



Association between vitamin D3 deficiency and iron status in children between six months to five years

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Abstract

A cross sectional hospital based selected study was done on children attending the pediatrics out patients department (age from 6 months to 5 years). Each child was examined for signs of vitamin D deficiency and iron deficiency, in addition to measuring of weight and height. Each child was sent for vitamin d3 level, iron level and complete blood count (including MCV, MCH). The total number of cases 106 case (50.9% female, 49.1% male). Most of the cases were between 4 years to 5 years 41.5%. 82.1% of the cases were on added solid diet. Regarding iron status, 55% of study cases were with normal iron level while 45% were within low level. The result also showed that the risk factor for vitamin D efficiency (poor sun exposure) was higher in males with percent of 34.6%, Where the risk factor (diet deficient in vitamin D3) was higher in females with percent of 42.6%. About 96.2% of males were have no risk factors of iron deficiency and 98.1% of females have also no risk factors of iron deficiency. The study also showed that, according to symptoms of vitamin d3 deficiency. Prolong bone pain among males were 88.5% and the females obtained the percent of 90.7%. There is a statistically significant difference at level of 0.05 in the distribution of study cases according to vitamin D3 status in regard to iron status.

Keywords Vitamin D deficiency, iron deficiency, risk factor and iron status

Introduction

Vitamin D is an essential nutrient that plays an important role in calcium homeostasis and bone health (Misra et al., 2008). Severe deficiency of vitamin D causes rickets in infants and children, and osteomalacia in all age group (Braegger et al., 2013). The clinical consequences of mild vitamin D deficiency are less well established. However, "chronically low vitamin D levels are associated with the development of low bone mineral density and other measures of reduced bone health, even in the absence of rickets" (Wagner et al. 2006; Munns et al., 2016).

Over 90% of vitamin D is derived from ultraviolet light and the rest is obtained from the diet. In a fair-skinned person, 20-30 minutes of sunlight exposure on the face and forearms at midday are estimated to generate the equivalent of around

2,000 IU of vitamin D (Balvers, 2015). for vitamin D production in people with increased skin pigmentation. Measures to decrease sun-exposure, like covering the skin or applying sunscreen to decrease vitamin D synthesis. Children who spend less time outside have a reduced vitamin D synthesis. The winter sun away from the equator is ineffective at mediating vitamin D synthesis (Cole et al., 2010). Formula milk and many foods such as breakfast cereals are supplemented with vitamin D, However, vitamin D deficiency Has re-emerged infants totally breast-fed in late infancy. It is also seen in extremely preterm infants from dietary deficiency of phosphorus, together with low stores of calcium and phosphorus (Beattie et al., 2009)

Iron is another essential nutrient. Approximately 75 percent is bound in the heme proteins hemoglobin and myoglobin. The remainder is bound in storage proteins such as ferritin and hemosiderin, and a small portion (3 percent) is bound in critical enzyme systems, such as catalase and

cytochromes. Storage iron is found primarily in the liver and spleen (ferritin and hemosiderin). Either diminished absorbable dietary iron or excessive loss of body iron can cause iron deficiency (Andrews & Bridges, 2000).

Poor absorption usually is due to an insufficient intake of dietary iron in an absorbable form. Hemorrhage is the most common cause of excessive loss of body iron, but it can occur with hemoglobinuria from intravascular hemolysis. Malabsorption of iron is relatively uncommon in the absence of small bowel disease (sprue, celiac disease, regional enteritis) or previous GI surgery (Mustafa & Al-Samarraie, 2020; Cleland et al., 2016; Eisenga et al., 2016). Iron and Vitamin D are synergistic increasing one often increases the other low levels of one related with levels of the other. the synergism occurs even without clinical deficiency of either one (Mustafa et al., 2020).

Materials and Methods

A cross-sectional hospital based selected study was done on children with vitamin D3 deficiency to assess iron status among those children between age 6 months and 5 years. The study was done at safin private hospital in sulymania city /Iraq, during the period from January 2019 to February 2020. The patient were selected by simple random sampling. Before inclusion each child, a written consent from their parent was taken.

Inclusion criteria

1. children aged 6 month to 5 years
2. have no apparent disorders
3. no chronic conditions such as renal failure.

Exclusion criteria

1. age <6 month > 5 years with conditions that may affect vitamin D3 and iron level.
2. who have chronic illness like DM, HT, CRF

Each child included in the study was assessed by prepared questionnaire (Alkanani et al., 2020). Each child included in the study was tested for signs of vitamin D3 deficiency and iron deficiency in addition to measuring of weight and height. Each child included in the study was sent for vitamin d3 level, iron level and complete blood count (including MCV, MCH). Vitamin D3 level was measured by drawn a 2ml blood from brachial vein using tourniquet, the blood was collected on gel tube (yellow cap) and analyzed by cobas e411. Vitamin D deficiency is defined as a serum 25(OH)D level of less than 20 ng/mL, While Vitamin D insufficiency has been defined as a serum 25(OH)D level of 20-29 ng/mL. A level of more than 88ng/ml was considered as a toxic level (Nguyen, 2019). Complete blood count (including MCV, MCH) was measured by Simply take a finger-prick sample, draw blood into the 20 µl micro-

capillary, slide the tube into the adapter and insert into the analyzer (SWELAB). The analysis starts automatically.

Iron was measured by taking the serum of blood and analyzed by cobas c311. less than 50mcg/dl considered as low and more than 120mcg/dl considered high (Devkota, 2019). Weight was assessed by UNICEF digital scale, twice measurements were taken and near weight was taken. Height was assessed by stadiometer depend on the age, supine length was taken for child under 2 years old and stand height was taken for the child more than 2 years old. weight and height measurements were plotted on a standard chart (WHO/UK) charts (RCPCH, 2013a; 2013b). The result were presented in tables and figures and statistical analysis was done using SPSS statistics

Results

We can see in table (1) that the age's categories were mixed for the study sample, most of the study cases were at age of (49-60 months) in percentage of 41.5%. And the males were 49.1% from the study sample, while the females were 50.9% of the study sample.

Table 1: General characteristics for the studied samples

Variable	Category	Frequency	Percentage
Age (months)	6-12	4	3.8
	13-24	16	15.1
	25-36	19	17.9
	37-48	23	21.7
	49 – 60	44	41.5
	Total	106	100.0
Gender	Male	52	49.1
	Female	54	50.9
	Total	106	100.0
Feeding	Mixed feeding (breast+ bottle feeding)	12	11.3
	Bottle feeding	2	1.9
	Breast feeding	5	4.7
	Solid diet	87	82.1
	Total	106	100.0
Wt (percentile)	Low (2nd)	2	1.9
	Normal (2 nd – 91 st)	96	90.6
	High (98 th – 99.6 th)	8	7.5
	Total	106	100.0
Ht (percentile)	Low (2nd)	1	.9
	Normal (2 nd – 91 st)	90	84.9
	High (98 th – 99.6 th)	15	14.2
	Total	106	100.0

The type feeding for the study sample were higher in the solid category 82.1% from the study sample. Also, the results showed that the weights for the participants were mixed, most of the study cases were within normal weight in

percent of 90.6% and the same was the height were most of the studied cases were in normal height 84.0%.

Table (2) showed the distribution of study cases that vitamin D3 deficient diet was the most common risk factor in females in percent of (42.6%), while poor sun exposure was the commonest among males in percent of (34.6%).

Table 2: Distribution of cases according to risk factors for vitaminD3 deficiency

Risk Factors	Male no (%)	Female no (%)	Total
Poor sun exposure	18 (34.6%)	15 (27.8%)	33 (31.1%)
Diet deficient in vit d3	17 (32.7%)	23 (42.6%)	40 (37.7%)
Exclusive breast feeding without vit d3 supplement	13 (25.0%)	15 (27.8%)	28 (26.4%)
No risk factors	4 (7.7%)	1 (1.9%)	5 (4.7%)

In table (3) we can see that the males have no risk factors of IDA with percent of (96.2%), and the females have no risk factors of IDA with percent f (98.1%), that assure the most sample of the study have no risk factors of IDA.

Table 3: The distribution of the study cases according to risk factors of IDA * gender

Risk Factors	Male no (%)	Female no (%)	Total
Prematurity	0 (0%)	0 (0%)	0 (0%)
Cow milk protein intolerance	0 (0%)	0 (0%)	0 (0%)
Bleeding	0 (0%)	0 (0%)	0 (0%)
Diet deficient in iron	2 (3.8%)	1 (1.9%)	3 (2.8%)
No risk factor	50(96.2%)	53(98.1%)	103(97.2%)

Table (4) showed that Prolong bone pain among males were (88.5%) and the females obtained the percent of (90.7%). On the other hand there is no symptoms of vit D3 deficiency for males with percent of (5.8%) and the percent of (9.3%) for the females.

Table 4: The distribution of the study cases according to symptoms of vitamin D3 deficiency

symptoms of vitamin D3 deficiency		Male no (%)	Female no (%)	Total
Bowing of the legs	No.	1	0	1
	%	1.9%	0.0%	0.9%
Delayed walking	No.	2	0	2
	%	3.8%	0.0%	1.9%
No symptoms	No.	3	5	8
	%	5.8%	9.3%	7.5%
Prolong bone pain	No.	46	49	95
	%	88.5%	90.7%	89.6%

The result showed in table (5) showed that there is a statistically significant differences at level of (0.05) in the Vit D3 according to the risk factors deficiency, ($\chi^2 = 12.764$) and the variance was in favor of (diet deficient in Vit D3) while the result was concentrate for the low category.

Table 5: The distribution of study cases according to risk factors of Vitamin D def in regard to Vitamin D3 status

Risk factors		vitd3		Total	df	Chi ²	Sig
		Low	Mediu m				
Diet deficient in vitamin d3	No.	38	2	40	3	12.764	0.005*
	%	38.0%	33.3%	37.7%			
Exclusive breast feeding without vitamin D supplement	No.	28	0	28			
	%	28.0%	0.0%	26.4%			
No risk factors	No.	3	2	5			
	%	3.0%	33.3%	4.7%			
poor sun exposure	No.	31	2	33			
	%	31.0%	33.3%	31.1%			
Total	No.	100	6	106			
	%	100.0%	100.0%	100.0%			

*: significant at level of 0.05

The results in table (6) showed that there is no statistically significant difference at level of (0.05) in the Iron status according to the age, gender, wt and ht. (χ^2) values were (2.927, 0.031, 1.739, 1.245) respectively for these demographical variables and these values not significant at level of (0.05)

Table 6: Show the distribution of study cases according to iron status

			Iron status		Total	Chi ²	df	Sig
			Low	Medium				
Age(months)	6-12	No.	3	1	4	2.927	4	0.570
		%	6.3%	1.7%	3.8%			
	13-24	No.	9	7	16			
		%	18.8%	12.1%	15.1%			
	25-36	No.	9	10	19			
		%	18.8%	17.2%	17.9%			
	37-48	No.	9	14	23			
		%	18.8%	24.1%	21.7%			
	49-60	No.	18	26	44			
		%	37.5%	44.8%	41.5%			
Total		No.	48	58	106			
		%	100.0%	100.0%	100.0%			
Gender	Male	No.	24	28	52	0.031	1	0.507
		%	50.0%	48.3%	49.1%			
	Female	No.	24	30	54			
		%	50.0%	51.7%	50.9%			
Total		No.	48	58	106			
		%	100.0%	100.0%	100.0%			
Wt percentile	Low (<2nd)	No.	0	2	2	1.739	2	0.419
		%	0.0%	3.4%	1.9%			
	Normal (2 nd – 91 st)	No.	44	52	96			
		%	91.7%	89.7%	90.6%			
High (98 th – 99.6 th)	No.	4	4	8				
	%	8.3%	6.9%	7.5%				
Total		No.	48	58	106			
		%	100.0%	100.0%	100.0%			
Ht Percentile	Low (<2nd)	No.	0	1	1	1.245	2	0.536
		%	0.0%	1.7%	0.9%			
	Normal (2 nd – 91 st)	No.	40	50	90			
		%	83.3%	86.2%	84.9%			
High (98 th – 99.6 th)	No.	8	7	15				
	%	16.7%	12.1%	14.2%				
Total		No.	48	58	106			
		%	100.0%	100.0%	100.0%			

Discussion

Vitamin D3 deficiency remains the most common cause of rickets globally and is prevalent even in industrialized countries. It frequently occurs in infancy because of a combination of poor intake and inadequate cutaneous synthesis. Transplacental transport of vitamin D, mostly 25-D, typically provides enough vitamin D for the first 2 months of life unless there is severe maternal vitamin D deficiency (Kliegman *et al.*, 2019). Iron deficiency anemia develops when body stores of iron drop too low to support normal red blood cell (RBC) production. Inadequate dietary iron, impaired iron absorption, bleeding, or loss of body iron in the urine may be the cause (Harper, 2020).

Most of the cases in our study with vitamin d3 deficiency who have risk factors related to poor sun exposure were males 34.6% this agrees with a study done by Young Eun Roh, in Busan (City in south Korea) (Roh *et al.*, 2016). 42% of

study cases who have vitamin d3 deficiency were between 4-5 years, this agrees with a study done by Eglė Butkutė in Lithuania (Butkute *et al.*, 2017).

Most of our cases were coming complaining of prolonged bone pain, males were 88.5% and the females obtained the percent of 90.7% this disagrees with a study which was done by Michie in UK, who found that most of the cases were presented in a hospital setting with either a history of hypocalcaemic seizures in infancy, or rickets or with delayed gross motor milestones in toddlers (Michie, 2010). In addition, most of our study cases reported no symptoms of iron deficiency, although they have a low iron level, this disagrees with a study done by *et al.*, which showed that children with iron deficiency got tired more easily, played less and were more hesitant compared to completely healthy children (Lozoff *et al.*, 1998).

Although 44% of our study cases were have a low iron level ,but we have not reported any risk factors for iron deficiency, this disagree with as study done by Adish who revealed that, Underlying causes of anaemia were lack of safe water and inadequate human waste management, maternal illiteracy and mother being ill, and having no food reserves. The root cause of these factors was poverty (Adish et al., 1999). In our study , we found that , most of study cases with low iron level were between 4-5 years , this disagree with study done by Eussen, who found that most children with iron deficiency were between the age 6-36 months (Eussen et al., 2015).

The result also revealed a statistically significant difference at level of 0.05 in the distribution of study cases according to vitamin D3 levels in regards to iron status this agree with study done by Jun Ah Lee in Korean children and adolescent (Lee et al., 2015). Most of the cases with low vitamin D3 level were females 51% and 49% were males this agree with study done by Michal in USA (Mclendom & Carlow, 2015). In addition, we found that most of the cases with vitamin D3 deficiency were with normal weight and height 91% and 85% respectively, this disagree with a study which was done by Kremer in Canada who found that vitamin D3 deficiency associated with decreased final height and increase in body mass index (Kremer et al., 2009) .

Conflict of Interest

The author hereby declares no conflict of interest.

Consent for publication

The author declares that the work has consent for publication.

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