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The Fallacy of the Fat Anemic Child

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Abstract

Background: Studies suggest the presence of iron deficiency among obese children, which would lead to a higher incidence of anemia in this group.

Aim: To assess the prevalence of anemia among overweight and obese children from two socioeconomic levels and two different regions in Brazil.

Methods: Hemoglobin and anthropometric data on 598 overweight and obese children and adolescents were obtained from two services specialized in the care of these children.

Results: The overall prevalence of anemia was 5.8% and mean hemoglobin level was 13.2 mg/dL, with no statistical difference for the two indicators according to overweight or obesity and age group. However, the mean hemoglobin was higher among boys and, in the service with care provided to a population of lower socioeconomic status, the prevalence of anemia was higher.

Conclusion: The prevalence of anemia found among overweight and obese children and adolescents was quite low, being higher in the poorest population. For overweight children and adolescents, anemia seems to be more related to socioeconomic status than to the presence of excess weight.

Keywords: Anemia; Overweight; Obesity; Iron; Famine; Occult

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Introduction

In 1966, Judisch JM, et al. (1966) [1] published an article entitled "The fallacy of the fat iron-deficient child", questioning the concept, prevailing at the time, that children with anemia were mostly obese. Currently, it is common the idea that, although it seems paradoxical, obese children, even if they ingest above their energy needs, may have a lack of micronutrients, due to the low quality of food, becoming a risk group for iron deficiency anemia [2,3]. This possibility was initially suggested by Wenzel BJ, et al. (1962) [4], who verified children with obesity and iron deficiency, observation confirmed by other authors [5-7]. In Brazil, Miraglia F, et al. (2015) [8] found a 44% prevalence of anemia among children with a body mass index (BMI) z-score above 2 and, in Bolivia, obesity and anemia coexisted among individuals living on the periphery of metropolitan regions [9].

Iron deficiency anemia is the final stage of iron deficiency, which begins with the depletion of reserves represented by the fall in plasma ferritin [10]. Thus, US data showed, in an article published in 2004, a twice higher risk of iron deficiency among overweight children, using as a criterion the reduction of plasma ferritin [3]. The present study evaluated the hypothesis that, considering that in the literature it is accepted that obesity is a risk factor for iron deficiency [11], the prevalence of iron deficiency anemia among obese children is expected to be high. To test this hypothesis, this prevalence was studied among obese and overweight children, from two socioeconomic levels and two different regions in Brazil.

Methods

Data were obtained from two services in different regions of the country and different customer profiles, between 1998 and 2020: Local 1: private clinic in *Ribeirão Preto*, southeastern region, specialized in nutritional diseases and serving clients with health insurance (n=144); Local 2: public health system patients from specialized obesity clinic at the *Hospital de Clínicas de Porto Alegre* (HCPA) (n = 454). The inclusion criteria were individuals aged between 5 and 18 years, with a BMI z score greater than 1. The exclusion criteria were impediment to perform anthropometry or absent or incomplete laboratory tests. All patients underwent anthropometric assessment at the first consultation and collected blood samples within 30 days. Anemia patients were considered when hemoglobin was below the cutoff point adjusted for

age according to international criteria [10]. Anthropometric assessment followed a standardized technique, with overweight being considered when the BMI z score was between 1 and 2 and obesity when it was above 2, according to the World Health Organization curves [12]. Laboratory tests at Local 1 were carried out in one of three certified laboratories that the family could choose, using similar methods and kits, and those from Local 2, in the laboratory of the University Hospital.

The project was approved by the services ethics committees, under the numbers UNAERP 94/2003 and HCPA 07/258.

Results

In the two locations, no differences were observed in terms of distribution by gender (p=0.3900) and by age (p=0.4307). Table 1 shows the prevalence of anemia (total: 5.8%) and hemoglobin averages (total: 13.2 mg/dL), with no statistical difference for the two indicators according to overweight or obesity and age group. However, the mean hemoglobin was higher among boys and, in the service with care provided to a population of lower socioeconomic status, the prevalence of anemia was higher.

Table 1: Prevalence of anemia and hemoglobin values among children and adolescents with overweight and obesity.

Group	Prevalence %	p*	Hemoglobin (mg/dL) x ± dp	p**
Boys	4.6	0.2251	13.4 (1.16)	0.0001
Girls	7.1		13.0 (0.90)	
Overweight	5.6	10.000	13.2 (0.98)	0.9685
Obesity	5.9		13.2 (1.08)	
5 to 9.9 years	4.0	0.1536	13.1 (0.98)	0.0693
10 to 18 years	6.9		13.3 (1.09)	
Place 1	2.1	0.0249	13.7 (1.05)	< 0.0001
Place 2	7.0		13.1 (1.01)	
Total	5.8		13.2	

Where: * Fisher exact test
** Mann-Whitney

Discussion

Obesity and anemia are the two most prevalent nutritional diseases in pediatric population. Among school and adolescent age groups, Brazil does not have data on anemia, but local studies from the last 15 years show variable prevalences of 9.3% in Maceió [13]; 22.9% in Niterói [14]; 24.5% in Salvador [15]; 26.9% in Brasília [16]; 16% among school age and 5% among adolescents in Acre [17]; and 19.3% in Campinas [18]. Regarding obesity, the latest national data [19] showed prevalence among adolescents of 27.6% (boys) and 23.4% (girls). Studies carried out since the 1960s showed that obese children were iron deficient and, therefore, would have a higher risk of developing iron deficiency anemia. However, later data of Peru [20], México [21] and India [22], who specifically focused on hemoglobin measurement, did not demonstrate high anemia prevalence among overweight children. According to Sal E, et al. (2018) [11], the mechanisms involved in iron deficiency among obese people could be several: poor quality food, high demand for increased blood volume, reduction in myoglobin due to physical inactivity and genetic predisposition. However, the most commonly used marker, ferritin, is influenced by the inflammatory state and may be altered even with adequate iron stores [23]; it is known that obesity is also accompanied by a chronic inflammatory process [24]. Hepcidin, the main controller of iron absorption, is one of the adipokines produced by adipose tissue and has an increased expression in obese people and, supposedly, could contribute to deficiency, as it would decrease the absorption of iron by enterocytes and the export of iron by macrophages and hepatocytes, increasing its sequestration in the spleen [11,25]. Thus, ferritin does not seem to be an adequate marker for assessing the nutritional iron status in obese children and, perhaps, there is, probably, no greater risk of iron deficiency anemia directly associated with childhood obesity. The data of the present study corroborate this hypothesis, since the prevalence of anemia found was extremely low, in two different regions of the country and with different social strata. In the service that treats patients of lower socioeconomic status, the prevalence, although low, was slightly higher, showing that, possibly, the economic factor leading to low nutritional quality food and low in iron of adequate bioavailability [26], is the determinant of the risk of iron deficiency anemia, and not obesity. Further studies are needed to verify whether the alleged iron deficiency associated with obesity is real or just a laboratory artifact. The use of other markers such as hepcidin, hemojuvelin, zinc-protoporphyrin and soluble transferrin receptors, associated with the simultaneous assessment of iron and hemoglobin deficiency markers, could help to clarify this issue.

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Availability of Data and Materials

Available upon request.

Authors Contributions

Carlos Alberto Nogueira-de-Almeida: Original idea, conception, data analysis, discussion, review, writing.

Luiz Antonio Del Ciampo: Data analysis, discussion, final review.

Ivan Savioli Ferraz: Data analysis, discussion, final review.

Maria Eduarda Nogueira de Almeida: Data collection, final review.

Andrea Contini Rodrigues: Data analysis, discussion, final review.

Fábio da Veiga Ued: Data analysis, discussion, review, final review.

Diego Biella: Data collection, final review.

Elza Daniel de Mello: Conception, data production, discussion, review.

Conflict of Interest Statement

Nothing to declare.

Consent of Publication

Authors affirm that:

1. None of the material in this manuscript is included in another manuscript, it has not been published previously, and it is not currently under consideration for publication elsewhere. If was approved La Prensa Medica will have exclusive rights about the article.

2. Ethical guidelines were followed by the investigators in performing the study in humans. The approval of the institutional review board of ethics committee is cited in the Methods.

3. Each author fully participated in the work, approved the

final version of the manuscript, and takes public responsibility for the content of the paper;

If requested, the authors will provide the data or will cooperate fully in obtaining and providing the data on which the manuscript is based for examination by the editors or their assignees.

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