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RESEARCH ARTICLE

Nutritional status of children in critical condition at admission to pediatric intensive care units

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ABSTRACT

Background. Epidemiology of the nutritional status of pediatric patients has changed in Mexico. As a consequence, there should be a growing awareness about nutritional diseases when patients are admitted to the pediatric intensive care units.
Methods. Anthropometric data of children upon admission to the Pediatric Intensive Care Unit (PICU) at the Hospital Infantil de México Federico Gómez were retrospectively recorded from November 2002 to December 2007. For children up to 2 years old, nutritional status was calculated using the Z-score of body mass index according to the World Health Organization; for older children (>2 up to 18 years old), the charts from the Centers for Disease Control and Prevention were used.
Results. Prevalence of malnutrition, risk of malnutrition, overweight and obesity for children up to 2 years of age was 36.2%, 24.1%, 4.6% y 4.9%, respectively. For children between 2 and 6 years of age, the figures were 24.2%, 22.1%, 9.2% and 7.6%, respectively. For children between 6 and 13 years old, the percentages were 16.1% for malnutrition, 16.8% risk for malnutrition, 16.1% overweight, and 5.8% for obesity. In adolescents these values were 16.2%, 16.9%, 15.6% and 2.1%, respectively.
Conclusions. Risk for diseases such as malnutrition continues to be present in children admitted to pediatric intensive care units. However, other emerging diseases such as overweight and obesity have a high frequency. This shows that the epidemiological situation of children with serious illnesses is not very different from the general population.

Key words: critical condition, nutritional status, children, malnutrition, obesity.

INTRODUCTION

Critically ill pediatric patients present with a wide and heterogeneous group of conditions and disorders that place them at risk of developing one or multi-organ dysfunction and several morbidities. These alterations usually are associated with a high increase in nutritional requirements, exposing the patient to metabolic stress.[1] Thus, children with any life-threatening condition require admission to the pediatric intensive care unit (PICU) in order to achieve timely diagnosis and therapeutic interventions for controlling organ dysfunction and recover physiological stability.[2]

Several studies have mentioned that, on admission to a PICU, there is a prevalence of childhood malnutrition from 24 to 65%, according to weight for height and height for age indicators (Waterlow classification).[3,4] In each of its presentations, malnutrition in the pediatric patient is associated with physiological instability and mortality between 15 and 24%.[5-7]

In a study in Paraguay in children under 5 years of age, the nutritional status of 239 children in critical con-

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dition was assessed using the Waterlow indicators. They found 36% of eutrophic children, 23% at risk of malnutrition, 31% with moderate and severe malnutrition, 7% with overweight and 3% were obese.[8] The results showed that although malnutrition prevails in the PICU, overweight and obesity are concurrent and already represent 10% of admissions to a PICU.

The nutritional status of pediatric patients in Mexico is undergoing an epidemiological transition. The National Survey of Health and Nutrition 2006 (ENSANUT 2006) showed that overweight and obesity were already prevalent in the general population, as they were observed in 5% of children <5 years of age, in 26% of school age children (6-12 years old) and 33.3% of adolescents. On the other hand, malnutrition decreased if compared with national surveys of the previous decade, with a prevalence of 5% for underweight, 12.7% for short height and 1.6% for wasting.[9] In the National Survey of Health and Nutrition 2012 (ENSANUT 2012), prevalence of overweight and obesity was higher than in 2006: 9.7% in children under 5 years old, 34.4% in 6-12 y.o. children (overweight 19.8% and obesity 14.6%) and 35% in adolescents. Likewise, malnutrition kept its decreasing trend, especially in children under 5 years old with a prevalence of 2.8% for underweight, 13.6% for short stature and 1.6% for wasting.[10]

The epidemiological change of nutritional status of Mexican children is clearly reflected in the contrast between the surveys of 2006 and 2012, with a strikingly higher frequency of overweight and obesity in the latest. Also, this could be reflected in the nutritional status of children on admission to the PICU, not only by the increase in the prevalence of overweight and obesity in the population itself, but because children with complex chronic illnesses survive longer due to new treatments, and many develop overweight or obesity as side effects of their treatment. Therefore, the objective of this study was to evaluate the nutritional status according to the Z score of body mass index (BMI) of children in critical condition on admission to the PICU at the Hospital Infantil de México Federico Gómez (HIMFG).

SUBJECTS AND METHODS

This retrospective study was conducted in the PICU of HIMFG from November 2002 to December 2007. With an agreement established since 2000 between the areas of PICU and HIMFG Nutrition Service, nutritionists are working in medical intensive care and surgical units with the aim to assess the nutritional status and provide support to patients during their hospital stay. Each patient had an anthropometric evaluation by trained personnel and equipment standardized for height and weight according to their clinical condition at that time. All data were recorded on tracking sheets specifically designed for this purpose from the time of patient admission until discharge from the PICU. To carry out this study we used the information from these tracking sheets. All data for this study were verified with data from the medical records. The anthropometric indicator according to WHO (WHO-Anthro) was used to diagnose the nutritional status in children under 2 years old[11] and anthropometric indicators from the Centers for Disease Control and Prevention (CDC 2000) for BMI Z score (standard deviation of BMI for age and gender) for children older than 2 years up to 20 years old.[12] When patients could not be weighed or measured due to the seriousness of their conditions, or in cases in which anthropometry was not determined by standardized personnel, weight and height recorded in the clinical files was used. Patients readmitted 15 days or later were considered to be new patients. A database using SPSS for Windows v.17 was designed *ad hoc*. The database was reviewed to identify missing and inconsistent data and was completed. Anthropometric indicators were obtained from the anthropometric data of the patients. The database was converted from SPSS to statistical program EPI-INFO 3.5.1-2008. Anthropometric indicators were then obtained for age and gender using the WHO-Anthro program available on the website of the WHO, which adjusts for the presence of edema to the BMI Z score as follows: a) eutrophic: BMI $\geq$0.9 to +1.0; b) risk of malnutrition: BMI from -1 to $\leq$ -2; c) malnourished: BMI $\leq$ -2; d) overweight: BMI 1.01–1.99; e) obesity: BMI $\geq$2.[13,15] Finally, we excluded cases with data located at the extremes in accordance with the provisions of the 2006 and 2012 ENSANUT[9,10] because these points will be considered invalid. Accordingly, values of BMI Z score beyond -4.20 or beyond +5.00 were excluded.

In accordance with the Helsinki Declaration (2008) and the Regulations of the General Health Law in Health Research (Chapter 17),[16,17] the study was considered without risk due to the retrospective design. Patient records were kept anonymous and confidentiality was ensured by

assigning each patient a consecutive number. The protocol was approved by the Ethics Committee of the HIMFG.

RESULTS

The total study population was 3,196 patients. For the analysis of nutritional status, patients were divided into two groups: infants up to 24 months old (40.2%) and those older than 2 years (59.8%) (Figure 1).

Of 1,285 children up to 2 years of age, 1,031 had complete data for weight and height (80.23%). Cases with extreme data were excluded in accordance with the provisions of the 2006 and 2012 ENSANUT.[9,10] Hence, the final sample of subjects up to 2 years of age was 904 (Figure 1). Of 1,911 patients older than 2 years, 1,788 patients (93.5%) had complete data for weight and height. After excluding the cases with extreme data, the final sample of children >2 years of age was 1,612 cases (Figure 1). No referred weight or height was employed in this study.

To determine the prevalence of nutritional status, patients were grouped according to age as follows: up to 2 years old, >2 up to 4 years, from 5 to 11 years old, and adolescents ≥12 years. The results were as follows: for 2 years of age and younger, malnutrition 36.2% (*n* =327), risk of malnutrition 24.1% (*n* =218), eutrophic 30.2% (*n* =273), overweight 4.6% (*n* =42) and obesity 4.9% (*n* =44). For the group >2 up to 4 years, malnutrition 24.2% (*n* =111), risk of malnutrition 22.1% (*n* =99), eutrophic 40.4% (*n* =181), overweight 9.2% (*n* =41) and obesity 7.6% (*n* =34). In the 5- to 11-year-old children, the results were malnutrition 16.1% (*n* =109), risk of malnutrition 16.8% (*n* =114), eutrophic 45.3% (*n* =307), overweight 16.1% (*n* =109) and obesity 5.8% (*n* =39). Finally, for those >12 years of age, 16.2% (*n* =76) had malnutrition, 16.9% (*n* =79) risk of malnutrition, 49.1% (*n* =230) eutrophic, 15.6% (*n* =73) overweight and 2.1% (*n* =10) obesity. Prevalence of the nutritional status of girls (Figure 2) and boys (Figure 3) is shown on admission to the PICU by categories of BMI Z score and age.

DISCUSSION

As expected, this study found that a high prevalence of malnutrition remains; however, it was also observed that overweight and obesity are present on admission of pediatric patients in critical condition to the PICU, regardless of age and gender.

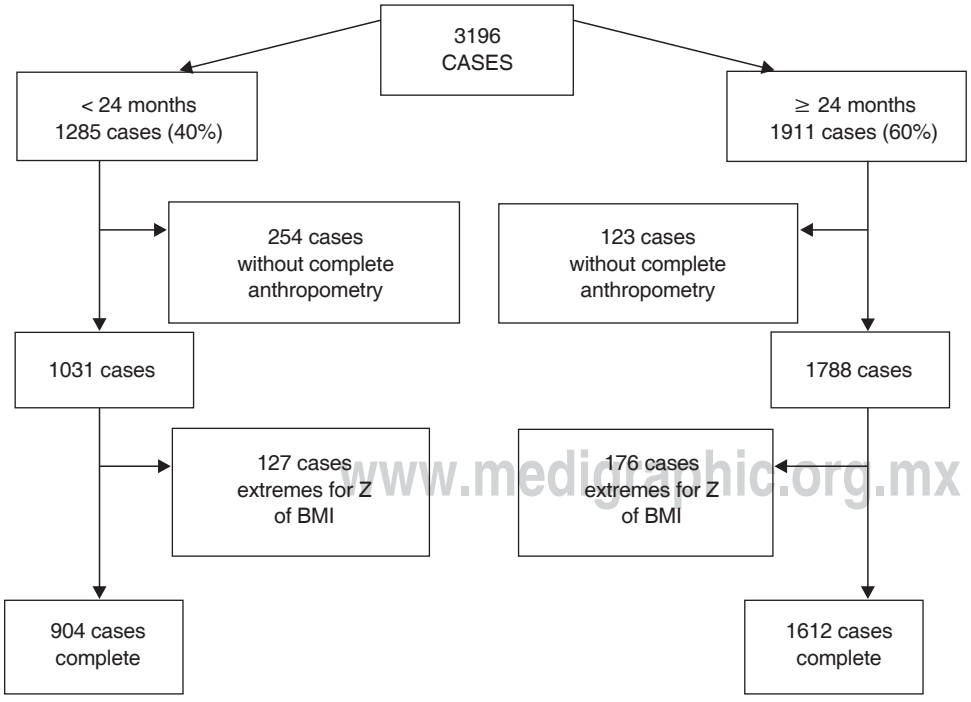

Figure 1.

Study population.

In subjects up to 2 years of age, the prevalence of malnutrition according to BMI Z score was high (36%), regardless of gender. This prevalence of malnutrition is higher than reported in the ENSANUT 2006 and adjusted according to the WHO tables,[18] although the indicators that were taken at that time were height for age (expense or detriment) with 16.1% and weight for age (wasting) with 1.6%. This finding is explained by the prevalence found in the general population and the type of severe, chronic and acute illnesses that are treated at the PICU of the referral hospitals such as HIMFG. Overweight (4.6%) and obesity (4.9%) were also observed in this group of patients, regardless of gender. This is consistent with the 10.8% rate of overweight and obesity reported in ENSANUT 2006 adjusted by tables from the WHO.[18] This is important because it means that, on admission to the PICU, at least one in ten children 2 years of age or younger are overweight/obese. This fact could completely change the epidemiology of patients admitted at the present time to PICU and contrasts with the type of patients that were admitted some years ago.

By combining the prevalence in children <5 years of age, we found that on admission to the PICU, malnutrition occurred in 30%, twice that reported in the ENSANUT 2006. On the other hand, overweight/obesity was found in 6.25% of those admitted to the PICU, which is somewhat higher than the prevalence of 5% reported by ENSANUT 2006.

For children 5-11 years old, the prevalence of malnutrition according to the Z score of the BMI was 16%, 5% more than reported by ENSANUT 2006. For overweight and obesity, the prevalence was 21.9%, similar to the 26% prevalence reported by the ENSANUT 2006.

In the group of children ≥12 years, the prevalence of malnutrition on admission to the PICU was 16.9%, 4% more than reported according to the ENSANUT 2006. Regarding overweight/obesity, we found a frequency of 17.7%, half of what was shown in the ENSANUT 2006. Although malnutrition is still present in the group of subjects ≥12 years of age, it is important to note that there was overweight/obesity in almost two of every ten adolescents entering the PICU. It is very likely that they may present several associated comorbidities, which may have some influence or even change future decision making regarding equipment, carrying out invasive procedures, drug calculations and various therapeutic interventions including nutritional support.

It should be noted that although there were no significant differences in the prevalence of nutritional status by gender at admission to the PICU, it is noteworthy that in the group of girls between 6 and 11 years old, there was a 10% higher prevalence of malnutrition and 5% less obesity compared with boys.

National surveys such as the ENSANUT mention that for the analysis of anthropometric indicators it is necessary to select only those whose values are "valid", i.d., for Z of BMI Z score between -4.20 and +5.00. All values beyond these figures are considered "not valid." Whereas this requirement would be necessary for the surveys, in pediatric populations as sick as the one analyzed in the PICU in this study, all children who were out of this range of BMI Z scores were "real." For this reason, this type of subpopulation warrants further future investigation.

It is difficult to compare the prevalence of nutritional status among different PICUs, both domestically and internationally because the populations may not be entirely

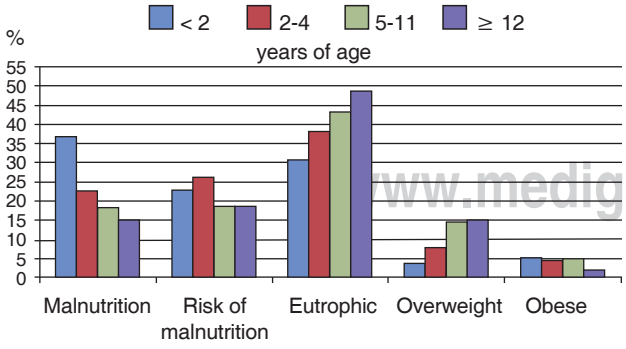

Figure 2. Nutritional status in girls according to category and age group (*n* =1,166).

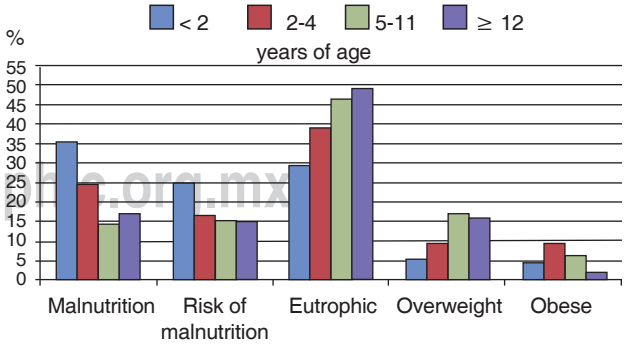

Figure 3. Nutritional status in boys according to category and age group (*n* =1,350).

comparable. It also contributes poorly defined admission criteria, variables from one unit to another, open or closed working system, the type of serious diseases prevalent in the community it serves, etc. In general, critical care units report malnutrition more frequently. In this study, the prevalence of malnutrition in the whole population was 16%, which is consistent with the results of Pollack et al. (15-20% prevalence),[5] whereas it is considerably lower than that reported by Hulstet al. (65% prevalence)[6] and by the Brazilian study of Leite et al. (24% prevalence).[7] However, the prevalence of malnutrition according to age group is higher in the most vulnerable children, i.e., 36% in patients 2 years old and younger. As in the study of Mesquita et al. conducted in Paraguay,[8] we already found overweight and obesity in the group of children 2 years and younger. Moreover, prevalence was even higher in all groups of children older than 2 years. This is consistent with the results of the study conducted in Brazil by De Souza-Menezes et al. (18%)[19] although not as high as the data of ENSANUT 2006 and 2012.

It is clear that, gradually, as a result of the epidemiological change that occurs in the general population, overweight and obesity are presenting more frequently in health institutions in Mexico.[20] The consequence is that an increase of admissions of children with these characteristics to the PICU should be expected. Health problems inherent to being overweight or obese are now added to the high complexity of serious chronic diseases, posing a new range of challenges faced by the pediatrician and the pediatric critical care specialist, i.e., chronic diseases such as obesity, type 2 diabetes, metabolic syndrome, dyslipidemia, etc. that used to be almost exclusive to adults and are now also present in children. This suggests that, in the near future, studies should be carried out to determine if these associations do exist and how they present and their potential impact on several common therapeutic interventions and on the approach to the prevention and management of comorbidities in critically ill patients. Together, the above information mandates us to consider adopting new and specific measures for the care of this subpopulation of patients at the PICUs.

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