Original Article / Özgün Araştırma

The Prevalance of Anemia and Nutriotional Anemia in Primary School Children in the City of Aydın

Aydın İl Merkezi İlköğretim Okulu Öğrencilerinde Anemi ve Nütrisyonel Anemi Prevalansının Saptanması

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Abstract

Objective: To determine the prevalence of anemia and nutritional anemia in primary school children in the city of Aydın.

Materials and Methods: In Aydın, the central town of Aydın province, a total of 496 students (56% were female) were enrolled into the study by using stratified random sampling method. The students were from the primary schools located in socio-economically low, medium, and high areas of primary health care centers. The avarage age of the students was 10.2 ± 2 years. Statistical analysis was performed using the Kolmogorov-Smirnov test, Student's t-test, Mann-Whitney U-test and Chi-Square test.

Results: The prevalence of anemia, iron-deficiency (ID), iron-deficiency anemia (IDA), vitamin B12 deficiency and vitamin B12 deficiency anemia was 15.7%, 38.7%, 8.3%, 9.1%, 0.8%, respectively. No folic acid deficiency was detected. Among the anemias, 42% of them were microcytic, 58% of them were normocytic and the 45.5% of the microcytic anemias were IDA. Among the females, the rate of ID was 45.1% and the rate of IDA was 11.6%, while in boys the same rates were 30.6% and 4.1%, respectively (p<0.05). Microcytosis was present in 36.5% of subjects with IDA. The Mentzer index was <13 in 13.3% of subjects with microcytic anemia and IDA, and in 77.7% of children with microcytic anemia and no IDA (p<0.001). Regarding socio-demographic characteristics of children; the only statistically significant difference was in the parameters of mother education and anemia.

Conclusion: The prevalence of anemia represents a minor public health problem according to the World Health Organization criteria among the primary school students in the central town of Aydın province. Exploration of the reason of anemia among pre-school children, proper treatment of nutritional anemia cases with adequate duration and dose, dietary organizations and proper follow-up will lower the incidence of anemia and nutritional anemia among primary school children. Our study showed that thalassemia trait is defined as a major problem in the differential dignosis of IDA in our region. Diagnosing of these cases with thalassemia will prevent the unnecessary iron therapy and will provide a genetic counseling to the family.

Öz

Amaç: Aydın ili Merkez İlköğretim Okulu öğrencilerinde anemi ve nütrisyonel anemi sıklığını belirlemektir.

Gereç ve Yöntemler: Aydın il merkezinde, 2008-2009 öğretim yılında, sosyo-ekonomik düzeyi iyi, orta ve düşük sağlık ocağı bölgelerinde bulunan ve tabakalı

rastgele örnek seçim yöntemine göre belirlenen ilköğretim okullarında eğitim gören 1-8. sınıf öğrencilerini kapsayan toplam 496 (%56'sı kız) öğrenci çalışmaya alındı. Çocukların yaş ortalamaları 10,2±2 idi. İstatistiksel analizler için Kolmogorov-Smirnov testi, Student t-testi, Mann Whitney U testi ve ki-kare testi uygulandı.

Bulgular: Anemi, demir eksikliği (DE), demir eksikliği anemisi (DEA), B12 eksikliği ve B12 eksikliği anemisi prevalansı sırasıyla %15,7, %38,7, %8,3, %9,1, %0,8 saptandı. Folik asit eksikliğine rastlanmadı. Tüm anemilerin %42'si mikrositer, %58'i normositer; mikrositer anemilerin %45,5'i DEA idi. Kızlarda DE oranı %45,1, DEA oranı %11,6 iken, erkeklerde bu oranlar sırasıyla %30,6 ve %4,1 idi (p<0,05). DEA'sı olanların %36,5'inde mikrositoz mevcuttu. Mikrositik anemisi ve DEA olan olguların %13,3'ünde, mikrositik anemisi olup DEA olmayan olguların ise %77,7'sinde Mentzer indeksi <13 idi (p<0,001). Daha önce anemi saptanması ve demir ilacı verilmesi oranları anemi saptanan çocuklarda %33,3 ve %29,5, anemi saptanmayan çocuklarda %18,2 ve %15,6 idi. DEA saptanan öğrencilerin %19,8'i, saptanmayan öğrencilerin ise %19,5'i daha önce demir ilacı almıştı. Sosyo-demografik özelliklerden sadece anne eğitim düzeyi ile anemi arasında anlamlı ilişki bulundu.

Sonuç: Aydın il merkezi ilköğretim okulu öğrencilerindeki anemi prevalansı Dünya Sağlık Örgütü'ne göre hafif düzeyde sosyal sağlık problemi oluşturmaktadır. Okul öncesi dönemde anemi saptanan çocuklarda nedenin aydınlatılması, tedavi verilen nütrisyonel anemili olguların uygun süre ve dozda tedavi almalarının sağlanması, beslenmelerinin düzenlenmesi ve izlemlerinin yapılması ilköğretim öğrencilerindeki anemi ve nütrisyonel anemi oranlarını düşürecektir. DEA saptanan çocukların yaklaşık 1/5'inin önceden tedavi alması, tedavi ve izlemlerin iyi yapılmadığını düşündürmektedir. Bu nedenle okul çocuklarında tarama programları yapılmalıdır.

Introduction

Anemia is a disease having high prevalence worldwide. Anemia can occur at all stages of life mostly in pre-school age of children and pregnancy period (1). Iron deficiency (ID) is the most common nutritional deficiency in childhood and affects 20-50% of world's population (2-4). ID is a condition which causes growth retardation and cognitive development retardation, therefore, reduces performance capacity of the country and causes damages on country's economic sources. Iron deficiency anemia (IDA) is observed 36% and 8% of people in developing countries and economically advanced countries, respectively. The World Health Organization (WHO) considers that it is an important health problem in Turkey with a rate of above 40% (5).

In childhood, adequate level of vitamin B12 and folate are vital for the development of organ systems, such as central nervous system, hematopoetic system, and cardiovascular system. When deficiency takes place, particularly the tissues with fast regeneration capacity are affected (6). Childhood is the period when growth and development have the highest spead, therefore, problems of childhood are significantly important (7).

If we take the clinical effects of all nutritional anemia into the consideration, it is important that we should provide necessary precautions for public health-care instead of just individual therapies. To produce this data, screening investigations are needed. This research was performed in order to evaluate the prevalence of anemia an nutrirional anemia among the students of Aydın primary schools.

Materials and Methods

This is a cross-sectional study which is performed between April and June 2009 on 496 children who were students of 1st to 8st grades of primary schools. Schools, which were selected by stratified random sampling method, are located in various areas of primary health care centers with high, medium and low socio-economic status. Sellection of schools was performed after categorizing them into three areas. Then, the schools ans classes were selected by using random number table. Children, who underwent acute infection during the study and whose parents did not give permission for blood tests, were excluded.

Data Collection

The aim of the study was explained to the Directorate of National Education of Aydın province and to the school administrations and necessary permissions were obtained. After that, the study was explained to parents and their written consent were taken. The research group whas composed of paediatricians and nurses. A questionnaire has been prepared and was distributed to the students in order for their parents to answer. The questionnaire included socio-demographic information about the students, alimentation conditions, anemia history and their medications. Development of participants were assessed by a paediatrician using a marked length scale and weighing machine with minimum intervals of one mm and 100 g, respectively. Two mililiters of blood was drawn by a paediatric nurse to an EDTA tube for hemogram, and 3 mililiters in order to measure serum iron, serum iron binding capacity, ferritin, B12 and folic acid to a regular test-tube by pediatric nurse.

Description

For the diagnosis of anemia, the lowest limit of hemoglobin (Hb) level was defined as as 11.5 g/dl for children aged 5-7 years, 12 g/dl for those aged 8-11 years, 12 g/dl for females aged 12-14 years, and 12.5 g/dl for males aged 12-14 years. ID was diagnosed for students without anemia when low ferritin and transferrin saturation were observed (8). Vitamin B12 and folic acid levels below 200 pg/ml and 3 ng/ml, respectively were considered vitamin B12 and folic acid deficiency.

Measurement and Assesment

The blood samples were assessed in the hematology and biochemistry laboratories at Adnan Menderes University Medical Faculty using the kits which were provided by Adnan Menderes University Medical Faculty, Science Research and Project Board.

1. Routine hemogram analysis was performed by impedance method by Beckman Coulter appliance,

2. Serum iron level was evaluated with calorimetric spectrophotometric method by using commercial kit in routine biochemistry autoanalyzer ARCHITECT (Floor No: 30-4200/R1),

3. Serum iron binding capacity was assessed with calorimetric spectrophotometric method by using commercial kit (REF 6K9520) in routine biochemistry autoanalyzer ARCHITECT,

4. Serum ferritin level was detected with electroluminescence method by using commercial kit (Floor No: L2KFE2) in IMMULATE 2000 routine hormone analyzer,

5. Serum folic acid level was detected with electroluminescence method by using commercial kit (Floor No: L2FO2) in IMMULATE 2000 routine hormone analyzer,

6. Serum vitamin B12 level was detected with electroluminescence method by using commercial kit (Floor No: L2KVB2) in IMMULATE 2000 routine hormone analyzer.

Height and weight percentiles were assessed with respect to Turkish children development percentile tables.

Statistical Analysis

SSPS (Software Package) 14.0 statistics package program was used for statistical analysis of the study results. Concordance of constant variables to normal distribution was analyzed by the Kolmogorov-Smirnov test. Since mothers' ages exhibited normal distribution, its descriptive statistics were shown as mean ± SD. Student's t-test was used for independent groups. The variables did not exhibit normal distribution, therefore, their descriptive statistics were shown as median (25-75%). The Mann-Whitney U-test was used for comparing the groups. Descriptive statistics of categorical variables were shown as frequency and percentages. Chi-square test was performed. P value of less than 0.05 was considered statistically significant.

Results

A total of 496 students [277 female (56%), 219 male (44%)] total 496 with the mean age of 10.2±2 years were included in this study between April and June 2009. Only 1.4% of students have failed one class and the success rates with respect to excellent, good, moderate was 35.7%, 39.7% and 14%, respectively. It was observed that approximately half of the students ate meat 1-2 times a week and drank milk less than one glass daily, and 71.4% of students drank tea more than two small glasses a day. Fifty-four percent of mothers and 46% of fathers had graduated from primary school and 1% of fathers were illiterate. 35% of families had an income less than 500 TL and 55% of families had an income between 500 and 2000 TL monthly.

Regarding height and weight: percentages of students for <3p, 3-97 p and >97 p ratio was 3%, 92%, 5% and 6%, 88.5%, 5.5%, respectively.

The mean hemoglobin level of the students was 12.6±0.8 g/dl (7.5-15.5 g/dl). The mean hemoglobin level of males was 12.9±0.9 g/dl and that of females was 12.5±1.05 g/dl. There was no statistically significant difference between the groups (p>0.05).

The mean hemoglobin level in female and male children ages of 7-11 was 12.5±0.8 g/dl and 12.7±0.7 g/dl, respectively (p>0.05). The mean hemoglobin level in female and male students aged between 12 and 15 years was 12.6±1.2 g/dl and 13.3±0.9 g/dl, respectively (p>0.05). Results of hematological parameters for genders are shown in Table 1.

In our study, the prevalence of anemia, IDA and ID were found to be 15.7% (n=78), 8.3% (n=41) and 38.7% (n=192), respectively.

The number of school children with high, medium and low socio-economic levels was 213 (42.9%), 151 (30.5%) and 132 (26.6%), respectively. The prevalence of anemia, ID and IDA was found to be

higher in schools with a high socio-economic level. However, this difference was not significant (Table 2). The prevalence of anemia among children aged 7-11 years was found to be 15.3% (n=46), that of ID 37.2% (n=112), IDA 6.3% (n=19), and B12 vitamin deficiency anemia (B12DA) 0.3% (n=1). The prevalence of anemia, ID, IDA, B12DA among children aged 12-15 years was determined as 16.4% (n=32), 41% (n=80), 11.3% (n=22), 1.5% (n=3), respectively (p>0.05). The prevalence of B12 deficiency (B12D) among chidren aged 7-11 and 12-15 years was 5.6% (n=17) and 14.4% (n=28), respectively (p<0.05).

Although the frequency of ID and IDA in female students was found to be 45.1% and 11.6%, respectively, in male students, it was 30.6% and 4.1%, respectively (p<0.05). It was detected that 17.7% of female students and 13.2% of male students had anemia (p>0.05). Although anemia was found in 9.1% of all students, B12D was found in only 0.8%. In our study, we did not identify any folic acid deficiency case.

Low ferritin level or low transferrin saturation definition was considered ID. The prevalence of ID and IDA was 8.7% and 4%, respectively for the cases where low ferritin level was used for diagnosis. The prevalence of ID and IDA was found to be 6.5% and 3.6%, respectively when low ferritin level and transferrin saturation were used for diagnosis (Table 3).

Forty-two percent of all anemia cases were microcytic, the other 58% were normocytic. We did not detect macrocytosis. 45.5% of microcytic anemia cases were IDA. Microcytosis was detected in 36.5% of students who had IDA.

Red blood cell (RBC) levels were normal in 14 (93.3%) of 15 children with microcytic anemia and IDA. RBC levels were low in one of them and were normal in 9 (50%) of 18 children with microcytic anemia but without IDA; RBC levels were high in the rest 50% of the cases (p<0.05). Mentzer index (mean corpuscular volume (MCV)/RBCx100) in 14 students with microcytic anemia (77.7%) without IDA was

Table 1. Results of hematological parameters for genders; mean ± SD, minimum and maximum levels

Hematological parameters	Female		Male	
	Mean ± SD	Min-Max	Mean ± SD	Min-Max
Hb (g/dl)*	12.5±1.05	7.4-15.1	12.9±0.9	9.2-15.5
Htc (%)*	36.6±2.9	24-43	37.4±2.9	28.1-47.1
RDW (%)*	13.8±1.3	11.8-23.3	13.7±0.8	12.2-17.6
MCV (fl)*	80.7±6.3	49-93	80.5±5.2	56-92
Ferritin (ng/ml)*	24±16.1	3-130	27.4±16.8	3-135
B12 (pg/ml)*	344±184.3	150-1000	333±76.6	150-946
Folate (ng/ml)*	8±2.6	3.7-19.9	7.7±2.5	3.2-15.4

p>0.05, SD: Standard deviation, min: Minimum, max: Maximum, Hb: Hemoglobin, Htc: Hematocrit, RDW: Red cell distribution width, MCV: Mean corpuscular volume

Table 2. Distribution of the prevalence of anemia, iron deficiency, iron deficiency anemia, B12 deficiency, B12 deficiency anemia according to schools+

	High		Total n (%)	Medium		Total n (%)	Low		Total n (%)	p
	MAE* n (%)	GP** n (%)		HCO*** n (%)	FMU**** n (%)		Ilicabası n (%)	HUR***** n (%)		
Anemia	20 (19.4)	15 (13.6)	35 (16)	12 (11.5)	12 (25.5)	24 (15.8)	5 (10.2)	14 (16.9)	19 (14.3)	>0.05
ID	33 (32)	48 (43.6)	81 (38)	34 (32.7)	20 (42.6)	54 (35.7)	19 (38.8)	38 (45.8)	57 (43.1)	>0.05
IDA	8 (7.8)	8 (7.3)	16 (7.5)	8 (7.7)	7 (14.9)	15 (10)	3 (6.1)	7 (8.4)	10 (7.5)	>0.05
B12D	8 (7.8)	6 (5.5)	14 (6.5)	8 (7.7)	9 (19.1)	17 (11.2)	6 (12.2)	8 (9.6)	14 (10.6)	<0.05
B12DA	2 (1.9)	0 (0)	2 (0.9)	0 (0)	2 (4.3)	2 (1.3)	0 (0)	0 (0)	0 (0)	>0.05

ID: Iron deficiency, IDA: Iron deficiency anemia, B12D: B12 deficiency, B12DA: B12 deficiency anemia, +: Schools included in the study were divided into three categories as a high, medium and low sosyo-economic leves. *Mehmet Akif Ersoy Primary School; **Gazipaşa Primary School; ***Hacı Celal Oto Primary School; ****Fevzi Mürüvvet Uğurlu Primary School; *****Hürriyet Primary School

<13, whereas in four of the subjects (22.3%) it was >13 (p<0.001). Red cell distribution width (RDW) was <14 in 13 (86.7%) of 15 children with microcytic anemia and IDA and in 17 (94.5%) of 18 children with microcytic anemia but without IDA (p>0.05) (Table 4).

Children with or without anemia, ID, IDA, B12D and B12D anemia were assessed with regard to anorexia, weakness, abdominal pain and pica history. No significant difference was detected.

Anemia was diagnosed previously in 26 (33.3%) of 78 children with anemia and in 76 (18.2%) of 418 children without anemia; 23 (29.5%) children with anemia and 65 (15.6%) children without anemia received iron treatment for ID previously (p<0.05).

Anemia was diagnosed previously in 38 (19.8%) of 192 children with ID and 32 (16.7%) children received medical treatment for ID; anemia was diagnosed previously in 9 (22%) of 41 children with IDA and 8 (19.5%) children received iron treatment for ID. A significant difference was found between proportion of getting iron treatment for ID and anemia in children with and without ID and IDA (p>0.05). The relationship between children with anemia, ID, and IDA and history of iron therapy and anemia is shown in Table 5.

Starting age for nourishment with cow milk was 7 months (range: 1-36 months), 8 months (range: 1-36 months), and 7 months (range: 1-18 months) in children with anemia, ID and IDA, respectively. The duration of nourishment with breast milk was 10.2

months (range: 1-36 month), 10 months (range: 1-36 months), 9 months (range: 1-24 months) in children with anemia, ID and IDA, respectively. Starting age for drinking tea was 25 months (range: 1-120 months), 26 months (range: 3-20 months), and 25 months (range: 5-84 months) in children with anemia, ID and IDA, respectively. The age when meat was first added to the diet was 18 months (range: 3-96 months), 17 months (range: 5-72 months), 17 months (range: 6-72 months) in children with anemia, ID and IDA, respectively.

When children with anemia, ID, IDA, B12D, and B12DA were compared with regard to their socio-demografic features, it was observed that 16.7% of mothers of children with anemia had high school or lower level of education and it was the only one parameter which showed a significant difference (Table 6).

Discussion

Anemia is defined as a reduction in RBC and/or hemoglobin levels (9). According to WHO's research, the prevalence of anemia was found to be 22.9-

Table 3. The revalence of iron deficiency and iron deficiency anemia according to the criteria of identification

	Low ferritin	Low ferritin or TS	Low ferritin and TS
ID	8.7%	38.7%	6.5%
IDA	4%	8.3%	3.6%
ID: Iron deficiency, IDA: Iron deficiency anemia, TS: Transferrin saturation			

Table 4. Comparison of Mentzer index, red cell distribution width and red blood cell values in microcytic anemia with or without iron deficiency anemia

	Microcytic anemia		
	Without IDA n=18	With IDA n=15	p
Mentzer index <13 Mentzer index ≥13	14 (77.7%) 4 (22.3%)	2 (13.3%) 13 (86.7%)	<0.001
RDW >14 RDW ≤14	1 (5.5%) 17 (94.5%)	2 (13.3%) 13 (86.7%)	0.579
High RBC value Normal RBC value Low RBC value	9 (50%) 9 (50%) 0	0 (0%) 14 (93.3%) 1 (6.7%)	0.002
RDW: Red cell distribution width, RBC: Red blood cell, IDA: Iron deficiency anemia			

Table 5. The relationship between children with anemia, iron deficiency, and iron deficiency anemia and history of iron theraphy and anemia

	With anemia n=78 (%)	Without anemia n=418 (%)	p	With ID n=192 (%)	Without ID n=304 (%)	p	With IDA n=41 (%)	Without IDA n=455 (%)	p
Anemia	26 (33.3)	76 (18.2)	<0.05	38 (19.8)	64 (21.1)	>0.05	9 (22)	93 (20.4)	>0.05
Iron therapy	23 (29.5)	65 (15.6)	<0.05	32 (16.7)	56 (18.4)	>0.05	8 (19.5)	80 (17.6)	>0.05
ID: Iron deficiency, IDA: Iron deficiency anemia									

Table 6. Comparison of socio-demografic features of chidren with anemia, iron deficiency, iron deficiency anemia, B12 deficiency, and B12 deficiency anemia

	Anemia (%)	ID (%)	IDA (%)	B12D (%)	B12DA (%)
Mother education level					
High school and lower	16.7*	38.6	8.7	9.6	0.9
University	2.8*	38.9	2.8	2.8	0
Father education level					
High school and lower	17.1	38.2	8.8	9.2	0.7
University	8.1	41.9	5.4	8.1	1.4
Meat in diet					
Two times or less/week	16.2	39.2	8.9	8.9	1.1
Two times or more/week	14.3	37.3	6.3	9.5	0
Cow milk					
>2 glass/day	11.8	35.3	2.9	14.7	0
<2 glass/day	16	39	8.7	8.7	0
Tea					
>2 glass/day	14.8	40.2	7.5	9.8	1.1
<2 glass/day	18.1	34.8	10.1	7.2	0
Monthly income					
<500 TL	15.2	35.4	8.4	9.6	0
500-2000 TL	17.9	41	9.2	9.9	1.5
>2000 TL	4.4	37.8	2.2	2.2	0
School success					
Excellent-good	14.7	38	7	8.6	0.8
Moderate-poor	18.9	41	12.3	10.7	8
Height percentile					
<3 p	14.8	37	7.4	7.4	0
3-97 p	15.8	38.8	8.3	9.2	0.9
Weight percentile					
<3 p	33.3	20	13.3	0	0
3-97 p	15.5	39.3	8.2	9.4	0.9
*p<0.05, ID: Iron deficiency, IDA: Iron deficiency anemia, B12D: B12 deficiency, B12DA: B12 deficiency anemia					

26.7% in the general and was found to be 25.4% in children of school age. According to WHO, when the prevalence of anemia is <5%, it does not create a problem. A prevalence of 5-19% represents a mild public health issue, whereas between 20-39% moderate and >40% is severe. With the prevalence of anemia of approximately 30%, Turkey has a moderate public health problem (10).

Different anemia criteria were used in anemia prevalence studies performed in our country. In some studies (11-14) like in ours, hemoglobin levels were taken as reference for different age groups. In some other studies, the WHO criteria (15-17) have been used.

Kapaklıkaya (18) found the prevalence of anemia in outpatient children aged 7-9 and 10-14 years to be

15.2% and 7.5%, respectively. The prevalence of anemia in outpatient primary school children in İstanbul was found to be 27.6% by Gür et al. (19), in children of 6-14 years of age in the west coast of İstanbul - 30% by Çetin and Aydın (20), in children aged 6-16 years - 7.8% (1.5% in 6-11 years of age, 5.4% in12-16 years of age) in Urfa by Koç et al. (21), in primary school children group of 9-12 years age in Urfa - 5% by Koç et al. (22), in primary school children group in Malatya - 12.9% (countrified schools - 20%, urban schools - 5.6%) by Kaya et al. (13), in children aged 7-14 years in Elazığ - 15% by Baydaş and Türköğlu (17), in 14-16 years aged children in Kocaeli - 6.8% by Kara (23), in children aged 6-12 years - 24.7% and those aged 13-18 years in Kahramanmaraş - 4.3% by Kilinc et al. (11); in 6-11 years old children - 28% and 11-16 years old children in Bursa - 35% by Kılıçbay (14), and in primary school children group in Diyarbakır was found to be 2.9% by Toksöz (16). In our study, the prevalence of anemia was detected as 15.7%. The reason for variable prevalences in children between 7 and 11 years of age and those between 12 and 15 years of age (15.3-16.4%) can be a result of increased iron need because of fast growth in adolescence period.

Educational level of mother plays an important role in child's health. Low-level maternal education negatively affects children's eating habits (24). Kaya et al. (13) suggested that a low level of education in mother increases the risk of IDA 2.99 times. The prevalence of IDA was found to be 20% in collage educated mother's children and 34% in children of mother with lower education mother's in a study conducted in 2000 in İzmir (25). In another study Taşyenen (26) compared the prevalence of anemia in children of primary school educated mother and higher educated mother in Manisa city and found that the prevalence of IDA in children of mothers with lower educational level was statistically significantly higher than those of mothers with higher level of education. In their study performed in Malatya, an eastern city of Turkey, Kaya et al. (13) compared two groups of school children from urban and rural areas. They found statistically significant association between IDA and the following items in both populations; milk drinking habit, health insurance, education level of mother, tea and milk drinking habits. However, this association was not found in children aged 11-18 years in rural population. Keskin et al. (27) conducted a study covering nine primary schools in İzmir, Ankara

and İstanbul cities and they found a statistically significant difference in height and weigh between male population groups having high and mid level socio-economic status, while the difference was not statistically significant in female population. Çetin and Aydın (20) evaluated the relationship of anemia with gender, malnutrition, parents' education level, and monthly income parameters in 910 healthy children in İstanbul city and the results were not statistically significant. In this study, we compared children with anemia, ID, IDA and B12 depletion for socio-economic demographic characteristics (milk, meat and tea feeding habits, parents' education level, monthly income, school success, and height and weigh percentiles). We found a statistically significant difference only in mothers' education level and anemia.

Mothers of 16.7% of children with anemia had a educatio level lower than high school, and those of 28% of children had college graduation (p<0.05). Additionally, fathers' education level seems to have an effect on the prevalence of anemia (high school vs. below than high school: 17.1% and 8.1%, respectively). However, the difference was not statistically significant.

It has been hypothesized that anemia and nutritional anemia have higher prevalences in children of families with lower socio-economic status (13). We did not find any statistically significant association between monthly income level and anemia, ID, IDA, B12D and B12DA in our study. In addition, there were no differences in the prevalence of anemia, ID, IDA and B12DA between children selected from schools located in socio-economically low, moderate and high areas.

In developed areas, the prevalence of poor appetite and abdominal was higher and history of pica was less common. Based on these results, we hypothesized that poor appetite and abdominal pain were related with snack habit, parents' attention to well eating and easy reaching to foods in socio-economically developed schools; and pica was related with prior iron or zinc depletion in moderate and poor developed population.

The prevalence of ID was 45.1% and iron depletion anemia was 11.6% in female population, these rates were 30.6% and 4.1%, respectively in male population (p<0.05). According to the results obtained for different age groups: in 12-15 years age group, ID

was found in 53 of 114 female students (46.5%) and in 27 of 81 male students (33.3%); IDA was found in 18 female students (15.8%) and in 4 male students (4.9%) (p<0.05). In 7-11 years age group, ID was found in 72 of 163 female students (44.2%) and 40 of 138 male students (29%); IDA was found in 14 female students (8.6%) and 5 male students (3.6%) (p<0.05). Menstruation helps to explain the differences between female and male students in 12-15 years age group but it cannot explain the differences in 7-11 years age group. This shows that there may be other causes affecting results and these factors must be studied and identified.

One of the major factors that play a major role in the development of anemia is the lack of dietary iron. Feeding with animal origin and vitamin C rich diets reduces the risk of developing IDA (28). Tasyenen (26) found that IDA was associated with low consumption of meat. Keskin et al. (27) conducted a study covering nine primary schools in Izmir, Ankara and İstanbul cities and detected that tea drinking had a higher rate in male, socio-economically low level population and also meat and fish eating habits had lower rates in this group. We also compared children with ID, IDA, B12D and B12DA for meat eating, cow milk drinking, and tea drinking habits, however, we did not find any statistically significant difference.

Children with/without anemia, ID and IDA were compared for median age of starting to drink cow milk, duration of breast milk feeding, time of first tea drinking and starting to eat meat and the differences were not statistically significant. This shows us that feeding factors in infancy period do not affect anemia, ID and IDA development in primary school children.

26 of 78 children (33%) with anemia and 76 of 418 children (18.2%) without anemia had a previous diagnosis of anemia. 23 of anemic children (29.5%) and 65 of children without anemia (15.6%) had been prescribed iron therapy previously. Iron depletion was found in 38 of 192 children (19.8%) who had beed diagnosed with anemia previously of whom 16.7% had iron therapy prescription. Nine of 41 children (22%) with IDA had a previous diagnosis of anemia and 19.5% had been prescribed iron therapy. These data indicate that the children with IDA were not diagnosed appropriately, and those who were diagnosed and prescribed were not followed properly. Physicians must be educated in order to make efficient

differential diagnosis and prevent nutritional anemia.

Anemia is classified based on etiology (inefficient erythrocyte or hemoglobin production, increased erythrocyte destruction, blood loss) or size of erythrocytes (microcytic, normocytic or macrocytic) (9). We found that macrocytic anemia was present in 33 of (42%) 78 children with anemia (15.7%) and the remaining 45 children (58%) were defined as normocytic. IDA is the major cause of microcytic anemia (29) and was found in 15 children (45.5%) in our study. Four of 45 children with B12 depletion were diagnosed with anemia and defined as normocytic anemia

High RDW, low, high or normal RBC and Mentzer Index >13 are expected in IDA patients. Normal RDW, high RBC and Mentzer index <13 are expected in thalassemia patients mostly (29). Mentzer Index was found to be lower than 13 in 14 (77%) patients with non-IDA microcytic anemia, and 2 patients (13.3%) with microcytic anemia with IDA. RBC was found to be normal in 14 children (93.3%) and low in one child with microcytic IDA. None of the children with non-IDA microcytic anemia had low level of RBC. RBC level was found to be high in half of the cases. RDW was found high in 29 (70.8%) and normal in 12 (29.2%) of 41 children. Presence of IDA diagnosed patients with a Mentzer Index lower than 13 shows that thalassemia trait and IDA could be seen concomitantly in a patient. For this reason, patients must be assessed carefully. RBC was found normal in 92% of IDA patients and RDW was found normal in one third of IDA patients. These results show that neither RDW nor RBC has a high specifity for detection of IDA.

Most of the studies about ID conducted in our country were designed to detect anemia principally. Iron deficienc was investigated later in these children. Furthermore, in these studies and in other studies designed to detect ID directly different methods and criteria were used for diagnosing IDA (22). However, the, prevalence of IDA was found to be 5.5% in a study of prevalence of ID and IDA by Berçem et al. (30) which was performed in children aged 12-18 years in Sivas city. Küçükdönmez et al. (31) found the prevalence of ID and IDA in 6-13 years age children in Ankara city as 15.7% and 1.7%, respectively. In another study conducted by Bulut (32) in Sivas city, IDA prevalence was found as 1.7% in 7-12 years age children population. Tasyenen (26) found the prevalence of IDA as 1.4% in children aged 7-12 years in Manisa

city. Güngör (33) found that the prevalence of IDA was 9.4% in 7-14 age healthy children population in Samsun. In another study performed in Izmir in 2000, IDA prevalence was found to be 16.8% in children aged six months-15 years and peak of the prevalence was detected in 0-2 year ages (25). Keskin et al. (27) designed a study covering nine schools in Izmir, Ankara and İstanbul (three schools from each city) and defined the criteria as ferritin <15 ng/ml and Hb <12g/dl for all age groups. They found the prevalence of ID and IDA as 19.1% and 3.9%, respectively in 12-13 age children population. TS <16% ferritin <12 ng/ml and Hb <11 g/dl was defined as IDA criteria for all age groups and IDA prevalence was found as 30.1% in Izmir city and 17.8% in Manisa city in six months-15 years age children population (34). Kocak et al. (35) used a low TS level as a diagnostic criterion and they found the frequency of ID in children as 19.6% in Adana. Teziç et al. (36) also prefered a decreased level of TS as a diagnostic criterion and found the prevalence of ID as 14.9% in 12-17 years age children population in Trabzon. The prevalence of ID was found as 5.45%, 21.78% and 10.9% when assessed with ferritin levels, with only transferrin saturation and with serum iron level and transferrin saturation, respectively (22). Kilinc et al. (11) used a low ferritin level as a diagnostic criterion for IDA and found the prevalence as 12.5% in 6-12 years age children population and 1.7% in 13-18 years age children population in Kahramanmaraş. Berçem et al. (30) conducted a study on primary school and high school students in Sivas city and found the prevalence of IDA as 32% in 12-14 years age and 29.5% in 15-18 years age children population when serum ferritin level was defined as diagnostic criteria. This rate was found to be 5.5% in overall group. Toksöz (16) assessed hematocrit levels analyzed with micromethod assay (based on WHO criteria) and anemia was found in 2.9% of primary school students in Diyarbakır. Kılıçbay (14) assessed IDA prevalence based on NHANES III criteria and found 7.4% in 1-16 years years age, 18% in 0-2 years age, 8% in 2-6 years age, 4% in 6-11 years age and 7% in 11-16 years age children who were admitted to a hospital in Bursa. Ece et al. (34) analyzed ferritine and transferrin saturation parameters and found the prevalence of IDA as 8.3% in 6-11 years age and 6.8% in 12-15 years age children population in Manisa. Differences between the prevalence of ID and IDA may be due to regional differences in dietary habits, socio-economic factors and different criteria used in the diagnosis of IDA.

These results show that there is a need to study the prevalence of anemia, ID and IDA for each region. We designed this study to identify the rates in our region. We assessed the hemoglobin values depending on NHANES III criteria for each age group. Individuals with acute infection were not included in this study because ferritin is an acute phase reactant. Ferritin was not taken into account by itself but together with TS.

Halterman et al. (37) conducted a study on 5398 children and detected an important decrease of school performance in children with ID. Berrak et al. (38) treated patients diagnosed with ID for three months and reevaluated the individuals. A significant increase was observed in the results of mental and motor development test scores. Since ID affects children's school performance, we also identified the prevalence of ID in our region. The rate of ID was found to be 38.7% and this indicates that there is need for preventive measures in order to overcome this problem.

Thalassemia trait must be considered in the differential diagnosis of IDA. Mentzer index is a commonly used index for differential diagnosis. Mentzer index <13 is in favor of thalassemia trait. The Index has a value higher than 13 in IDA. RDW is another parameter used in the differential diagnosis. RDW is found normal or slightly higher in thalassemia trait but RDW is found higher than 16 in most of IDA cases (29). Thalassemia trait prevalence is 4.1% in Aydın (higher than the overall prevalence for our country; 2.1%) (39). For that reason, we performed the differential diagnosis of IDA and thalassemia trait at the first step.

Mentzer index was found <13 in two of (13.3%) 15 cases with microcytic IDA and 14 of (77.7%) 18 cases with microcytic but non-IDA (p<0.001). These results indicate that thalassemia trait is the most important problem in the differential diagnosis of IDA. Identifying these cases as thalassemia will help to prevent unnecessary iron-supply treatment and provide genetic consultion to the families. It will also help to diagnose other thalassemia trait individuals in the same family. When thalassemia trait and IDA is seen in a patient concomitantly, HbA2 level could be evaluated within normal values (B-chain synthesis decreases in IDA). For that reason, we recommend to perform hemoglobin electrophoresis in cases of IDA with Mentzer index <13.

Nutritional anemia is seen in underdeveloped

and developing countries most commonly. This type of anemia results from insufficient uptake of some essential nutrients. This problem leads to an important public health problem in these countries. Most common type of nutritional anemia is IDA followed by folate deficiency and B12DA (40).

Cobalamin and folic acid deficiency constitutes 95% of cases in children with megaloblastic anemia. We did not observe folic acid deficiency in our study. The reason for this might be the high consumption of folic acid rich vegetables and fruits often in Aydın area.

B12D was assessed among different age groups and a statistically significant difference was found: 5.6% (n=17) in 7-11 years age children and 14.4% (n=28) in 12-15 years age children (p<0.05). Decreased serum level of B12 was found in 45 cases (9.1%). Four of these cases had concomitant anemia (0.8%). Macrocytosis was found in none of the cases with decreased serum level of B12, and all had normal MCV values. Family history or clinical presentation of megaloblastic anemia was found in none of the cases. None of these individuals were vegetarian or vegan. Decrease in serum B12 vitamin level is regarded as a sensitive test but pseudo-decrease in serum B12 level can be seen also in patients with folate deficiency, pregnancy, oral-contraceptive use, multiple myeloma, HIV infection and low haptocorrin levels (41). None of the possible causes above was appropriate in our cases except haptocorrin deficiency. Haptocorrin deficiency also could not be excluded. For the diagnosis of B12DA, evaluation of methylmalonic acid and homocysteine levels recommended in such patients.

Conclusion

The prevalence of anemia in our region is 15.7% and this means that our region has mild level social health problem based on the WHO criteria. The prevalence of ID and IDA was found as 38.7% and 8.3%, respectively and 20% of these children had previously been prescribed with iron-therapy. Half of the microcytic anemia is constituted by ID in our region and these patients are most likely referred to as thalassemia trait based on blood parameters. Thalassemia trait is defined as a major problem in the diferential diagnosis of IDA differential diagnosis in our region. For that reason, the exact cause of anemia must be identified in pre-school period children with anemia. Treatment of patients who had been

previously treated for nutritional anemia must be continued with appropriate dose and duration. The nutrition of these patients must be organized and followed up. Necessary preventive studies must be performed to prevent ID and B12DA and screening programs must be performed for early detection of these problems.

Authorship Contributions

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