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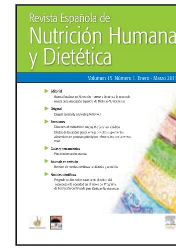

REVISIÓN

Disorders of malnutrition among the Saharawi children

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KEYWORDS
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Abstract
It is first article that reviews the literature on the problem of disorders of malnutrition among Saharawi children. Most of the studies reveal problems mainly of celiac disease, goiter, geophagia, undernutrition, wasting, stunting, overweight, scurvy, rickets and iron-deficiency anaemia.

PALABRAS CLAVE
Niños saharauis;
Desórdenes de la malnutrición

Desórdenes de malnutrición entre los niños saharauis

Resumen
Esta es la primera revisión que aborda las publicaciones relacionadas con los problemas de los desórdenes de la malnutrición entre los niños saharauis. Mucho de los estudios revelan problemas principalmente de celiaquía, bocio, geofagia, desnutrición, emaciación, baja talla, sobrepeso, escorbuto, raquitismo y anemia ferropénica.

Introduction

The Saharawi refugees, mainly 80% are women, children and elderly, are located in one of the most hostile and barren deserts of the world, which were previously considered uninhabitable desert. It is located in the remote south-western corner of Algeria, near the town of Tindouf. They are organized into four large camps called wilayas (is similar to province or camp). Each wilaya is named after a main town in Western Sahara as are Ausserd *(Awsard),* El Aaiun *(Al-'Uyun),* Smara *(Smara),* situated in the *hamada* of Tindouf, separated between them by the distance around 9 and 30 km and placed further north in comparison with the other *wilaya* called Dajla *(Dakhla)* (Fig. 1). Furthermore,

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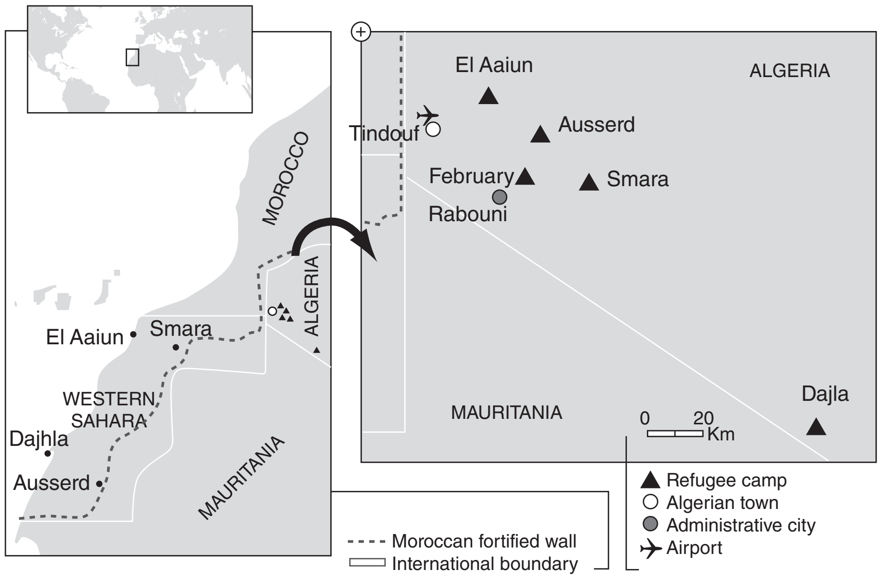

Figure 1 Map of Saharawi refugee camps.

each *wilaya* is divided into seven or eight district called daira, which are each made up of four neighbourhoods. *Wilaya* of Dakhla is grouped by eight *daira,* whereas the rest of *wilayas* is constituted by seven *dairas*. Every daira has its own primary school, health clinic, and administration. Between 6000 and 8000 refugees live in each *daira.* Furthermore, there are two important secondary school called 12nd October and 27th February. The 27th February School started as a boarding school for women that is situated close to the camp of Smara, but with time it has grown and become residential, now the size of a camp's *daira,* and I therefore refer to it as a fifth camp.[1-4]
Some of these Saharawi children between the ages of eight and thirteen are hosted by European families, mainly in Spain and Italy, in their homes for a two-month period during the summer according to the "holydays in peace" program. This annual holiday program that allows between 7000 and 10,000 Saharawi children receive medical examinations and treatment, as well as gifts of clothes, toys, and money which they take back with them to the camps and many of them return year after year to the same host homes.[2,3,5]

Disorders of malnutrition among the Saharawi children

Disorders of malnutrition among Saharawi children are reflected in the bibliography being problems mainly of celiac disease, goitre, geophagia, undernutrition, wasting, stunting, overweight, scurvy, rickets and iron-deficiency anaemia.

Celiac disease

Celiac disease is commonly misdiagnosed due to that its symptoms are similar to those of other diseases as are irritable bowel syndrome, iron-deficiency anaemia caused by menstrual blood loss, Crohn's disease, diverticulitis, intestinal infections, and chronic fatigue syndrome.[6] Rätsch and Catassi (2001)[7] shown that abdominal pain and distension are symptoms significantly commoner among Saharawi children with celiac disease. To diagnose celiac disease, physicians will usually test blood to measure levels of Immunoglobulin A (IgA), anti-tissue transglutaminase (tTGA) and/or IgA anti-endomysial antibodies (AEA) being used in several studies[7-12] of Saharawi children with positive results for the celiac disease. Furthermore, the serological diagnosis is confirmed habitually by finding the typical celiac enteropathy upon intestinal biopsy. According to Catassi et al (1999)[8] and Sarquella et al (2004),[12] there is unusually high prevalence (5.6 and 10.4%, respectively) of celiac disease among the Saharawi people that in any other population thus studied in the world (0.5-1%) being probably related to following factors:

Nutritional factors. In the last century, the Saharawi dietary habits have changed being mainly two options to explain the high prevalence of celiac disease.[7] First, the reduction of the duration of exclusive breastfeeding. Second, gluten-containing cereals, especially wheat, can provide more than 50% of the total dietary energy in this group population in comparison with the historic diet of this population based in the consumption of small cereals to the detriment of diet based on prolonged camel milk and meat, dates and sugar and supported with on prolonged breastfeeding.

Genetic factors. Celiac disease is closely associated with genes that code human leukocytes antigens from class two (HLA-II), mainly of DQ2 and DQ8 classes being DQ2 (90%) much less frequency DQ8 (5-10%).[14] However, there is between 5 and 10% of celiac disease patient with DQ2 and DQ8-negative, for this reason is necessary but not a sufficient condition to develop this digestive disease. López-Vázquez et al (2004)[14] suggested that another possible gene present called DQ2/DR3/B8, in addition to the DQ2 and DQ8 heterodimers, may modulate the development of a slow progression and less aggressive forms of celiac disease called atypical form which the extra-intestinal features predominate including chronic iron deficiency anaemia and short stature among others. Tieng et al (2002)[15] indicated that the allele including in the DQ2/DR3/B8 haplotype help to encode an altered form of the protein without the intracytoplasmatic tail that could be expressed in the apical zone of enterocytes which affect to the interaction with the intestinal intraepithelial lymphocyte and this may provide a protective effect in gut epithelium, which could explain the absence of intestinal manifestations in the atypical form. The DQ2/DR3/B8 haplotype has been studied in the Saharawi population affected with the celiac disease.[14] Results indicated that the development of atypical or typical forms for this group population may be due to gene or genes located in the side of the DQ2/DR3/B8 haplotype.

Environmental factors. Data of Catassi et al (1999)[8] not support a negative influence of celiac disease on childhood mortality, due to the percentage of AEA-positivity tended to increase with age. This group speculated that this digestive disease gave a selective advantage to affected individuals by "protecting" them from intestinal infections/parasites due to that in the enteropathy is covered by less differentiated enterocytes that partially lack the membrane receptors used for adhesion of bacteria and/or parasites.

The treatment of celiac disease, based on lifelong exclusion from the diet of gluten containing cereals, is exceptionally difficult in Saharawi refugee camps but Rätsch and Catassi (2001)[7] is developing a multifaceted project including implementation of a gluten-free diet, incorporation of machinery to be used to mill these cereals, educational courses for health and school personnel and families, identification and registration of all affected individuals, centralized management of gluten-free food storage and distribution and maintain contacts with other national societies and international agencies to help to the treatment. Furthermore, Saharawi children hosted in other countries must be diagnosed in the celiac disease and advised to their families in the consumption of gluten-free food during their staying in summer.[16]

Euthyroid goitre

Goitre refers to any visible enlargement of the thyroid gland being the only organ in the body to use iodine. The recommended daily iodine intake is 50 μg for infants (<12 months), 90 μg for children up to the age of 6 years, 120 μg for children 7-12 years old, 150 μg for adolescents and adults, and 200 μg for pregnant and lactating women.[17] Goitre is common around the world because many regions have inadequate iodine intake; however the situation is "slightly" different because in Saharawi refugee camps, there is an excessive intake of iodine,[18] this situation has been cited in three place in the world; Central China,[19] Hokkaido (Japan)[20] and in USA[21] that have an endemic goitre caused by excessive iodine intake. To diagnostic goitre, several measurements must be carried out, as are:

Table 1 Urinary iodine concentrations[17] in Saharawi children

Degree of intake in population	Population median urinary iodine (μg/L)
Excessive intake[22]	≥300
Normal intake	100-299
Mild deficiency	50-99
Moderate deficiency	20-49
Severe deficiency	<20

1. Urinary iodine. It is a good marker of the very recent dietary intake of iodine. The cut-off values for urinary iodine excretion are demonstrated in Table 1. Several studies demonstrated high values in urinary iodine concentration in Saharawi children as reflected in Table 2. Benmiloud et al (1994)[26] reflected that in Algeria, excluded Saharawi refugee camps in Tindouf, the mean value of urinary iodine is 26.6 μg/L.
2. Clinical sign as is visible goitre. Tables 3 and 4 show the simplified classification of goitre and prevalence of visible goitre in Saharawi children, respectively. Díaz-Cadórniga et al (2003)[24] detected a percentage of visible goitre in females higher than males and being the highest prevalence in the range from 10 to 12 years and a reduction from 16 years old, until 60 and 37% in females and males, respectively.
3. Determination of the serum levels of thyroid stimulating hormone (TSH) and thyroid hormones. Díaz-Cadórniga et al (2003)[24] analyzed TSH and thyroxin (T4) in 129 children in schools of Saharawi refugee camps in Tindouf obtaining a mean of 8.7 μg/dL and 2.7 mU/L, respectively.

In the bibliography, the following hypotheses were explained to justify the relation of excess iodine and goitre:

1. High iodine concentration in food and drinking water. Díaz-Cadórniga et al (2003)[24] obtained a range of concentration between 180 to 400 μg/L in drinking water from three schools (9th June, 12th Octuber and 27th February) of Saharawi refugee camps in Tindouf (Algeria). Pezzino et al (1998)[18] detected a mean concentration of 259 and 934 μg/L in drinking water from Rabouni and Dakhla, respectively, and UNHCR/WFP/NIRFN (2005)[29] observed adequate iodine level in samples of water from tank and aqueduct from Dakhla (8.3-20 μg/L) and Smara (25.7 μg/L) and extremely high level in El-Aauin (292.8-294.7 μg/L) and Ausserd (319.7-325.2 μg/L) areas. However, UNHCR/WFP/NIRFN (2005)[29] suggested that if in the summer season the consume of drinking water can be higher than 1 litre/person/day and the daily iodine intake can reach 1 mg/person/day, there is no concern for toxicity assuming 1 mg as the maximum allowed intake level.[30] But it is a mistake. This explanation would be certain if we used the maximum allowed intake level (1 mg/person/day) for adult, however IOM (2002)[30] established the maximum allowed intake level in 200 and

Table 2 Urinary iodine concentrations in Saharawi children

Sample (Number/Age range)	Place	Urinary iodine concentration (μg/L)		References
Adolescents (42/10-19)	Dakhla (Algeria)	747	62-1380	UNHCR/WFP/NIRFN (2002)[23]
Adolescents (23/10-19)	Smara (Algeria)	1823	350-3320	UNHCR/WFP/NIRFN (2002)[23]
Adolescents (16/10-19)	Awserd (Algeria)	1416	126-2350	UNHCR/WFP/NIRFN (2002)[23]
Adolescents (34/10-19)	El Aiun (Algeria)	1754	390-3900	UNHCR/WFP/NIRFN (2002)[23]
Children (207/7-16)	9th June School (Algeria)	992	—	Díaz-Cadórniga et al (2003)[24]
Children (205/7-16)	12th October School (Algeria)	954	—	Díaz-Cadórniga et al (2003)[24]
Children (74/7-16)	27th February School (Algeria)	919	—	Díaz-Cadórniga et al (2003)[24]
Children	Saharawi refugee camps in Tindouf (Algeria)	—	363-769	Pezzino et al (1998)[18]
Children (416/6-14)	Saharawi refugee camps in Tindouf (Algeria)	565	102-3594	SMH-DH/NCA/AUC (2008)[25]

Table 3 Revised classification of goitre[27]

Classification	Description
Grade 0	No palpable or visible goitre
Grade 1	A goitre that is palpable but not visible when the neck is in the normal position (i.e. the thyroid is not visibly enlarged). Thyroid nodules in a thyroid which is otherwise not enlarged fall into this category
Grade 2	A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated

300 μg/person/day for children in the range of 1-3 and 4-8 years, respectively. Really, children with goitre are ingested iodine between three and five times of the maximum allowed intake level. For foods, the only rich source of iodine is seafood, but several studies[7,23,29,31-33] reflected a low ingestion being sardines and tuna fish the most common seafood.

2. Presence of goitrogens. Goitrogens are substances suggested to interfere with the proper functioning of thyroid hormone synthesis and utilization. The pseudohalide ion thiocyanate (SCN^-) interferes with the thyroid gland's uptake and metabolism of iodine through competitive inhibition.[34,35] Díaz-Cadórniga et al (2003)[24] obtained a low value (0.36 mg/100 mL) of urinary SCN^- in Saharawi children in refugee camps. Furthermore, several studies of these children[7,23,29,31-33] reflected a low ingestion of foods with goitrogens known. In the other hand, Delange et al (1980)[36] suggested that many substances have been proposed as potential goitrogens of public health importance but it has been difficult to confirm or reject these hypotheses or to estimate the importance of a goitrogenic effect in any one population. For this reason, this author proposed that the epidemiological indicator urinary I/SCN^- ratio could help to assess the presence of the potential goitrogenic effects. According to the study of Díaz-Cadórniga et al

Table 4 Prevalence of visible goitre in Saharawi children

Sample (Number/Age range)	Place	Prevalence (%)	References
Adolescents (162/10-19)	Dakhla (Algeria)	6.8	UNHCR/WFP/NIRFN (2002)[23]
Adolescents (158/10-19)	Smara (Algeria)	13.9	UNHCR/WFP/NIRFN (2002)[23]
Adolescents (112/10-19)	Awserd (Algeria)	4.5	UNHCR/WFP/NIRFN (2002)[23]
Adolescents (157/10-19)	El Aiun (Algeria)	2.6	UNHCR/WFP/NIRFN (2002)[23]
Children (242/7-16)	Spain*	0.4	Paricio Talayero et al (1998)[28]
Children (208/7-16)	9th June School (Algeria)	56	Díaz-Cadórniga et al (2003)[24]
Children (205/7-16)	12th October School (Algeria)	58	Díaz-Cadórniga et al (2003)[24]
Children (157/7-16)	27th February School (Algeria)	61	Díaz-Cadórniga et al (2003)[24]
Children	Saharawi refugee camps in Tindouf (Algeria)	28	Pezzino et al (1998)[18]
Children (242/7-16)	Spain*	0.4	Paricio Talayero et al (1998)[28]
Children (421/6-14)	Saharawi refugee camps in Tindouf (Algeria)	11	SMH-DH/NCA/AUC (2008)[25]

*Studied children are hosted in Spain during summer.

(2003)[24] and using their data, we obtain a mean urinary I/SCN⁻ ratio of 268 μg/mg. This value is higher than the postulated cut-off <3 μg/mg to indicate the possible goitrogenic effect. However, several authors[34,37-41] have questioned this ratio and the utility of the I/SCN⁻ ratio for assessment of potential goitrogenic effects was unclear.

3. Presence of other minerals. Gaur et al (1989)[42] and Yang et al (1994)[43] described a high prevalence of goitre (29.5 and 72%, respectively) in area of India and China, respectively. The last study claimed a drinking water with high values in fluoride and iodine concentration due to that the analysis of urinary iodine and fluoride detected 816 μg/L and 2.08 mg, respectively whereas Gaur et al (1989)[42] hypothesised this goitre due to the presence of several minerals in drinking water as are calcium, magnesium, fluoride and chloride among others. Taylor (1954)[44] and Murray et al (1982)[45] confirmed the endemic goitre in areas with hard water. Díaz-Cadórniga et al (2003)[24] analyzed drinking water in three school children in Saharawi refugee camps in Tindouf obtaining high values for chloride (1500 mg/L), fluoride (0.7-1.5 mg/L), hardness water (20-50 F) and total solids (2100 mg/L).
4. The Wolff-Chaikoff effect. Wolff et al (1949)[46] explained a transient phenomenon suggested that a dramatic increase in the plasma iodide load causes the thyroid gland to block iodine organification. According to this effect, Díaz-Cadórniga et al (2003)[24] and Suzuki (1980)[47] justified this effect among others by explaining of euryt hroid goitre.
5. Thyroid autoimmunity. Boyages et al (1989),[48] Delange (1995)[49] and Dunn (1989)[50] suggested that endemic goitre by excessive iodine intake is caused by thyroid autoimmunity. However, Díaz-Cadórniga et al (2003)[24] demonstrated that autoimmunity is negative.
6. Other factors. Díaz-Cadórniga et al (2003),[24] El Mahdi et al (1986),[51] Gaitan (1990)[34] and Peterson (2000)[52] suggested other possibilities to justify this goitre as are malnutrition and bacterial contamination of drinking water but these studies didn't carry out this analysis. In 1997, Mora-Castro,[53] UNHCR administrator responsible for water, indicated that the water in the Saharawi refugee camps is either of borderline quality or unfit for human consumption and is also highly contaminated with faecal matter. Lopriore et al (2004)[54] reflected, strangely classified as parasitic infections, the presence of Escherichia coli in several samples screened in Saharawi refugee camps. Docampo and Molinero (2006)[55] reflected that the highest value (>30 colony forming unit/100 ml) of contamination for coliforms is obtained in Dakhla being the prevalence of goitre in this wilaya lower (6.8%) than in Smara (13.9%).[23] The problem of bacteriological contamination of drinking water required a technical solution being the best-proposed idea of Mora-Castro.[53] He indicated that a centralised water-supply system for each camp, with a building of a reservoir in the surrounding hills, an adequate number of water supply points fed by gravity and automatic chlorination devices in the reservoirs to disinfect the water, can help to reduce the bacteriological problems.

Malnutrition

Underweight

It is called to the prevalence for low z-score for Weight for Age (WAZ) but not distinguish between wasting (acute malnutrition) and stunting (chronic malnutrition). A child can be underweight for his age because he is stunted, because he is wasted, or because he is wasted and stunted. However, WAZ is a good over all indicator of a population's nutritional status. Z-score <–3 and z-score <–2 (corresponds to a weight three and two standard deviations, respectively, smaller than the mean) indicated severe underweight and underweight (including severe underweight, z-score <–3), respectively. Z-score cut-offs are routinely used to assess the need for a nutritional interventions. Table 5 shows the prevalence of WAZ in several studies carried out with Saharawi children. In general, these values are higher than the prevalence of Underweight in Western Africa (26.8%).[56]

Stunting

The z-score for Height for Age (HAZ) is a measure of linear growth. Stunting is called to the prevalence for low z-score for Height for Age (HAZ) which indicated the result of reduced (stunted) skeletal growth. Stunting occurs due to poor economic conditions rather than to dietary deficiency, but there is little or no proof of stunting having been caused by a specific deficiency in a population. Z-score <-3 and z-score <–2 indicated severe stunting and stunting (including severe underweight, z-score <–3), respectively. The prevalence of HAZ is reflected in Table 6. Stunting, which is present from 16.1% in children higher than 5 years[33] to 46% in children fewer than 5 years,[57] is the prevalent form of malnutrition in children. These values are higher than the prevalence of stunting in Western Africa (32%).[56] The increment of stunting between 2001 and 2005 can be explained to that World Food Program had earlier given complementary food to all children less those 5 years but between 2001 and 2005, this was stopped. Ferrari (2006)[58] indicated that stunted children have a higher risk (RR=1.7-1.8) of being overweight adults (BMI 85th percentile). Furthermore, malnourished children coexisted with maternal overweight/obesity in 37.6% of the households.

Wasting

Wasting, or thinness, is called to the prevalence for low z-score for Weight for Height (WHZ) which indicated unusually thin or wasted bodies due to a reduction in soft tissue mass. Wasting occurs due inadequate feeding habits, to lack of food in the families or to be a result of widespread diarrhoea or febrile disease. Z-score <–2 indicated wasting or thinness, if there is also an oedema, it is called global acute malnutrition, whereas severe acute malnutrition includes those cases with a weight for height index below a z score of –3. Table 7 shows the prevalence of WHZ in several studies. In general, the last value is slightly lower than the prevalence of wastingt in Western Africa (10.2%).[56]

Table 5 Prevalence of Weight for Age (WAZ) in Saharawi children

Place	n	Age (months)	Z-score (%)				Ref.
			<–3	<–2	Normal	>2	
Saharawi refugee camps in Tindouf	26	0-6	—	3.8	96.2	—	UNHCR/CISP/NRIFN (2001)[33]
	587	6-59	9.4	25.7	64.9	—	
	693	60-119	4.3	17.5	78.2	—	
Saharawi refugee camps in Tindouf	785	6-59	7.7	28.8	63.5	—	UNHCR/WFP/NIRFN (2005)[29]

Table 6 Prevalence of Height for Age (HAZ) in Saharawi childre

Place	n	Age (months)	Z-score (%)				Ref.
			<–3	<–2	Normal	>2	
Saharawi refugee camps in Tindouf	26	0-6	—	—	100	—	UNHCR/CISP/NRIFN (2001)[33]
	535	6-59	14	21.5	64.5	—	
	671	60-119	8.2	16.1	75.7	—	
Saharawi refugee camps in Tindouf	200	6-17	12	18	70	—	UNHCR/WFP/ICH (2002)[23]
	175	18-29	14.3	23.4	62.3	—	
	181	30-41	13.8	21	65.2	—	
	168	42-53	10.1	23.2	66.7	—	
	126	54-59	3.2	23.8	73	—	
Saharawi refugee camps in Tindouf	785	6-59	15.6	38.9	45.5	—	UNHCR/WFP/NIRFN (2005)[29]
Saharawi refugee camps in Tindouf	—	6-59	—	46	54	—	Branca (1997)[57]
Saharawi refugee camps in Tindouf	1144	36-72	—	32.7	67.3	—	Lopriere et al (2004)[54]

Overweight

The high WHZ (z-score <2) is indicator of being overweight. According to the Table 7, the prevalence of overweight in Hausa (Smara) was higher than in other wilayas,[32] and studies[23,29,33,57] being reflected in some of them of combination of child malnutrition and overweight, called dual forms of malnutrition.

Vitamin deficiencies

The literature focussed in the Saharawi children emphasized mainly three deficiencies as are:

Vitamin C deficiency. Scurvy results from insufficient intake of vitamin C. One out of 843 (0.1%) Saharawi children,[23] aged from 6 to 59 months, revealed peri-follicular haemorrhages but no other clinic signs were detected being the significance of this observation remained unclear. There is a marked contrast in comparison with 27.4% of the cases with clinical signs of vitamin C deficiency in women in fertile age.[29] Rätsch and Catassi (2001)[7] studied the cumulative frequency of food items ingested by the Saharawi children with celiac disease being potatoes the third food more consumed with 27% of frequency of consumption. Furthermore, the ingestion of camel milk, with 15% of frequency composition, reflected other option to take vitamin C.[60] The available of vitamin C rich food, as are potatoes, tomatoes and onions, was found 36, 45 and 63% households, respectively, in the study of NCA/AUC (2005).[32]

Vitamin D deficiency. It causes rickets due to the failure of osteoid to calcify in a growing person being also associated to dietary deficiency of calcium or phosphorus. UNHCR/WFP/ICH (2002)[23] revealed only two out of 843 (0.2%) children with signs of bowlegs and none with rachitic rosary. However, Doménech et al (2007)[16] reflected rachitic rosary in one out of 270 (0.4%) Saharawi children hosted in Spain.

Vitamin A deficiency. A personal communication of Ferrari cited in NCA/AUC (2005)[32] indicated that 51 and 7% of the Saharawi children had moderate (serum retinol <20 μg/dL) and severe (serum retinol <10 μg/dL) vitamin A deficiency,

Table 7 Prevalence of Weight forHeight (WHZ) in Saharawi children

Place	n	Age (months)	Z-score (%)				Ref.
			<−3	<−2	Normal	>2	
Saharawi refugee camps in Tindouf	27	0-6	—	7.4	88.9	3.7	UNHCR/CISP/NRIFN (2001)[33]
	561	6-59	4.5	8.7	64.5	0.7	UNHCR/WFP/ICH (2002)[23]
	655	60-119	8.2	16.1	75.7	2.4	UNHCR/WFP/NIRFN (2005)[29]
Saharawi refugee camps in Tindouf	200	6-17	3	9.5	87.5	—	UNHCR/WFP/ICH (2002)[23]
	175	18-29	1.1	8	90.9	—	Lopriere et al (2004)[54]
	181	30-41	1.7	10.5	87.8	—	
	168	42-53	1.2	4.8	94	—	
	126	54-59	4.8	8.7	86.5	—	
Saharawi refugee camps in Tindouf	785	6-59	2.3	7.7	90	—	UNHCR/WFP/NIRFN (2005)[29]
Saharawi refugee camps in Tindouf	155,430	6-59	—	10.6	89.4	—	Seal et al (2005)[59]
Saharawi refugee camps in Tindouf	—	6-59	—	10	90	—	Branca (1997)[57]

respectively, in a study carried out in 2001. This high prevalence is related with the relatively high presence of night blindness reported in women in fertile (20.6%).[32]

Mineral deficiencies

The literature focussed in the Saharawi children emphasized mainly two deficiencies as are:

Zinc deficiency. Lopriore et al (2004)[54] reported to most Saharawi mothers that their children would frequently eat soil, called geophagia, being behaviour indicative of severe iron and zinc deficiencies.[61]

Iron deficiency. If there is intestinal bleeding (caused by parasitic infections) and/or dietary intake or absorption of iron is insufficient occurs iron-deficiency anaemia. The data shows a strong ecological correlation between the prevalence of iron deficiency and anaemia. To diagnostic this type of anaemia, several measurements must be carried out, as are mainly:

1. Serum transferrin receptor (sTfR). This parameter is a measure of iron deficiency because it is relatively unaffected by the acute phase response associated with inflammation and infection.[59] The normal range is between 3 and 8.5 μg/mL in the studies of Saharawi children according to the used manufacturers instructions. The overall level of iron deficiency in Saharawi adolescent, aged from 10 to 19 years, is 34.1%[33] and 34.1 and 62.3% for Saharawi children aged from 0.5 to 5 years[29,59] as determined of sTFR with a cut-off of >8.5 μg/mL.
2. Haemoglobin. WHO (2001)[62] proposes the cut-off points used to define classes of anaemia based on blood haemoglobin concentrations, which are shown in Table 8. Furthermore, WHO (2001)[62] suggested that a prevalence of anaemia of at least 40%, 15-40% and of less than 15% can be classified as high, medium and low, according to the public health significance. Table 9 reflected prevalence of anaemia among Saharawi children. The mean of haemoglobin concentration in children, aged from 0 to 119 months, is 11.7 g/dL[33] showing two situations; *i)* the biggest reduction, going down from 7163 to 44%[33] in children between 6 and 59 months although is very high level of public health significance, and *ii)* the decrease of anaemia from 4863 to 18%33 for children, aged from 60 to 119 months, is 11.7 g/dL showing the biggest reduction, going down from 71 to 44%[33] in children between 6 and 59 months although is very high level of public health significance. UNHCR/WFP/ICH (2002)[23] detected 35.3% anemic children being the percentage slightly higher in boys (36.1%) than girls (34.4%) aged from 6 to 59 years. Rätsch and Catassi (2001)[7] reflected that haemoglobin values tended to be lower in these children with celiac disease than in population without this digestive disorder.

The prevalence of anaemia in Saharawi children hosted in Spain or Italy is reflected in several studies.[7,9-11,28,64] There are a large number of risk factors that may contribute to the development of anaemia in Saharawi children as are:

1. Poor iron dietary intake. It is reflected by Vijayaraghavan (1995).[65] Lopriore et al (2004)[54] carried out a study of 374 stunted children which ingested a highly nutrient-dense spread fortified with multiple vitamins and minerals. This study reflected that this product had a highly significant effect on haemoglobin concentration and hematocrit as well as on anaemia distribution over the six-month period dropping by nearly 90% of total anaemia and demonstrated that the anaemia was caused by a dietary deficiency. Furthermore, this micronutrient-fortified spread is adequate to correct pre-existing anaemia in high-risk

Table 8 Definition of anemia based on blood haemoglobin concentrations (g/dL) according to the WHO (2001)[62]

Age	Severe anemia	Moderate anemia	Mild anemia	No anemia
Children (6-59 months)	<7	7-9.9	10-10.9	≥11

Table 9 Prevalence of anaemia in Saharawi children

Place (Year)	n	Age (months)	Anaemia (%)				Ref.
			Severe	Moderate	Mild	No anaemia	
Saharawi refugee camps in Tindouf (2001)	29	0-6	—	17.2	31	51.7	UNHCR/CISP/NRIFN (2001)[33]
	601	6-59	3.5	23	17.6	55.9	
	697	60-119	—	3	15.2	81.8	
Saharawi refugee camps in Tindouf (2002)	204	6-59	—	17.6	17.7	64.7	UNHCR/WFP/ICH (2002)[23]
Saharawi refugee camps in Tindouf (2005)	382	6-59	10.5	38.7	23.8	26.9	UNHCR/WFP/NIRFN (2005)[29]
Saharawi refugee camps in Tindouf (2001-2002)	204	6-59		35.3	64.7	Seal et al (2005)[59]	
Saharawi refugee camps in Tindouf (1997)	—	<60		70	30	Branca (1997)[57]	

groups, in comparison with the inefficiency of iron-fortified flour and vitamin A- and vitamin C- fortified powdered skim milk used previously in this group population.

2. Parasitic and other infections. As are:

—Malaria, as possible risk factor of anaemia, is discharged in Saharawi refugee camps in Tindouf due to the very dry Saharan desert environment.[23,59]

—Helminth infections are discharged due to that no evidence of significant levels UNHCR/WFP/ICH (2002).[23]

Lopriore et al (2004)[54] demonstrated that the antiparasitic treatment not produce any significant differences in the reduction of anaemia in stunted children aged 3 and 6 years.

3. Other causes. UNHCR/WFP/ICH (2002)[23] suggested the consumption of tea as risk factor of anaemia due to the chelation of iron in the intestine that makes it unavailable for absorption by the body. Saharawi children, aged from 10 to 14 years, in Saharawi refugee camps in Tindouf, consumed this drink.[16,31] Other causes as blood loss due to the menstruation or inherited conditions are not reflected in any studies of Saharawi children.

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Conflict of interest

The authors declare no conflict of interest.

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