Nutr Hosp. 2017; 34(1):41-50 ISSN 0212-1611 - CODEN NUHOEQ S.V.R. 318

Nutrición Hospitalaria

Trabajo Original

Pediatría

Risk of malnutrition of hospitalized children in a university public hospital

Riesgo de desnutrición en niños hospitalizados en un hospital público universitario

Nelly Carolina Muñoz-Esparza[1], Edgar Manuel Vásquez-Garibay[1,2], Enrique Romero-Velarde[1,2] and Rogelio Troyo-Sanromán[1]

[1]Instituto de Nutrición Humana. Universidad de Guadalajara. Guadalajara, México. [2]Hospital Civil de Guadalajara Dr. Juan I. Menchaca. Guadalajara, México

Abstract

Objective: The study aimed to demonstrate that the duration of hospitalization has a significant effect on the nutritional status of children treated in a university hospital.

Methods: A longitudinal study was conducted during 2014, with a non-random sampling site concentration in children from birth to 19 years who were admitted to the hospital in the past 24 hours and who met the inclusion criteria and had signed informed consent. Upon entering, at 7 days, and at discharge, anthropometric indices, including weight/age, height/age, weight/height, BMI/age, head circumference/age, triceps and subscapular skin folds, and fat percentage, were obtained. Student's t-test, U Mann–Whitney, ANOVA, chi square, Wilcoxon, and odds ratios were used to analyze the data.

Results: In total, 206 patients were included: 40% infants, 25% preschoolers, 15% schoolchildren, and 20% teenagers. Infants had a significant improvement from admission to discharge in the indices weight/length ($p = 0.042$) and BMI ($p = 0.002$); adolescents showed decreased BMI from admission to discharge from the hospital ($p = 0.05$). Patients with longer hospitalization (more than 10 days) had an increased deficit in anthropometric indices at admission ($p < 0.05$). Infants had a higher risk of deficit in the BMI index and height/age than preschoolers, schoolchildren, and adolescents between admission and discharge.

Conclusion: When the nutritional condition of a child was critical at admission, the child remained hospitalized significantly longer. Infants come under the age group most vulnerable to malnutrition and require greater monitoring of nutritional status during hospitalization.

Key words:

Nutritional status. Malnutrition. Hospitalized child.

Resumen

Objetivo: demostrar que la duración de la hospitalización tiene un efecto significativo sobre el estado nutricional de niños internados en un hospital para población general.

Métodos: estudio longitudinal llevado a cabo durante 2014 en niños con edades comprendidas desde el nacimiento hasta los 19 años, ingresados en un hospital público en las últimas 24 horas. Al ingreso, a los 7 días y al alta hospitalaria se obtuvieron los índices antropométricos peso/edad, talla/edad, peso/talla, IMC/edad, circunferencia cefálica/edad, pliegues cutáneos tricipital y subescapular y el porcentaje de grasa. Para el análisis de datos se utilizaron las pruebas t de Student, U Mann-Whitney, ANOVA, Chi-cuadrado, Wilcoxon y razón de momios.

Resultados: se incluyeron 206 pacientes: 40% lactantes, 25% preescolares, 15% escolares y 20% adolescentes. Los lactantes tuvieron una mejoría significativa desde el ingreso al alta en los índices peso/talla ($p = 0,042$) y el IMC ($p = 0,002$); los adolescentes mostraron una disminución del IMC desde el ingreso hasta el alta del hospital ($p = 0,05$). Hubo mayor déficit en los índices antropométricos al ingreso en pacientes con una hospitalización superior a 10 días ($p < 0,05$). Entre el ingreso y el alta, los lactantes tuvieron un riesgo mayor de déficit en el índice talla/edad y en el IMC que los niños preescolares, escolares y adolescentes.

Conclusión: cuando la condición nutricia del niño fue crítica al ingreso, permaneció hospitalizado por un periodo significativamente más largo. Los lactantes fueron el grupo etario más vulnerable a la desnutrición y requieren de mayor vigilancia del estado nutricio y la alimentación durante la hospitalización.

Palabras clave:

Estado nutricional. Desnutrición. Niños hospitalizados.

Received: 03/06/2016
Accepted: 10/10/2016

Correspondence:

Edgar M. Vásquez Garibay. Instituto de Nutrición Humana. Hospital Civil de Guadalajara Dr. Juan I. Menchaca. Salvador Quevedo y Zubieta, 350, Col. Independencia. 44340 Guadalajara, Jalisco. México
e-mail: vasquez.garibay@gmail.com

Muñoz-Esparza NC, Vásquez-Garibay EM, Romero-Velarde E, Troyo-Sanromán R. Risk of malnutrition of hospitalized children in a university public hospital. Nutr Hosp 2017;34:41-50

DOI: http://dx.doi.org/10.20960/nh.974

INTRODUCTION

Children are characterized by a high demand for nutrients due to the process of growth and development, particularly during the windows of accelerated growth (stages of infancy and puberty) (1). When a child is hospitalized, the risk of malnutrition can be exacerbated for several reasons:

- Severity of clinical conditions associated with pathological processes that led to hospitalization or admission to intensive care units (2).
- The use of medication that may alter the intake and/or metabolism of nutrients.
- Insufficient food intake due to clinical conditions or stress (prolonged fasting).
- Increase in demand for nutrients.
- Excessive loss of nutrients (1-3).

The nutritional status may be affected by hospitalization, especially if it occurs for prolonged periods (4,5); the frequency of weight loss during hospitalization is common in the pediatric population, between 7% and 51% of hospitalized patients in many hospitals worldwide (6).

Patients admitted to the hospital with some degree of (moderate/severe) malnutrition remain unchanged during hospitalization (4), whereas patients with adequate nutritional status at admission deteriorate at discharge (5-11). In Mexico, there are few studies that have explored this issue. In a study in premature newborns with very low birth weights, 44% admitted to a neonatal intensive care unit were undernourished, and at discharge this increased to 67% (12). Therefore, the purpose of the present study was to demonstrate that the duration of hospitalization has a significant adverse effect on the nutritional status, according to the age group they belong to and their pathologies at admission and discharge.

METHODS

In a longitudinal study of the subject as its own control, with a non-random sampling, 761 patients hospitalized in the clinical wards of the Division of Pediatric Hospital Civil de Guadalajara Dr. Juan I. Manchaca were included in a period of 9 months. All participants who entered in the past 24 hours daily, Monday to Friday, to any of the following wards were included: infants, preschools, schoolchildren (13), infectious diseases, pneumology, neurology, intermediate care, surgery, gastroenterology, and onco-hematology. Those who spend less than 72 hours in the emergency room and whose parents or legally responsible person signed the informed consent were selected. Patients hospitalized in the infant nutrition unit, burn unit, intensive care unit, or nephrology unit, children with cerebral palsy and those who could not take anthropometric measurements, and those who were re-hospitalized in less than three months were not included. The reason was to avoid difficulties in providing the effect of hospitalization on the nutritional status of children with frequent diseases. Patients were excluded if they were discharged before the seven days of hospitalization, if they worsened, if they were transferred to an intensive care unit, and if their records had incomplete data. Ultimately, the sample was 206 patients. Each participant (or family) was filled out a questionnaire, which included general identification and socio-demographic data. To estimate the sample size with a 95% confidence interval, $\alpha = 0.05$ and β power of 0.80 were used. The mean of the prevalence of undernutrition of weight/stature (10%), weight/age (18%), stature/age (21%) and BMI (14.7%) was estimated from the study of Moraes et al. (10). The calculated sample size was 242 participants.

ANTHROPOMETRIC MEASUREMENTS

According to previous standardization of two observers to the method of Habitch (14), the following measurements were taken: weight of children under 24 months, without clothes, on a scale with a capacity of 20 kg and a readability of 5 g (Seca-354, Hamburg, Germany); in children older than 24 months, in short trouser and/or coat, on a scale with a minimum reading of 100 g (Tanita UM-081, Tokyo, Japan). Length of participants less than 24 months of age was obtained without clothes in an infantometer (Seca-416, Hamburg, Germany); height of participants over 24 months of age was performed with a graduated scale (Seca-214, Hamburg, Germany) without shoes, with the tip of their feet slightly apart and their heels together, and head, shoulders, buttocks, and heels aligned vertically.

The measuring of head circumference was made in infants less than three years old, was obtained with a metallic tape measure (Rosscraft, USA). The tape was firmly applied around the head in the supraciliar region, so that it went by the most prominent part of frontal area and occipital protuberance. Medium upper arm circumference (MUAC) was obtained with the same metal tape measure; it was held in the middle of the left arm. The triceps skinfold (TSF) was taken in the inner back of the middle part of the previously marked arm; subscapular skinfold (SSF) was taken at the lower edge of the scapula. Both measurements were performed on the left arm with a Lange skinfold caliper (Michigan, USA). The anthropometric measurements were performed on admission, at 7 days and at hospital discharge.

With the anthropometric measurements, Z score of the indices weight/length, weight/height, weight/age, length/age, height/age, head circumference/age, and body mass index for age (BMI/age) were estimated. The program WHO Anthro version 3.2.2 and version 1.0.4 Plus were used (15,16). They were taken as reference normal limits marking the WHO ± 2 standard deviation (SD). Children under 5 years were considered overweight at > +2 SD and obese at > +3SD, and at five years and older, overweight at > +1 SD and obese at > +2 SD. With the TSFs and SSFs, the percentage of body fat with the equation of Slaughter (17) was also estimated. The treating physician, according to the dietary department and the correspondent age group, prescribed the diet received by patients.

STATISTICAL ANALYSIS

For comparison of means of the subject as their own controls, the Wilcoxon test was used. For quantitative variables of independent samples, Student's *t*-test, U Mann-Whitney, and ANOVA were also used. As post-hoc tests, repeated measures with the Bonferroni test were also obtained. For qualitative variables, chi-square test and Wilcoxon test were used. The odds ratio (OR) and its 95% confidence interval (CI) were estimated to identify the likelihood of epidemiological meaning. SPSS software version 20 was used.

ETHICAL CONSIDERATIONS

The research protocol was reviewed and approved by bioethics committees and research Hospital Civil of Guadalajara Dr. Juan I. Menchaca, with the registration number in the Ministry of Health of Jalisco: 1342-1314.

RESULTS

Table I shows the percentage of patients admitted to the hospital according to the age group and clinical ward. The study group of 206 patients (52% girls) with at least two measurements were included. Predominant diagnoses were of internal medicine (26.2%), pneumology (25.2%), oncology (11.7%), and surgical conditions (11.2%); and to a lesser extent were infection diseases (6.8%), neurology (8.7%), gastroenterology (6.8%), and without diagnosis (4.4%). The total sample was stratified into two groups: group 1 ($n = 160$) patients realized two anthropometric measurements, and their hospitalization ranged between 7 and 10 days (9.7 ± 3 d). Group 2 ($n = 46$) comprised patients who had three anthropometric measurements, and their hospitalization was longer than 10 days (20.7 ± 10.6 d).

Table II shows the anthropometric measurements of groups 1 and 2 according to age groups. In both groups, infants improved, with the exception of percentage of body fat in the first group, and adolescents tended to nutritional deterioration during the hospital stay. Regarding the anthropometric indices of weight/age, height/age, weight/height, BMI, and head circumference (Z), infants showed greater deficits at admission and improved during hospitalization. In adolescents, a significant decrease in BMI (z) during the hospital stay was observed; it was more evident in group 2 (Table III). In group 2 patients, whose hospital stay was longer than 10 days, anthropometric indices at hospital admission were more affected compared with group 1, whose hospital stay was less than 10 days.

At admission, in group 1 (discharge at 7-10 days), the deficits in height/age index ($p = 0.030$), head circumference ($p = 0.028$), and BMI ($p = 0.001$) were higher in infants *versus* preschoolers; at seven days, the deficit in BMI was also higher in infants *versus* preschoolers ($p = 0.033$). At admission, there was also a higher deficit in the height/age index ($p < 0.001$) in infants *versus* schoolchildren and in infants *versus* adolescents ($p = 0.03$); and there were also higher deficits in BMI ($p = 0.004$) at admission and at 7 days ($p = 0.014$) in infants *versus* adolescents. At admission, there were also higher deficits in the height/age index in preschoolers than in schoolchildren ($p = 0.047$).

Table I. Percentage of admission to the hospital according to the age group and clinical ward

Variable	Whole population n = 761		Study population n = 206	
	Frecuency	Percentage	Frecuency	Percentage
Age group				
Infants	238	31	83	40
Preschooler	221	29	51	25
Schoolchildren	172	23	31	15
Adolescents	130	17	41	20
Clinical ward				
Infants	51	6.7	13	6.3
Preschooler	70	9.1	23	11.2
Schoolchildren	122	16	31	15
Infectology	46	6	18	8.7
Intermediate therapy	43	5.7	10	4.9
Neumology	132	17.3	40	19.4
Neurology	41	5.4	3	1.5
Surgery	133	17.5	32	15.5
Gastroenterology	22	2.9	7	3.4
Onco-hematology	101	13.3	29	14.1

Table II. Anthropometric measurements according to study group (1 and 2) and age group during hospitalization

Variables	Time of measure	n	Infants X ± SD	n	Preschoolers X ± SD	n	Schoolchildren X ± SD	n	Adolescents X ± SD	p*
Group 1 (discharge at 7 to 10 days)										
Age (months)	Admission	72	6.26 ± 4.5	37	47.2 ± 15.7	27	107.4 ± 16.5	24	173 ± 17.9	NA
Weight (kg)	Admission	72	6.08 ± 2.3^{1}	37	14.7 ± 3.4	27	27.6 ± 9.6	24	51.1 ± 13.3	^{1}p = 0.006
	7 days	72	6.15 ± 2.3^{1}	37	14.6 ± 3.6	27	27.3 ± 9.5	24	50.5 ± 13	
Height (cm)	Admission	72	62.7 ± 9	37	98.5 ± 10.4	27	130.6 ± 9.3	24	159 ± 10	NA
BMI (kg/m^2)	Admission	72	14.7 ± 2.5^{2}	37	15.0 ± 1.4	27	15.8 ± 3.5	24	20 ± 4.2	^{2}p = 0.003
	7 days	72	15.0 ± 2.4^{2}	37	14.9 ± 1.3	27	15.7 ± 3.5	24	19.8 ± 4.2	
Head circumference (cm)	Admission	70	40.3 ± 4.2	10	48.1 ± 1.9	–	–	–	–	p > 0.05
	7 days	70	40.6 ± 4.2	9	48.1 ± 2.0	–	–	–	–	
MUAC (cm)	Admission	72	11.5 ± 2.2	37	14.8 ± 1.8^{3}	27	18.2 ± 3.9^{4}	24	23.9 ± 4.1	^{3}p = 0.004
	7 days	72	11.5 ± 2.2	37	14.5 ± 1.6^{3}	27	17.9 ± 3.8^{4}	24	23.7 ± 4.3	^{4}p = 0.001
TSF (mm)	Admission	72	7.2 ± 3	37	8.2 ± 2.6	27	11.6 ± 6.5^{5}	24	15.0 ± 7.2	^{5}p = 0.015
	7 days	72	7 ± 2.3	37	7.8 ± 2.7	27	10.9 ± 6.2^{5}	24	14.9 ± 7.5	
SSF (mm)	Admission	72	5.7 ± 2.3	37	5.3 ± 1.8	27	8.0 ± 5.5	24	13.1 ± 6.3^{6}	^{6}p < 0.001
	7 days	72	5.4 ± 2	37	5.0 ± 1.7	27	7.6 ± 4.6	24	11.3 ± 5.2^{6}	
Body fat %	Admission	72	12.3 ± 5^{7}	37	13.1 ± 4	27	17.4 ± 9.1	24	23.8 ± 8.9^{8}	^{7}p = 0.025
	7 days	72	11.8 ± 4.6^{7}	37	12.3 ± 3.9	27	16.6 ± 8.5	24	22.6 ± 8.7^{8}	^{8}p < 0.001
Group 2 (discharge > 10 days)										
Age (months)	Admission	11	3.6 ± 2.7	14	38.2 ± 17	4	124 ± 7.9	17	174.5 ± 15.4	NA
Weight (kg)	Admission	11	4.7 ± 1.9	14	13.4 ± 5.4	4	36.5 ± 13	17	47.7 ± 13.4^{1}	^{1}p = 0.044
	Discharge	11	4.8 ± 1.8	14	13.2 ± 5	4	35.4 ± 12.5	17	46.7 ± 12.6^{1}	
Height (cm)	Admission	11	57.7 ± 7.7 ^{2}	14	93.5 ± 14.1	4	141.6 ± 5.4	17	158 ± 12.2	^{2}p = 0.001
	Discharge	11	58.7 ± 7.5 ^{2}	14	93.8 ± 14	4	140.8 ± 5.6	17	158.2 ± 12.4	
BMI (kg/m^2)	Admission	11	13.5 ± 2.3	14	14.6 ± 2.1	4	18.2 ± 5.2	17	19 ± 4.7^{3}	^{3}p = 0.017
	Discharge	11	13.3 ± 2.6	14	14.5 ± 1.8	4	17.6 ± 5	17	18.5 ± 4.5^{3}	
Head circumference (cm)	Admission	11	38.2 ± 3.9 ^{4}	6	45.7 ± 2.6	–	–	–	–	^{4}p = 0.009
	Discharge	11	38.8 ± 3.9 ^{4}	6	46.0 ± 2.8	–	–	–	–	
MUAC (cm)	Admission	11	10.1 ± 1.9	14	13.9 ± 2.7	4	19.7 ± 6	17	23.2 ± 4.7^{5}	^{5}p = 0.002
	Discharge	11	10.1 ± 1.9	14	13.5 ± 2.2	4	19.8 ± 5.3	17	22.5 ± 4.6^{5}	
TSF (mm)	Admission	11	5.3 ± 2.1	14	6.7 ± 3.1	4	15.5 ± 11.9	17	14.7 ± 8.5^{6}	^{6}p = 0.002
	Discharge	11	5.7 ± 2.9	14	7.0 ± 2.7	4	16.4 ± 10.6	17	12.8 ± 7.5^{6}	
SSF (mm)	Admission	11	4.5 ± 1.7	14	5.1 ± 2.5	4	12.6 ± 10.3	17	11.6 ± 5.7	p > 0.05
	Discharge	11	4.5 ± 1.9	14	5.0 ± 1.4	4	12.6 ± 9.5	17	11.1 ± 5.6	
Body fat %	Admission	11	9.2 ± 4	14	11.2 ± 5.4	4	22.0 ± 15.7	17	21.9 ± 9.1^{7}	^{7}p = 0.025
	Discharge	11	9.5 ± 4.6	14	11.5 ± 3.9	4	23.1 ± 14.1	17	20.6 ± 8.8^{7}	

*MUAC: Medium upper arm circumference; TSF: Triceps skinfold; SSF: Subscapular skinfold; *With Wilcoxon test, comparison of repeated measures with the subject as its own control p < 0.05 significance unilateral.*

Table III. Anthropometric indices. Group 1 discharge between 7 and 10 days (two measurements); group 2 discharge > 10 days (three measurements)

Variables	Age group	n	Admission	7 days	Discharge (> 10 days)	p*
			X ± SD	X ± SD	X ± SD	
Weight/height (Z)	*Group 1*					
	Infants	71	-0.98 ± 1.67	-0.77 ± 1.69	–	p = 0.002
	Preschoolers	26	-0.48 ± 0.88[#]	-0.74 ± 0.98	–	p = 0.045
	Group 2					
	Infants	11	-1.56 ± 1.43	-1.41 ± 1.61[1]	-1.98 ± 1.97[1]	[1]p = 0.042
	Preschoolers	12	-1.40 ± 1.94[#]	-1.41 ± 1.72	-1.39 ± 1.60	p > 0.05
BMI/age (Z)	*Group 1*					
	Infants	72	-1.45 ± 1.84	-1.26 ± 1.83[&]	–	p = 0.002
	Preschoolers	37	-0.33 ± 1.05	-0.47 ± 1.02	–	p = 0.138
	Schoolchildren	27	-0.70 ± 1.84	-0.81 ± 1.84	–	p = 0.156
	Adolescents	24	-0.19 ± 1.61	-0.24 ± 1.55	–	p = 0.155
	Group 2					
	Infants	11	-2.42 ± 1.80	-2.27 ± 1.96[&]	-2.62 ± 2.17	p > 0.05
	Preschoolers	14	-1.02 ± 1.94	-1.05 ± 1.72	-0.89 ± 1.76	p > 0.05
	Schoolchildren	4	-0.14 ± 2.4	-0.11 ± 2.4	-0.46 ± 2.76	p > 0.05
	Adolescents	17	-0.77 ± 1.78[2]	-0.89 ± 1.73[2]	-0.98 ± 1.79	[2]p = 0.054
Height/age (Z)	*Group 1*					
	Infants	72	-1.67 ± 1.91	–	–	NA
	Preschoolers	37	-0.87 ± 1.28	–	–	NA
	Schoolchildren	27	-0.31 ± 0.89	–	–	NA
	Adolescents	24	-0.38 ± 1.26	–	–	NA
	Group 2					
	Infants	11	-2.50 ± 1.68	–	-2.11 ± 1.54	p = 0.005
	Preschoolers	14	-1.01 ± 1.71	–	-0.96 ± 1.66	p = 0.326
	Schoolchildren	4	-0.008 ± 1.03	–	-0.05 ± 1.07	p = 0.250
	Adolescents	17	-0.54 ± 1.34	–	-0.53 ± 1.39	p =0.387
Head circumference (Z)	*Group 1*					
	Infants	70	-1.49 ± 1.91	-1.26 ± 1.85	–	p < 0.001
	Preschoolers	10	-0.24 ± 1.45	-0.19 ± 1.57	–	p = 0.063
	Group 2					
	Infants	11	-2.17 ± 1.72[3,4]	-2.03 ± 1.73[3]	-1.86 ± 1.80[4]	[3]p = 0.004 [4]p = 0.048
	Preschoolers	6	-1.53 ± 1.83[5]	-1.37 ± 1.82	-1.32 ± 1.91[5]	[5]p = 0.031
Weight/age (Z)	*Group 1*					
	Infants	72	-1.93 ± 1.99	-1.82 ± 196[+]	–	p = 0.011
	Preschoolers	37	-0.77 ± 1.12	-0.87 ± 1.19	–	p = 0.120
	Schoolchildren	19	-0.80 ± 1.33	-0.88 ± 1.38	–	p = 0.205
	Group 2					
	Infants	11	-3.01 ± 1.90	-2.91 ± 1.98[+]	-2.96 ± 2.04	p > 0.05
	Preschoolers	14	-1.24 ± 2.15	-1.30 ± 1.95	-0.92 ± 2.10	p > 0.05
	Schoolchildren	1	-0.53 ± 0	-0.62 ± 0	-0.22 ± 0	p > 0.05

**With Wilcoxon test, comparison of repeated measures with the subject as its own control, p < 0.05 significance unilateral. Student's t-test for independent samples (group 1* vs. *group 2): [#]Weight/height in preschoolers at admission p = 0.026; [&]BMI at 7 days, p = 0.046; [+]Weight/age in infants at 7 days, p = 0.045; NA: non-applicable.*

In group 2 (discharge > 10 days), the deficits in the height/age index were higher in infants than in preschoolers at admission (p = 0.05) and at discharge (p = 0.014); the deficits of BMI were also higher at admission (p = 0.048), at seven days (p = 0.033), and at discharge (p = 0.023) in infants than in preschoolers. Major deficits occurred in infants *versus* schoolchildren in the height/age index at admission and at discharge (p = 0.007) and in BMI at admission (p = 0.045). There was also a higher deficit in height/age index at admission and at discharge (p < 0.005) and in BMI at admission (p = 0.018), 7 days (p = 0.030), and at discharge (p = 0.021) in infants *versus* adolescents.

Table IV shows the subjects and percentage of BMI (z) and height/age (z) according to the study groups (1 and 2) and age groups during hospitalization. In the total of group 1 according to BMI (n = 160, discharge at 7-10 days), there were differences at admission *versus* at discharge: severe malnutrition (13.8% *vs.* 10.6%), moderate malnutrition (8.1% *vs.* 11.3%), mild malnutrition (20% *vs.* 20%), normal BMI (44.4% *vs.* 45.6%), overweight (11.3% *vs.* 9.4%), and obesity (2.5% *vs.* 3.1%), respectively. In the total of group 2 (n = 46, discharge > 10 days), the following differences were observed at admission *versus* discharge: severe malnutrition (15.2% *vs.* 23.9%), moderate malnutrition (21.7% *vs.* 15.2%), mild malnutrition (23.9% *vs.* 21.7%), normal BMI (23.9% *vs.* 23.9%), overweight (8.7% *vs.* 10.9%), and obesity (6.5% *vs.* 4.3%), respectively. According to the height/age index in group 1 (n = 160, discharge at seven to 10 days), chronic malnutrition and/or linear growth retardation was observed in 20.7% and normal height in 79.4%. In group 2 (n = 46, discharge > 10 days), chronic malnutrition and/or linear growth retardation was observed in 19.5%, normal height in 78.2%, and higher height in 2.2%.

In the total population divided by the age group, it was observed that the risk of deficit in BMI at admission was higher in infants (38.6%) than in preschoolers (11.8%) (OR = 4.7 [95% CI 1.8, 12.3], p < 0.001); at 7 days in infants (34.9%) than in preschoolers (9.8%), (OR = 4.9 [95% CI 1.8, 13.8], p = 0.001) and at discharge in infants (72.7%) than in preschoolers (21.4%) (OR = 9.8 [95% CI 1.6, 61.6], p = 0.010). At admission, deficit in BMI among infants (38.6%) *vs.* schoolchildren (19.4%) (OR = 2.6 [95% CI 0.97, 7.1], p = 0.053); in infants (38.6%) *vs.* adolescents (19.5%), (OR = 2.6 [95% CI 1.1, 6.3], *p* = 0.033); and deficit in BMI at discharge in infants (72.7%) *vs.* adolescents (35.3%), (OR = 4.9 [95% CI 0.93, 25.7], p = 0.053). At admission, regarding the deficit in the height/age index, a frank trend to higher risk of deficit in infants (34.9%) than in preschoolers (19.6%) (OR = 2.2 [95% CI 0.96, 5], p = 0.058) was observed, and also in infants (34.9%) than schoolchildren (3.2%) (OR = 16.1 [95% CI 2.1, 124], p < 0.001), and infants (34.9%) than adolescents (4.9%) (OR = 10.5 [95% CI 2.4, 46.5], p < 0.001). At discharge, in infants (36.4%) than in adolescents (5.9%), (OR = 9.14 [0.86, 97.3], p = 0.039). Finally, the largest deficit was observed in the height/age index at admission in preschoolers (19.6%) than in adolescents (4.9%), (OR = 4.8 [95% CI 0.98, 23.1], p = 0.037).

Table V shows the average of the BMI/age index according to the discharge pathology at admission, seven days, and discharge in the study population (n = 206). By dividing the population by discharge pathologies, greater involvement of the BMI (z) at admission in diseases of respiratory and gastroenterology origin was observed. However, a deterioration of BMI during hospitalization in patients with surgical pathology, infection diseases, and neurological origin was observed, whereas patients with gastroenterological pathology tend to improve during hospitalization. With respect to the height/age index (z), greater involvement was seen in patients with diseases of the respiratory tract and infection diseases (Table VI).

DISCUSSION

This study, as in others, predominated hospitalized infants (4,18). When comparing group 1 (discharge between 7 and 10 days) with group 2 (discharge > 10 days), it was observed that since hospital admission, group 2 showed greater deficits in both indicators expressing an acute deficit (weight/height and BMI) and those expressing a chronic failure (height/age and head circumference) in the nutritional status. At admission, in both study groups, infants were the age group that was most affected in their nutritional status. The primary cause of the deficit of these indicators could be due to a chronic food insufficiency, frequent respiratory and/or digestive infections, or the combination of both factors (19). It seems that as a child gets older, indicators of chronic deficit tend to normalize and acute deficit indicators virtually disappear, as noted in the National Survey of Health and Nutrition in Mexico (20,21).

Infants were the age group that significantly improved their anthropometric indicators (weight/height, BMI, height/age, and head circumference) during the hospital stay. It is likely that the apparent improvement in the nutritional status observed during the first seven days of hospitalization was due to the redistribution of fluids and correction of electrolyte imbalance. In schoolchildren and predominantly in adolescents, a gradual and significant difference between anthropometric values at admission, seven days, and discharge, particularly in BMI (p = 0.054), was observed. It was noted that at admission, infants had a 2.6 times greater probability of acute deficit that schoolchildren and teenagers. This probability of higher deficit in infants than schoolchildren disappeared in the following measurements. Comparing infants *versus* schoolchildren, at admission and 7 days, there was a probability 16 times higher in infants' deficit in this index. When comparing the percentage of children with a deficit in the height/age index among infants and adolescents, deficits in infants are approximately 10 times more likely.

It has been noted that the deficit in head circumference is an indicator of chronic malnutrition that seems more sensitive than the height/age index (22). In our study, in infants and preschoolers, there was a deficit in head circumference significantly greater at admission than discharge. This deficit was higher in infants than in preschoolers at admission, at 7 days, and at discharge. It is important to emphasize that in both age groups, one of three children had a head circumference below -2 SD, with implications of a smaller size of the brains and in cognitive development (23).

Table IV. Subjects and percentage (%) of BMI (Z) and height/age (Z) according to the study group (1 and 2) and age group during hospitalization

Variable	Time at measure	n	< -3 SD	> -3 SD to -2 SD	> -2 SD to < -1 SD	> -1 SD to < +1 SD	> +1 SD to < +2 SD	> +2 SD
Body mass index								
Group 1 (discharge at 7 to 10 days)								
Infants	Admission	72	17 (23.6)	8 (11.1)	13 (18.1)	28 (38.9)	6 (8.3)	–
	7 days	72	14 (19.4)	8 (11.1)	12 (16.7)	32 (44.4)	4 (8.3)	–
Preschoolers	Admission	37	–	2 (5.4)	7 (18.9)	24 (64.9)	4 (10.8)	–
	7 days	37	–	2 (5.4)	10 (27)	21 (56.8)	3 (8.1)	1 (2.7)
Schoolchildren	Admission	27	3 (11.1)	2 (7.4)	9 (33.3)	8 (29.6)	3 (11.1)	2 (7.4)
	7 days	27	2 (7.4)	6 (22.2)	6 (22.2)	9 (33.3)	2 (7.4)	2 (7.4)
Adolescents	Admission	24	2 (8.3)	1 (4.2)	3 (12.5)	11 (45.8)	5 (20.8)	2 (8.3)
	7 days	24	1 (4.2)	2 (8.3)	4 (16.7)	11 (45.8)	4 (16.7)	2 (8.3)
Group 2 (discharge > 10 days)								
Infants	Admission	11	4 (36.4)	3 (27.3)	1 (9.1)	3 (27.3)	–	–
	Discharge	11	6 (54.5)	2 (18.2)	–	2 (18.2)	1 (9.1)	–
Preschoolers	Admission	14	2 (14.3)	2 (14.3)	4 (28.6)	4 (28.6)	1 (7.1)	1 (7.1)
	Discharge	14	2 (14.3)	1 (7.1)	5 (35.7)	5 (35.7)	–	1 (7.1)
Schoolchildren	Admission	4	–	1 (25)	1 (25)	–	1 (25)	1 (25
	Discharge	4	1 (25)	–	1 (25)	–	2 (50)	--
Adolescents	Admission	17	1 (5.9)	4 (23.5)	5 (29.4)	4 (23.5)	2 (11.8)	1 (5.9)
	Discharge	17	2 (11.8)	2 (23.5)	4 (23.5)	4 (23.5)	2 (11.8)	1 (5.9)
Height/age								
Group 1 (discharge at 7 to 10 days)								
Infants	Admission	72	16 (22.2)	8 (11.1)	19 (26.4)	27 (3.5)	2 (2.8)	–
Preschoolers	Admission	37	2 (5.4)	5 (13.5)	11 (29.7)	17 (45.9)	2 (5.4)	–
Schoolchildren	Admission	27	–	1 (3.7)	5 (18.5)	21 (77.8)	–	–
Adolescents	Admission	24	1 (4.2)	–	6 (25)	13 (54.2)	4 (16.7)	–
Group 2 (discharge > 10 days)								
Infants	Admission	11	4 (36.4)	1 (9.1)	4 (36.4)	2 (18.2)	–	–
Preschoolers	Admission	14	2 (14.3)	1 (7.1)	1 (7.1)	9 (64.3)	–	1 (7.1)
Schoolchildren	Admission	4	–	–	1 (25)	2 (50)	1 (25)	–
Adolescents	Admission	17	1 (5.9)	–	4 (23.5)	11 (64.7)	1 (5.9)	–

Table V. Average of BMI/age index (Z score) according to the discharge pathology at admission, 7 days, and discharge in the total population (n = 206)

Time	BMI/AGE					
	n	Average	SD	Median	Minimum	Maximum
Surgical						
Admission	23	-0.39	1.65	0.02	-3.54	2.27
7 days	23	-0.74	1.56	-0.41	-4.21	2.11
Discharge	6	-1.29	2.32	-1.47	-3.76	2.04
Infectology						
Admission	12	-0.41	1.64	-0.21	-4.44	1.96
7 days	12	-0.38	1.65	-0.46	-4.31	1.98
Discharge	3	-2.44	1.96	-3.18	-3.92	-0.21
Internal Medicine						
Admission	54	-0.94	1.82	-1.03	-5.26	2.36
7 days	54	-0.92	1.88	-0.89	-6.31	2.34
Discharge	14	-1.02	2.17	-1.26	-5.63	1.86
Oncology						
Admission	24	-0.12[1,2]	1.32	-0.02	-2.46	2.50
7 days	24	-0.23[3]	1.42	-0.29	-2.98	2.23
Discharge	6	0.58	1.18	0.71	-1.21	2.05
Pneumology						
Admission	52	-1.59[1]	1.66	-1.36	-5.37	2.02
7 days	52	-1.40	1.56	-1.15	-5.89	2.01
Discharge	8	-2.77	1.74	-2.97	-5.55	0.04
Neurology						
Admission	18	-0.26[4]	1.78	-0.19	-5.05	2.41
7 days	18	-0.2[5]	1.64	-0.10	-4.30	2.46
Discharge	3	-1.92	0.62	-1.93	-2.54	-1.30
Gastroenterology						
Admission	14	-2.18[2,4]	2.10	-2.70	-5.35	1.32
7 days	14	-2.16[3,5]	1.89	-2.41	-4.77	1.40
Discharge	5	-1.12	2.07	-1.52	-4.13	1.20
Without diagnosis						
Admission	9	-0.98	1.46	-0.96	-3.90	0.61
7 days	9	-0.77	1.56	-0.79	-4.43	0.79
Discharge	1	-0.28	–	-0.28	-0.28	-0.28

One-way ANOVA and post-hoc *Bonferroni test to compare diagnosis: At admission: [1]Oncology* vs. *Pneumology, p = 0.016; [2]Gastroenterology* vs. *Oncology, p = 0.011; at 7 days: [3]Oncology* vs. *Gastroenterology, p = 0.021; [4]At admission: Neurology* vs. *Gastroenterology, p = 0.048; [5]At 7 days: Neurology* vs. *Gastroenterology, p = 0.036.*

The vast majority of patients presented diverse diseases of internal medicine (26%), pulmonology (25%), oncology (12%), and surgery (11%). Diseases of internal medicine had a very sparse character, with various diseases; however, this group emphasized a greater deficit in the indices of weight/height and BMI, which worsened progressively. Gastroenterology and pneumology patients were significantly more affected at admission and seven days than patients with cancer and neurological disorders. One reason could be that the gastroenterological patients were younger. Oncology patients, usually older, were more supervised from the medical and nutritional point of view because they were known in the hospital for months or years before.

Higher frequency of overweight and obesity in schoolchildren (14.8%) and adolescents (25%) at hospital discharge as

Table VI. Average height/age index (Z score) according to the discharge diagnosis at admission and discharge in the total population (n = 206)

Height/age						
	n	**Average**	**SD**	**Median**	**Minimum**	**Maximum**
Surgical						
Admission	23	-0.30[1]	1.21	-0.31	-2.16	1.87
Discharge	6	0.12	1.26	0.16	-1.38	2.07
Infectology						
Admission	12	-1.81	1.95	-1.59	-5.94	0.54
Discharge	3	-2.13	2.13	-1.10	-4.58	-0.72
Internal Medicine						
Admission	54	-0.85	1.51	-0.57	-4.88	1.49
Discharge	14	-0.64	1.23	-0.69	-3.88	1.20
Oncology						
Admission	24	-0.62	1.14	-0.71	-2.60	2.01
Discharge	6	0.11	1.02	-0.21	-0.60	2.15
Pneumology						
Admission	52	-1.74[1]	1.78	-1.53	-6.57	1.88
Discharge	8	-2.14	1.85	-1.96	-4.96	0.64
Neurology						
Admission	18	-0.88	1.76	-0.85	-5.62	1.68
Discharge	3	-2.35	1.80	-1.33	-4.43	-1.30
Gastroenterology						
Admission	14	-1.00	1.57	-0.66	-4.89	1.29
Discharge	5	-0.87	0.70	-0.46	-1.96	-0.31
Without diagnosis						
Admission	9	-1.24	2.11	-1.10	-5.48	0.86
Discharge	1	-3.18	–	-3.18	-3.18	-3.18

With one-way ANOVA and post-hoc *Bonferroni test to compare pathologies: height/age at admission: [1]Surgical* vs. *pneumology, p = 0.011.*

observed, whereas in infants and preschoolers, the frequencies of these entities were practically non-existent. The coexistence of hospitalized patients with acute and chronic malnutrition and overweight and obese patients reflects a nutritional transition phenomenon that is observed in virtually all states of the country (17,24,25).

Strengths: sex ratio was similar; participants were included during nine months of the year. Overall, no pronounced climatic variations among different seasons are found in this central west region of the country; the same number of participants, with two measurements, one at admission and other at seven days of hospitalization were included. *Limitations:* the size of observations by age group was variable: the largest number of participants were infants and the lowest were adolescents; patients with three measurements accounted for about 25% of participants; pathological diagnoses were grouped by hospitalization areas of the pediatrics clinical wards and might have a bias by age group.

In conclusion, our study showed that hospitalization has a significant effect on the nutritional status of children, sometimes favorable and sometimes not, as has been observed in other studies (4-11,17,26). In the study population that had longer hospital stays (longer than 10 days), they were significantly affected at admission in the anthropometric indicators that showed a deficit of acute and chronic nutritional status compared with those who stayed less than 10 days. Infants and preschoolers to a lesser extent had a greater effect on their nutritional status than schoolchildren and adolescents. This finding implies the need to closely monitoring infants that are hospitalized, due to their greater vulnerability to acute and chronic malnutrition. The study confirms that the nutritional status of children may be a predictor of the duration of hospitalization (26,27). Therefore, it is essential that every child who is hospitalized undergoes a proper assessment of nutritional status by trained professionals and that they participate in the appropriate dietary management that ensures optimal energy and nutrient intake according to the circumstances of each patient (26).

ACKNOWLEDGMENTS

We appreciate the work and collaboration of Martha Rivera during the fieldwork.

REFERENCES

1. Gomila AA, De Grandis ES, Visconti GB, et al. Estado nutricional en niños internados en Salas de Cuidados Mínimos. Hospital de Niños de la Santísima Trinidad, Córdoba. Arch Argent Pediatr 2009;107:37-42.
2. Corish CA, Kennedy NP. Protein-energy undernutrition in hospital in-patients. Brit J Nutr 2000;83:575-91.
3. Moreno Villares JM, Oliveros Leal L, Pedrón Giner C. Desnutrición hospitalaria en niños. Acta Pediatr Esp 2005;63:63-9.
4. Ferreira HS, França AO. Evolution of nutritional status in hospitalized children. J Pediatr (Rio J) 2002;78:491-6.
5. Waitzberg DL, Ravacci GR, Raslan M. Desnutrición hospitalaria. Nutr Hosp 2011;26:254-64.
6. Doğan Y, Erkan T, Yalvaç S, et al. Nutritional status of patients hospitalized in pediatric clinic. Turk J Gastroenterol 2005;16:212-6.
7. Kazem AI, Hassan MK. Effect of hospitalization on the nutritional status of under five children. Med J Basrah University 2011;29:51-6.
8. Durán P, Ramos O. Modificación en la situación nutricional durante la internación y factores asociados. Arch Argent Pediatr 2001;99:405-13.
9. Rocha GA, Rocha EJ, Martins CV. The effects of hospitalization on the nutritional status of children. J Pediatr (Rio J) 2006;82:70-4.
10. Moraes-Silveira CR, de Mello ED, Antonacci-Carvalho PR. Evolution of nutritional status of pediatric in patients of a tertiary care general hospital in Brazil. Nutr Hosp 2008;23:599-606.
11. Sarni RO, Carvalho MF, Monte CM, et al. Anthropometric evaluation, risk factors for malnutrition, and nutritional therapy for children in teaching hospitals in Brazil. J Pediatr (Rio J) 2009;85:223-8.
12. Larios-del Toro YE, Vasquez-Garibay EM, González-Ojeda A, et al. A longitudinal evaluation of growth outcomes at hospital discharge of very-low-birth-weight preterm infants. Eur J Clin Nutr 2012;66:474-80.
13. Ramos-Galván R. Crecimiento y desarrollo físicos. Cuadernos de nutrición 1984;1:17-32.
14. Habitch JP. Estandarización de métodos epidemiológicos cuantitativos sobre el terreno. Bol Oficina Sanit Panam 1974;76:375-84.
15. World Health Organization Web site. The WHO Child Growth Standards; 2006. http://www.who.int/childgrowth/standards/en/ Accessed November 12, 2013.
16. World Health Organization Web site. Growth reference data for 5-19 years; 2007 http://www.who.int/growthref/en/ Accessed November 12, 2013
17. Slaughter MH, Lohman TG, Boileau RE, et al. Skinfold equation for estimation of body fatness in children and youth. Hum Biol 1988;60:709-23.
18. Santafé-Sánchez LR, Sánchez-Rodríguez DA, Villegas-Galarza AL, et al. Nutritional status among hospitalized children with mixed diagnoses at a referral teaching hospital in Manizales, Colombia. Nutr Hosp 2012;27:1451-9.
19. Galván M, Amigo H. Programas destinados a disminuir la desnutrición crónica. Una revisión en América Latina. Arch Latinoam Nutr 2007;57:316-26.
20. Gutiérrez JP, Rivera-Dommarco J, Shamah-Levy T, et al. Encuesta Nacional de Salud y Nutrición 2012. Resultados Nacionales. Instituto Nacional de Salud Pública: Cuernavaca, México; 2012.
21. Rivera-Dommarco JA, Cuevas-Nasu L, González de Cosío T, et al. Desnutrición crónica en México en el último cuarto de siglo: análisis de cuatro encuestas nacionales. Salud Pública Méx 2013;55:161-9.
22. Ravasco P, Anderson H, Mardones F. Métodos de valoración del estado nutricional. Nutr Hosp 2010;3:57-66.
23. García-Alix A, Sáenz-de Pipaón M, Martínez M, Salas-Hernández S, Quero J. Utilidad del perímetro cefálico en el recién nacido para anticipar problemas en el neurodesarrollo. Rev Neurol 2004;39:548-54.
24. Vásquez-Garibay EM, Álvarez-Treviño L, Romero-Velarde E. Importancia de la transición nutricia en la población materno-infantil. Parte I. Experiencias en México. Bol Med Hosp Infant Mex 2009;66:109-23.
25. Macías-Rosales R, Vásquez-Garibay EM, Larrosa-Haro A, et al. Secondary malnutrition and overweight in a pediatric referral hospital: Associated factors. J Pediatr Gastroenterol Nutr 2009;48:226-32.
26. Moreno-Villares JM, Varea-Calderón V, Bousoño-García C. Malnutrición en el niño ingresado en un hospital. Resultados de una encuesta nacional. An Pediatr (Barc) 2016: http://dx.doi.org/10.1016/j.anpedi.2015.12.013
27. Hendrikse WH, Reilly JJ, Weaver LT. Malnutrition in a children´s hospital. Clin Nutr 1997;16:13-8.