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ORIGINAL ARTICLE

Comparison of Pica Prevalence Between Children and Adolescents with Iron Deficiency and Iron Deficiency Anaemia: A Prospective Cross-Sectional Study

Demir Eksikliği ve Demir Eksikliği Anemisi Olan Çocuklar ve Ergenler Arasındaki Pika Prevalansının Karşılaştırılması: Bir Prospektif Kesitsel Çalışma

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ABSTRACT

Background/Aims: The existing literature lacks comprehensive data on the association between the severity of iron deficiency (ID) and pica prevalence in children and adolescents. The aim of this study was to explore the prevalence of pica in apparently healthy children and adolescents, and to compare its occurrence between those diagnosed with ID and those with IDA.
Methods: This prospective cross-sectional study was conducted at the outpatient paediatric clinic over a period of three months. A total of 504 children and adolescents were enrolled in the study. Participants were categorized into three groups based on primary laboratory findings: Group 1 (healthy), Group 2 (isolated ID), and Group 3 (IDA).
Results: A pica prevalence rate of 5.35% was observed, with a significantly higher occurrence among children suffering from IDA compared to those with ID and their healthy counterparts (p: <0.0001). Moreover, the prevalence was significantly higher in the 12-17.9 years age group (p: 0.01). Female sex and serum ferritin level emerged as the most significant independent predictors associated with pica in our investigation.
Conclusions: Our study demonstrated a higher prevalence of the pica among children suffering from IDA, the most severe form of iron deficiencies, compared with those with isolated ID.

Keywords: Adolescent, children, iron deficiency, iron deficiency anaemia, pica

ÖZ

Arka Plan/Amaçlar: Mevcut literatürde demir eksikliğinin şiddeti (DE) ile çocuk ve ergenlerde pika prevalansı arasındaki ilişkiye dair kapsamlı veriler bulunmamaktadır. Bu çalışmanın amacı görünüşte sağlıklı çocuk ve ergenlerde pika prevalansını araştırmak ve DE tanısı alan kişiler ile DEA tanısı alan kişiler arasındaki görülme sıklığını karşılaştırmaktı.
Yöntemler: Bu prospektif kesitsel çalışma, pediatri polikliniğinde üç ay boyunca gerçekleştirildi. Çalışmaya toplam 504 çocuk ve ergen katılmıştır. Katılımcılar birincil laboratuvar bulgularına göre üç gruba ayrıldı: Grup 1 (sağlıklı), Grup 2 (izole DE) ve Grup 3 (DEA).
Bulgular: %5,35'lik bir pika yaygınlık oranı gözlendi; DEA'lı çocuklar arasında, DE'li çocuklar ve onların sağlıklı akranlarıyla karşılaştırıldığında önemli ölçüde daha yüksek bir görülme sıklığı gözlendi (p: <0,0001). Ayrıca 12-17,9 yaş grubunda prevalans anlamlı olarak daha yüksekti (p:0,01). Araştırmamızda kız cinsiyeti ve serum ferritin düzeyi pika ile ilişkili en önemli bağımsız belirleyiciler olarak ortaya çıktı.
Sonuçlar: Çalışmamız, demir eksikliğinin en şiddetli şekli olan DEA'dan mustarip çocuklarda, izole DE'li çocuklarla karşılaştırıldığında pika prevalansının daha yüksek olduğunu gösterdi.

Anahtar Kelimeler: ergen, çocuk, demir eksikliği, demir eksikliği anemisi, pika

Introduction

Iron deficiency (ID) stands as the predominant aetiology of nutritional anaemia on a global scale, posing a substantial public health challenge, particularly in developing regions (1). Epidemiological investigations have revealed a concerning prevalence of anaemia among children in these settings, with reports indicating that around one-third of preschool-aged children and half of those aged 5-15 years suffer from this condition (2,3). The spectrum of ID encompasses a continuum ranging from ID without anaemia to the more severe form known as IDA. ID without anaemia comprises two distinct stages: iron-deficient erythropoiesis, characterized by depleted iron stores and subsequent decreased transport iron, and iron depletion, denoting a reduction in stored iron levels. IDA represents the most severe manifestation of ID (4). Notably, iron plays a critical role in brain development, particularly in children, influencing various processes such as monoamine neurotransmitter function, myelination, as well as glial and neuronal energy metabolism (5). Iron deficiency anaemia (IDA) typically remains asymptomatic unless it reaches severe levels. 2 In instances where IDA manifests in early childhood, especially in severe and prolonged forms, it can lead to neurodevelopmental

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and cognitive impairments, which may not be entirely reversible despite the correction of the underlying IDA (2,6).

Pica is characterized by the recurrent consumption of non-nutritive and non-food substances outside the context of culturally normative practices or other mental or physical conditions lasting for a minimum duration of one month (7,8). The prevalence of pica exhibits variations among different populations, with reported frequencies showing discrepancies (9,10). Early diagnosis of pica can help prevent the complications it may cause (7).

The exact pathophysiological mechanisms of pica remain uncertain, despite numerous proposed aetiologies in the current medical literature. These proposed etiological factors include sensations of hunger, deficiencies in essential micronutrients such as iron, zinc, and calcium, gastrointestinal disturbances like dyspepsia, heightened family stress, and comorbid psychiatric conditions such as obsessive-compulsive disorder. Furthermore, a proclivity towards the taste and texture of non-nutritive substances ingested has been identified as a contributing factor (11,12). Although pica can manifest across all age groups, it is more commonly reported in children, individuals with mental retardation, those experiencing learning difficulties, and pregnant women. Notably, pica has been particularly associated with ID and IDA.

The observation that pica can occur even in the pre-anemic stage of ID in children and may serve as a valuable indicator for predicting ID is noteworthy. The intricate relationship between ID and pica remains incompletely elucidated, with studies suggesting bidirectional influences between the two conditions (8). The existing literature lacks comprehensive data on the association between the severity of ID and pica prevalence in children and adolescents, particularly in comparing isolated ID with IDA. This study aims to fill the gap in the literature by investigating the prevalence of pica in apparently healthy children and adolescents, comparing its occurrence between those diagnosed with isolated ID and IDA.

Material and Methods

Study design and sampling

The study design was approved by the Karatay University Ethics Committee under the approval number 2023/018, 17.11.2023. All participants gave informed consent. This prospective cross-sectional study was conducted at the outpatient paediatric clinic of Konya Beyhekim Training and Research Hospital, Turkiye, over a period of three months, from December 1, 2023, to March 1, 2024. Data pertaining to participants' application dates, sex, age, and laboratory parameters were extracted from the hospital's electronic information system.

Sample size calculation

The sample size for the current study was calculated based on an estimated pica prevalence of 12.3%, as reported in a previous study (13). Utilizing the G*Power 3.1.9.7 software, key parameters such as an alpha error of 5%, a difference of 10%, and a power level set at 80% were established. The calculated minimum required sample size based on these parameters was 504 children. The present study successfully enrolled a participant cohort that met the predetermined sample size threshold.

Inclusion criteria encompassed children and adolescents aged >2 to 17.9 years who were extensively queried about their pica history during the study period. Haemogram, serum iron, total iron binding capacity, and ferritin levels were assessed in all participants.

Exclusion criteria comprised children under 24 months, those with active infection, C-reactive protein levels >5 mg/dl, hemolytic anaemia, thalassemia, sickle cell disease, developmental delays, or neurological abnormalities such as autism spectrum disorders. Individuals with missing laboratory data were excluded.

Participants were categorized into three groups based on primary laboratory findings: Group 1 (healthy), Group 2 (isolated ID), and Group 3 (IDA). Age stratification included children aged >2–4.9 years, 5–11.9 years, and adolescents aged 12–17.9 years. Pica history was obtained from parents of preverbal children and directly from older children and adolescents, detailing episode durations and ingested substances, adhering to DSM-V criteria for diagnosis (14).

Laboratory investigations

Haemogram analysis was conducted using flow cytometric method on the Shenzhen Mindray Auto Haematology Analyzer BC-6800 (Shenzhen, China). Analysis of serum iron and total iron-binding capacity was performed through calorimetric assay using a commercial kit on the Shenzhen Mindray BS-2000M (Shenzhen, China). Serum ferritin level was determined using an immunoassay method with a commercial kit (ADVIA Centaur®) on the Siemens ADVIA Centaur® XPT (Siemens Diagnostics, Tarrytown, NY, USA).

The diagnosis of anaemia was based on the criteria established by the World Health Organization (WHO). Specifically, anaemia was defined as haemoglobin (Hb) levels below 11 g/dL for children aged 2.1-4.9 years, below 11.5 g/dL for children aged 5-11.9 years, below 12 g/dL for females aged 15 years and above, and below 13 g/dL for males aged 15 years and above. ID was identified as ferritin levels below 12.0 ng/mL for children aged 24-59 months and below 15 ng/mL in children aged 5-10 years and adolescents (15). IDA was characterized by the simultaneous presence of anaemia and low ferritin levels, as per age-specific thresholds, in the absence of any underlying conditions that could impact these parameters (16,17).

Statistical Analysis

Categorical variables were expressed as numerical values and percentages. The distribution of the parameters was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. Given the non-normal distribution, all values were reported as median

Table 1. Comparison of Demographic Characteristics of Study Groups

	Healthy children (n:352)	Isolated iron deficiency (n:117)	Iron deficiency anaemia (n:35)	p-value			p-value€
Sex (Female/Male) (n, %)	188/164 (53.4/46.5)	69/48 (58.9/41.1)	29/6 (82.8/17.2)				
Age (years)	9.30 (6.8)	9.90 (10)	14 (10.1)	**0.034**§	G1-2 0.359	G2-3 0.104	G1-3 **0.009**
Pica (n, %)	6 (1.7)	5 (4.3)	16 (45.7)	**<0.0001***			
Pica duration (months)	6 (3)	2 (2.5)	24 (25.5) §	0.002	G1-2 0.082	G2-3 0.017	G1-3 **0.001**

Quantitative variables were presented as the median (IQR). Qualitative variables were expressed as number and percentages.

Results were compared using the Kruskal–Wallis test followed by the Bonferroni-corrected Mann–Whitney U test.

Significance was determined by p<0.05 for the Kruskal Wallis test and p<0.016 (p = 0.05/3) for the Bonferroni correction.

P-values with statistical significance were highlighted in bold.

Chi-square test were performed to compare categorical variables.

§Kruskal–Wallis test, € Mann–Whitney U test, *Chi-square test

G1-2: Healthy group versus isolated iron deficiency group

G2-3: Isolated iron deficiency group versus Iron deficiency anaemia group

G1-3: Healthy group versus Iron deficiency anaemia group

with interquartile range (IQR). The comparison of categorical variables across different groups was conducted using the chi-square test or Fisher's exact test. Group comparisons were made using the Mann-Whitney U test. The Kruskal-Wallis analysis of variance test was employed for group comparisons, and the Bonferroni corrected Mann–Whitney U-test was used for multiple comparisons. A significance level of p<0.05, or p<0.05/k for k comparisons was considered statistically significant. Forward stepwise multivariate logistic regression was applied to identify risk factors for pica. The statistical analysis was performed using the SPSS software package for Windows, version 21.0.

Results

Comparison of Demographic Characteristics of Study Groups

A total of 504 children and adolescents were enrolled in the study. Demographic analysis revealed a sex distribution of 43.3% males and 56.7% females, with ages ranging from >2 to 17.9 years and a median age of 9.85 years (IQR: 7.7, minimum-maximum 2.1-17.9 years). Upon sex-based analysis, it was observed that 24.1% of females exhibited isolated ID, with 10.1% experiencing IDA. In contrast, 22% of males showed isolated ID, with only 2.8% diagnosed with IDA. Statistical analysis revealed no significant difference in the prevalence of ID between males and females (p=0.579). However, a statistically significant discrepancy was noted in the occurrence of IDA, which was higher in females than in males (p: 0.001). A higher median age was found in the IDA group compared to the healthy group, with statistical significance observed in the comparison of median ages between the study groups (p: 0.009). Among all participants, 5.35% had a history of pica, with the group with IDA demonstrating a significantly longer duration of pica compared to the healthy group (p: 0.001). The prevalence of pica was statistically significantly higher in the IDA group than in the ID and healthy groups (p<0.0001) (Table 1).

Table 2. Comparison of the Isolated Iron Deficiency and Iron Deficiency Anaemia Rates According To Sex and Age Groups in the Study Population

Age groups		Healthy children			Isolated iron deficiency			Iron deficiency anaemia			p-value*
	Males	Females	Total	Males	Females	Total	Males	Females	Total	
>2-4.9 years (n, %)	33 (51.6)	31 (48.4)	64[a] (18.2)	18 (62.1)	11 (37.9)	29[a,b] (24.8)	3 (37.5)	5 (62.5)	8[a] (22.9)	<0.0001
5-11.9 years (n, %)	83 (45.4)	100 (54.6)	183[b] (52)	19 (48.7)	20 (51.3)	39[b] (33.3)	2 (50)	2 (50)	4[b] (11.4)	
12-17.9 years (n, %)	48 (45.7)	57 (54.3)	105[a] (29.8)	11 (22.4)	38 (77.6)	49[a] (41.9)	1 (4.3)	22 (95.7)	23[a] (65.7)	
Total (n, %)	164 (46.6)	188 (53.4)	352 (69.84)	48 (41)	69 (59)	117 (23.21)	6 (17.2)	29 (82.8)	35 (6.95)	

Qualitative variables were expressed as number and percentages. P-values with statistical significance were highlighted in bold.

*Chi-square test

Table 3. Comparison of Sex-Specific Frequency of Pica across Age Groups

Age groups				
	Males	**Females**	**Total**	p-value*
>2-4.9 years, n (%)	54 (53.5)	47 (46.5)	101	
Pica	4 (7.4)	6 (12.76)	10 (9.9)	0.368
5-11.9 years, n (%)	104 (46)	122 (54)	226	
Pica	1 (0.8)	4 (3.2)	5 (2.2)	0.238
12-17.9 years, n (%)	60 (33.9)	117 (66.1)	177	
Pica	0 (0)	12 (10.2)	12 (6.78)	**0.010**
Total, n (%)	218 (43.3)	286 (56.7)	504	
Pica	5 (2.29)	22 (7.69)	27 (5.35)	**0.008**

Quantitative variables were presented as the median (IQR). Qualitative variables were expressed as number and percentages.

Isolated Iron Deficiency and Iron Deficiency Anaemia Rates According To Sex and Age Groups in the Study Population

The reported frequencies of various pica types included coffee grounds in 2.18% of children, paper in 1.19%, soil in 0.99%, clay in 0.39%, both soil and clay in

Table 4. Comparison of Laboratory Characteristics of Study Groups

Characteristics	All participants	Healthy children	Isolated iron deficiency	Iron deficiency anaemia	p-value§	p-value€
Iron (ng/mL)	68 (51)	72 (40)	70 (53)	31 (45)	<0.0001	G1-2 0.737 G2-3 <**0.0001** G1-3 <**0.0001**
Total iron-binding capacity (µg/dL)	293 (85)	278 (80)	311.4 (79)	366 (78)	<0.0001	G1-2 <**0.0001** G2-3 <**0.0001** G1-3 <**0.0001**
Ferritin (ng/mL)	20.90 (19.70)	27 (20.60)	10.60 (4.10)	6 (8.15)	<0.0001	G1-2 <**0.0001** G2-3 0.051 G1-3 <**0.0001**
RBC (10^6/µL)	4.92 (0.51)	4.91 (0.52)	4.94 (0.47)	4.92 (0.70)	0.240	
Platelet count (10^3/µL)	324 (92)	322 (95)	324 (80)	337 (117)	0.306	
Haemoglobin (g/dL)	13.10 (9.90)	13.20 (1.60)	13.20 (1.40)	11.10 (0.70)	<0.0001	G1-2 0.256 G2-3<**0.0001** G1-3 <**0.0001**
Haematocrit (%)	38.60 (4.70)	38.60 (4.50)	39.30 (4.85)	35.0 (5.05)	<0.0001	G1-2 0.730 G2-3<**0.0001** G1-3 <**0.0001**
MCV (fL)	79 (6.50)	79.10 (6.90)	78.90 (6.25)	77.0 (10.75)	0.047	G1-2 0.478 G2-3 0.062 G1-3 **0.015**
MCH (pg)	26.80 (2.30)	27 (2.10)	26.70 (2.50)	24.90 (4.35)	<0.0001	G1-2 0.129 G2-3<**0.0001** G1-3 <**0.0001**
MCHC (g/dL)	33.90 (1.60)	34.10 (1.50)	33.90 (1.50)	32.20 (2.10)	<0.0001	G1-2 0.086 G2-3<**0.0001** G1-3 <**0.0001**
RDW (%)	13.50 (1.10)	13.30 (1.0)	13.70 (1.20)	14.60 (3.30)	<0.0001	**G1-2 0.001** G2-3 **0.002** G1-3 <**0.0001**
MPV (fL)	9.70 (1.70)	9.70 (1.65)	9.80 (1.50)	9.80 (1.95)	0.818	

Abbreviations: RBC: Red blood count, MCV: Mean corpuscular volume, MCH: Mean corpuscular haemoglobin, MCHC: Mean corpuscular haemoglobin concentration, RDW: Red blood cell distribution width, MPV: Mean platelet volume

Quantitative variables were presented as the median (IQR). Qualitative variables were expressed as number. Results were compared using the Kruskal–Wallis test followed by the Bonferroni-corrected Mann–Whitney U test. Significance was determined by p<0.05 for the Kruskal Wallis test and p<0.016 (p = 0.05/3) for the Bonferroni correction. P-values with statistical significance were highlighted in bold.

G1-2: Healthy group versus isolated iron deficiency group

G2-3: isolated iron deficiency group versus Iron deficiency anaemia group

G1-3: Healthy group versus Iron deficiency anaemia group

Table 5. Comparison of Demographic and Laboratory Characteristics of Pica and Non-Pica Groups

Characteristics	Pica group (n:27)	Non-Pica group (n:477)	p-value
Sex (Female/Male) (n, %)	22/5 (81.5/18.5)	264/213 (55.3/44.7)	**0.008** *
Age (years)	11.95 (11.9)	9.20 (7.8)	0.652
Iron (ng/mL)	64.50 (39)	70 (51)	0.352
Total iron-binding capacity (µg/dL)	312 (116)	292 (85)	0.123
Ferritin (ng/mL)	11.85 (10.80)	21.30 (19.80)	**<0.0001** €
RBC (10^6/µL)	4.71 (0.53)	4.93 (0.48)	**0.005** €
Platelet count (10^3/µL)	342.5 (141.5)	323 (91)	0.268
Haemoglobin (g/dL)	11.35 (1.32)	13.20 (1.70)	**<0.0001** €
Haematocrit (%)	36.75 (6.25)	38.60 (4.70)	**0.017** €
MCV (fL)	78.45 (6.37)	79.0 (6.70)	0.828
MCH (pg)	26.80 (2.58)	26.80 (2.20)	0.616
MCHC (g/dL)	33.75 (1.93)	34.0 (1.60)	0.075
RDW (%)	13.70 (1.57)	13.50 (1.10)	0.265
MPV (fL)	9.55 (2.30)	9.70 (1.50)	0.580

Abbreviations: RBC: Red blood count, MCV: Mean corpuscular volume, MCH: Mean corpuscular haemoglobin, MCHC: Mean corpuscular haemoglobin concentration, RDW: Red blood cell distribution width, MPV: Mean platelet volume

*Chi-square test, € Mann–Whitney U test

0.19%, napkin in 0.19%, and cigarette butts in 0.19%. The study population was categorized into age groups as follows: 20% in the >2-4.9 age group, 44.9% in the 5-11.9 age group, and 35.1% in the 12-17.9 age group. Of all participants, approximately 23% were classified under isolated ID, with 13.6% females and 9.4% males, while the IDA group comprised around 7% of participants, with 5.8% females and 1.2% males, with the rest forming the healthy control group. Adolescents exhibited a significantly higher prevalence of isolated ID and IDA compared to other age groups (p<0.0001) (Table 2).

Sex-Specific Frequency of Pica across Age Groups

Sex-wise analysis revealed a higher frequency of pica in females than males (p: 0.008). Although no significant sex-specific differences were observed across age groups, adolescent females demonstrated a significantly higher prevalence of pica compared to males (p: 0.010) (Table 3). A significant difference in pica prevalence was noted among the age groups, with the rates of 2% in the >2-4.9 years group, 1% in the 5-11.9 years group, and 2.4% in the 12-17.9 years group exhibiting a higher prevalence (p: 0.01).

Laboratory Characteristics of Study Groups

Significant disparities were noted among groups in terms of serum iron, total iron binding capacity, and ferritin levels (p<0.0001). The IDA group displayed lower

serum iron levels and higher total iron binding capacity compared to the healthy and isolated ID groups. Additionally, serum ferritin levels were significantly lower in both the isolated ID and IDA groups compared to the healthy group ($p<0.0001$). Significant differences were observed in haematological parameters such as haemoglobin, haematocrit, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW) values among groups, with the IDA group demonstrating lower levels of haemoglobin, haematocrit, MCH, and MCHC, and higher RDW values compared to the isolated ID and healthy groups (Table 4). Additionally, individuals with pica exhibited statistically significant lower levels of serum ferritin, red blood cells (RBC), haemoglobin, and haematocrit compared to those without pica (Table 5).

Logistic regression of factors affecting pica

In the entire study cohort, a multiple regression analysis model was utilized to assess the variables that independently influenced pica. A multiple stepwise regression analysis was employed to elucidate the individual contributions of age, sex, serum ferritin level, haemoglobin, MCV, and RDW to the occurrence of pica. The results of the multivariate logistic regression analysis revealed that female sex ($\beta=2.767$, $p=0.047$, 95% Confidence Interval 1.015-7.544) and serum ferritin level ($\beta=0.919$, $p=0.001$, 95% Confidence Interval 0.875-0.965) emerged as the most significant independent predictors of pica in children.

Discussion

This study represents the first investigation in the literature to elucidate the relationship between the severity of ID and pica. Within our study cohort, a pica prevalence of 5.35% was observed, with a significantly higher occurrence among children suffering from IDA compared to those with ID and their healthy counterparts. Furthermore, a sex-based disparity in pica prevalence was statistically significant, with females exhibiting a higher prevalence than males. Notably, our findings revealed a markedly elevated prevalence of pica particularly among adolescent females. Female sex and serum ferritin level emerged as independent predictors of pica in our study. Moreover, the analysis indicated significantly lower levels of serum ferritin, RBC, haemoglobin, and haematocrit in the pica group compared to the non-pica group. This research, conducted in Konya within the Central Anatolian region of Turkiye, diverged from prior studies by highlighting coffee grounds as the predominant form of pica among children and adolescents in the region.

IDA demonstrates variable prevalence rates globally, contingent upon the level of development of individual countries. Reported prevalence rates of IDA in children range from 1.1% to 7.4% in the United States, 2-4% in Europe, and 64-71% in Africa (18,19). Since 2004, the Ministry of Health of the Republic of Turkiye has implemented iron supplementation from 4 months to 12 months of age. Despite two decades having passed since the inception of this initiative, ID persists in children over 24 months of age (20). According to a 2011 World Health Organization report, the prevalence of IDA among preschool children in Turkiye decreased from 32.5% to 30%. Limited studies in the past decade in Turkiye have focused on the prevalence of ID and IDA among children and adolescents. Previous investigations have shown variations in prevalence based on geographical location, methodologies, and age groups. Notably, studies encompassing infants under one year of age, during which IDA peaks, have reported higher prevalence rates. Across Turkiye, studies have reported ID prevalence ranging from 5.45% to 19.6%, with IDA prevalence varying from 1.4% to 30.1%. The prevalence of iron deficiency was 38.7% with IDA at 8.3% among school children in Aydın province(21), where females exhibited a higher rate of ID at 45.1% compared to males at 30.6%, and IDA rates were 11.6% in females and 4.1% in males, showing a significant sex-based difference, while a study in Samsun province(22), reported ID at 29.9% and IDA at 6.6% among children aged 7-14 years, and a study in Amasya province (23), found frequencies of ID at 26.2% and IDA at 13.1% in children aged 1-17 years, with higher rates of IDA observed in adolescent females. This study in Konya, Turkiye, represents the first investigation on the prevalence of ID, IDA, and pica among children and adolescents. Our findings revealed isolated ID in 23% of children and IDA in 7%. While the prevalence of ID and IDA in Konya was lower compared to previous studies, it was still noteworthy, with a significantly higher prevalence observed in females compared to males.

The prevalence of IDA in preschool-aged children, as reported by the WHO, stands at 27% (24). In our study, we found a 7.92% prevalence rate of IDA among children aged >2 to 4.9 years, with infants under 24 months excluded from the pica analysis. A recent systematic review, encompassing studies conducted in developing nations and focusing on children aged 10 and above, unveiled a variable prevalence range of IDA, spanning from 7.7% to 71.2% (1). In our study, the frequency of IDA among children aged 5 to 11.9 years was determined as 1.76%, with no significant sex-based differences observed. These findings indicate a notably lower prevalence of IDA in school-aged children compared to other age groups.

During adolescence, the increased iron requirement is attributed to rapid growth. Additionally, the onset of menstrual bleeding in females leads to a decrease in ferritin levels. The rising trend of irregular dietary habits and decreased consumption of iron-rich animal-based foods contribute to the development of IDA. Hence, the prevalence of IDA is higher in adolescent females (25-27). Globally, the exact prevalence of IDA among adolescents remains uncertain. In a study in the United States, approximately 17% of adolescent females were found to have ID, with 6% having IDA, while less than 1% of adolescent males showed ID. The WHO estimates that over 50% of females aged 12-15 in South-East Asia have anaemia, with no specific estimate available for males (28). A study in Nepal identified IDA in 6.86% of adolescent females and 5%

of adolescent males (29). In a retrospective study in Denizli province (25), the prevalence of IDA among adolescents was 3.3%, with the prevalence in females approximately 5 times higher than in males. Our study results indicated that children with IDA had a higher median age compared to the healthy control group. Furthermore, we observed a higher prevalence of IDA in females than in males. Consistent with the literature, our findings suggest that adolescent females are at a higher risk for IDA. Similarly, in our study, the prevalence of IDA in adolescent females was found 4.8 times higher than in males.

The aetiology of pica has been attributed to various factors; however, direct causality has not been established. The type and prevalence of pica consumed may vary depending on ethnic origin, geography, and socio-cultural factors. Additionally, factors such as the definition of pica in the study, the age group included in the study, and the participants' concealment of pica can influence the study results (30). Pica prevalence rates vary across different countries and age groups, with studies reporting rates of 12.3% in Germany13 among children aged 7-14, 6.7% in Iran (31) among children aged 6-15, 7.2% in Egypt (32) with an increasing prevalence with age, 30.7% in Sudan (33) among adolescent schoolchildren aged 10-19, and 3.8% in Switzerland7 among schoolchildren aged 7-13 using a clinical cut-off score of ≥4. The prevalence of pica in all participants in our study was found as 5.35%.

While studies on the prevalence of pica in children have been conducted in the literature, the number of studies specifically addressing pica in children with ID or IDA is limited. Some community-based studies have reported lower serum iron and ferritin levels in individuals with pica, suggesting a significant role of ID in the aetiology of pica (34). A previous meta-analysis has demonstrated a significant association between pica and low haemoglobin and haematocrit levels (35).

In our study, significant decreases in serum ferritin, haemoglobin, and haematocrit levels were observed in individuals with pica compared to those without. A study in Pakistan involving 862 children aged 2-6 with IDA reported a prevalence of pica at 37.2% (12). In our study, pica was identified in 45.7% of patients with IDA. Unlike previous studies, our research observed a higher prevalence of pica in older children and adolescents, with a significantly higher prevalence in females compared to males. Furthermore, individuals with IDA in our study had lower ferritin levels compared to those with isolated ID, and a significantly higher prevalence of pica was detected. Our study confirmed the previously established link between female sex and pica in Sudanese adolescents (33), identifying female sex and serum ferritin levels as independent predictors of pica in our cohort.

Serum ferritin serves as a reliable indicator of ID, with levels below 12 ng/mL strongly suggestive of ID (3). In our study, a decrease in ferritin levels was associated with 1.1 times increase in the likelihood of pica occurrence. Our findings demonstrated a relationship between the severity of ID and pica. Previous studies investigating pica prevalence in children with IDA noted that the prevalence of anaemia was moderate to severe, and the exclusion of adolescents from these studies may explain the higher prevalence of pica (12,36). In our study, most cases of IDA were mild, and adolescents, the age group with the highest prevalence of pica and IDA, were included.

Studies in the literature have indicated variations in pica prevalence based on sex (13,37). A recent study revealed that adolescent females had a 3.5 times higher risk of pica compared to males. Another study found a higher prevalence of geophagy in females compared to males (38). Similarly, in our study, the likelihood of pica occurrence in females was approximately 2.8 times more than in males. This finding may be attributed to the higher prevalence of IDA and pica in adolescent females in our study. The inclusion of infants or differences in study methodology in previous studies could also account for these discrepancies.

Pica, a condition characterized by the consumption of non-nutritive substances, has been linked to ID, with various substances such as clay, ice, starch, chalk, soap, paper, and raw rice being commonly ingested by individuals exhibiting pica behaviours (26). The relationship between pica and anaemia remains complex, with uncertainties regarding the causal direction of this association. Notably, pagophagia (ice consumption) has been strongly correlated with ID and has shown a greater response to iron therapy compared to other forms of pica, which have demonstrated varying degrees of efficacy in response to iron treatment (39,40). Among 120 children aged 2-10 with IDA and a history of pica in Pakistan, soil, sand, and lime were identified as the most common types of pica. Previous studies have highlighted soil consumption as the most common form of pica, accounting for 83% of cases in children with IDA in the South Eastern Anatolia region (41). In contrast to previous studies in Turkiye, our study identified coffee grounds as the most prevalent form of pica, which may be associated with the urban residence of patients visiting our clinic. Coffee ground pica has been predominantly reported in pregnant women rather than children in previous studies (42). Turkish coffee holds a significant cultural appeal in Turkish society, with its aroma being an enticing factor for individuals, potentially influencing those predisposed to pica behaviours towards coffee ground ingestion.

A limitation of our study was the lack of measurement of micronutrient concentrations such as zinc, calcium, and selenium. Additionally, the cross-sectional design of our study, which included patients admitted to the hospital, may not fully represent the general population. Nevertheless, the strengths of our study included a large sample size and the exclusion of children under the age of two.

Conclusions

Our study demonstrated a higher prevalence of pica in IDA, the most severe form of ID, compared to isolated ID. Female sex and serum ferritin levels were identified as independent variables associated with pica. Further prospective studies validating these results are warranted in this regard.

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