicing pica have not been shown to experience iron-specific cravings, pica substances often provide little to no bioavailable iron, and many individuals with anemia do not engage in pica [1,25,29]. Recent studies examining the frequency of pica in iron-deficient individuals found pica prevalence rates between 34% and 55% [30–32]. Conversely, some pica substances (e.g. earth, raw starches, ash) can cause anemia by interfering with micronutrient absorption (e.g. iron) [1,29]. Finally, many individuals without iron deficiency or anemia engage in pica.

The present findings are also consistent with previous literature in suggesting an association between pica and ethnicity. Whereas the first systematic review of pica found that individuals who were African American were four times more likely to exhibit pica [4], an increase of 2.22 times was demonstrated in the present meta-analysis. This discrepancy may be partly explained by the fact that the review conducted by Horner and colleagues [4] was performed over 20 years earlier than the present analysis; in the present study, the risk of pica among individuals of African-American ethnicity was observed to have diminished over time. Extrapolating beyond the data presently available to 2015, the present model would predict a risk ratio of 1.00 (95% CI 0.56–1.78), indicating parity in the risk of pica between African Americans and other ethnicities.

Cultural values and traditions can strongly influence the practice and acceptance of pica. By way of example, geophagia has strong associations with fertility and reproduction in the Kilifi District of Kenya [33] and among Ngwa women in southeastern Nigeria [7]. Additionally, within the Ngwa, geophagia is believed to reduce vomiting, and the risk of contracting infections and disease [7]. The DSM-5 recognizes the dangers of over-pathologizing a practice that is viewed as beneficial and symbolic in many areas of the world, stating that, for a behavior to inform a diagnosis, the behavior must not be part of a culturally supported or socially normative practice. However, neither the point at which a practice should be considered culturally supported, nor how this determination is to be made, is clear. Future versions of the DSM should more clearly explicate the construct of a culturally sanctioned practice because overall pica prevalence would likely decrease considerably if it was only diagnosed in regions or cultures where the practice violates cultural norms.

4.1. Limitations and future directions

Although the moderating variables examined in the present study accounted for a large amount of heterogeneity between studies, considerable unexplained variability remained. This was compounded by the fact that demographic information was often absent or reported inconsistently across studies. Similarly, the prevalence of pica would likely have been lower if the same diagnostic criteria were employed across all studies. Meeting strict DSM diagnostic criteria for pica was not a requirement for inclusion in the present meta-analysis owing to the myriad of definitions of pica used in the literature, the tendency to ignore duration criteria, and the lack of validated and standardized diagnostic assessment measures for pica. Pica is also often underreported by individuals owing to embarrassment or failing to consider a pica substance as non-food [1,5]. The development of a universal list of pica substances could potentially help to normalize pica and reduce stigma. Furthermore, additional studies are needed that examine the prevalence of pica in the general female population to assess whether pregnancy and the postpartum period are periods of heightened risk for the development of pica.

4.2. Conclusion

Across the studies included in the present meta-analysis, almost one third of participants who were pregnant or in the postpartum period reported practicing pica. However, considering the heterogeneity between studies, the estimated pica prevalence of 27.8% is unlikely to be representative of the general population who are pregnant or in the postpartum period. Living in Africa, low educational attainment, being African American, and having anemia were all associated with increased pica prevalence. The present study also suggests that the diagnostic criteria for pica need refinement, including practical guidance for interpreting whether, in a given environment, pica is a culturally sanctioned practice or not. The significant heterogeneity within the data suggests that there may be multiple pathways in the development of pica.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ijgo.2015.10.012.

Conflict of interest

The authors have no conflicts of interest.

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