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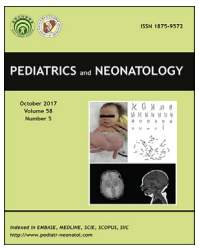

Original Article

The prevalence of undernutrition upon hospitalization in children in a developing country: A single hospital study from Malaysia

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Key Words
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Background: Undernourished children who require hospital care have a longer duration of hospitalization and respond poorly to modern medical therapy. The objective of the present study was to ascertain the nutritional status of children admitted to a pediatric tertiary center in Malaysia and the risk factors leading to undernutrition upon admission.
Methods: In this cross-sectional, hospital-based study, anthropometric measurements [weight, length/height, mid-upper arm circumference (MUAC), triceps skinfold thickness were performed in 285 children aged from 3 months to 15 years who were admitted to University Malaya Medical Centre, Kuala Lumpur in November 2013. Acute (wasting) and chronic (stunting) undernutrition were defined as weight-for-height (WFH) and height-for-age (HFA) < -2 standard deviation (S.D.), respectively. Underweight was defined as weight-for-age < -2 S.D. For children aged between 1 and 5 years of age, World Health Organization definition for acute undernutrition (HFA < -2 S.D. and/or MUAC < 12.5 cm) was also noted.
Results: Upon admission, the prevalence rates of acute and chronic undernutrition were 11% ($n = 32$) and 14% ($n = 41$), respectively. In addition, 7% ($n = 21$) had an MUAC of $<$ 12.5 cm, 15% had body-mass index < -2 S.D., and 7% ($n = 21$) had triceps skinfold thickness < -2 S.D., while 17% ($n = 47$) were underweight. Using the World Health Organization definition of acute undernutrition, an additional eight patients were noted to have acute undernutrition ($n = 40$, 14%). No significant risk factors associated with undernutrition were identified.
Conclusion: The prevalence of undernutrition among children admitted to a tertiary hospital in Malaysia was 14%. Strategies for systematic screening and provision of nutritional support in

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children at risk of undernutrition as well as treatment of undernutrition in children requiring hospitalization are needed.

1. Introduction

Undernourished children who require hospital care are at risk of staying for a longer duration in hospital and have a worse clinical outcome as compared to children with normal nutrition.[1–4] Undernutrition in hospitalized children is common in both resource-limited as well as resource-adequate countries.[3,5] For instance, moderate-to-severe underweight and acute severe malnutrition have been associated with an increased mortality in children who required hospital care for bacterial pneumonia in Malawi, a resource-limited country.[5] By contrast, lower total body fat mass and acute and chronic undernutrition were also noted to be associated with worse clinical outcomes in children undergoing surgery for congenital heart disease in a resource-adequate setting in California.[6]

The reported prevalence of undernutrition in hospitalized children ranged from 6% to 30%,[7,8] depending on the definition for undernutrition used.[7] Commonly, weight-for-height (WFH) standard deviation scores (S.D.S.) are used for wasting or acute malnutrition while height-for-age (HFA) S.D.S are used for chronic malnutrition or stunting.[7] Body mass index (BMI) is also commonly used to describe malnutrition.[7]

Medical conditions leading to an increased risk of undernutrition in children requiring hospital care include conditions with an increased metabolic demand (chronic lung disease, cardiac failure),[8–10] increased loss or malabsorption (cystic fibrosis, chronic inflammatory bowel disease, major burns),[9,11,12] and impaired/reduced oral intake (anorexia nervosa, severe mental retardation).[13,14]

There is a relative lack of data on the prevalence of undernutrition in hospitalized children from middle income countries, such as Malaysia. The present study aimed to address this knowledge gap by determining the prevalence of and the risk factors associated with undernutrition in children admitted to an academic hospital in Malaysia.

2. Methods

The present study was a cross-sectional, observational, hospital-based study conducted in University Malaya Medical Centre (UMMC), Kuala Lumpur from November 1, 2013 to November 30, 2013. UMMC is an academic and tertiary referral hospital for Kuala Lumpur and its surrounding region. The present study was approved by the institutional ethics committee of UMMC.

2.1. Study population

Consecutive children aged between 3 months and 16 years who were admitted to the children medical wards of UMMC during the study period and who fulfilled the inclusion criteria were included. The exclusion criteria were as follows: (1) children admitted for the assessment of non-accidental injury; (2) unstable medical conditions when growth parameters could not be obtained properly; and (3) children with a known syndromic diagnosis where growth charts for normal children are not applicable.

2.2. Patient recruitment

Each morning during the study period, a list of all admissions for the preceding 24 hours from each children's medical ward was reviewed. After applying the exclusion criteria, a list of suitable patients for enrolment was prepared. The parents of all patients were approached and informed consent was obtained before the interview was conducted.

2.3. Case definitions

Acute case refers to an admission for an acute recurring or nonrecurring symptom which, when treated, can improve and return the patient to his or her premorbid state. The patient must not have severe symptoms in between episodes to affect the progression of his or her growth. He or she must also not meet the definition for "chronic case". Chronic case refers to a patient with a chronic long-standing illness requiring frequent admissions (e.g., cancer) that has an effect on weight gain or growth, or admission for symptoms present more than 28 days prior to admission. Elective admission refers to a planned admission for a medical or surgical procedure or investigation. He or she must also not meet the definition for "emergency admission". Emergency admission refers to unplanned admission for a medical or surgical procedure or for investigation.

2.4. Data collection

Basic demographic and socioeconomic data (parental education, household income) as well as medical factors (vaccination status, duration of breastfeeding, underlying diagnosis) were collected.

2.5. Anthropometric measurements

Each morning, weighing scales of each ward were calibrated and stadiometers were checked prior to taking anthropometric measurements. To ensure standardization, all measurements were performed by a single investigator. The following anthropometric measurements were obtained: height, weight, mid-upper arm circumference

(MUAC), and triceps skinfold thickness. Height of the children was recorded to the nearest 1 mm using a fixed stadiometer. For children younger than 2 years of age, supine length was recorded with an infantometer. Children were weighed wearing minimum clothing and in the case of an infant, without a diaper. The results were recorded to the nearest 10 g. The MUAC measurements were made according to those described by Frisancho,[15] and were measured twice to the nearest 1 mm, and the average of both results was used.

World Health Organization (WHO) Child Growth Standards charts for boys and girls were used for children aged between 3 months and 60 months while Center for Disease Control and Prevention (CDC) Growth Curves for Children 2000 reference (www.cdc.gov) were used in children aged $\geq$ 61 months. WFH, HFA, weight-for-age (WFA), triceps skinfold thickness, and BMI data were converted into standard deviation (S.D.) score using WHO and CDC reference data, respectively.

2.6. Definitions for undernutrition

Acute undernutrition (wasting) was defined as WFH $<$ -2 S.D. To ensure that no children at risk of acute undernutrition were misclassified, the WHO criteria for undernutrition (WHO undernutrition; WFH $<$ -2 S.D. and/or MUAC $<$ 12.5 cm) was also used for children aged between 1 and 5 years of age.[16] Chronic undernutrition (stunting) was defined as HFA $<$ -2 S.D. Underweight was defined as WFA $<$ -2 S.D.

2.7. Statistical analysis

All data were managed with SPSS version 21.0 for Windows (SPSS, Chicago, IL, USA). Descriptive statistics were used for demographic characteristics and anthropometric measurements. Categorical variables were reported as proportion and were compared using χ^2 test. Fischer's exact test was used for small numbers. To determine associated risk factors of undernutrition, univariate analysis were performed followed by multivariate logistic regression analyses. Factors with a p value $<$ 0.1 on univariate logistic regression analysis were subjected to multivariate logistic regression. Crude and adjusted odds ratios were calculated to quantify the strength of association between risk factors/predictors and outcomes. The 95% confidence interval was determined and factors/predictors with p value $<$ 0.05 were considered as significant.

3. Results

During the study period, a total of 458 patients were admitted to the children's medical wards of UMMC. Of these, 173 patients were excluded for the following reasons: (1) accurate and complete anthropometric measurements were not feasible on admission (n = 71); (2) age below 3 months (n = 39); (3) a known syndromic diagnosis (n = 11); (4) parental refusal (n = 25); and (5) patients were discharged before all necessary data were collected (n = 27). Thus, a total of 285 patients were included in the study (Table 1). These patients were admitted for a wide variety of diagnoses (Table 1).

3.1. Basic demography

The basic demographic features of the 285 patients included in the present study are shown in Table 1. Briefly, approximately 37% (n = 107) of the patients were young children aged between 3 months and 24 months, while 39% (n = 111) were children aged above 60 months (Table 1). Slightly more than half (58%, n = 164) were males. Two-thirds (67%, n = 191) of the admissions were unplanned admissions (emergency admissions) while approximately two-thirds (63%, n = 180) of the patients had an underlying chronic medical illness.

Table 1 Basic demographic and clinical data and admitting diagnoses of 285 patients requiring hospitalization.

Characteristics		No. (n = 285)	%
Age (mo)	3–24	107	38
	25–60	67	24
	>60	111	39
Sex	Male	164	57.5
	Female	121	42.5
Father's education	Primary	10	4
	Secondary	169	59
	College/university	106	37
Mother's education	Primary	16	6
	Secondary	151	53
	College/university	118	41
Household income (RM)*	≤1500	58	20
	>1500	227	80
Vaccination status	Complete	271	95
	Incomplete	14	5
Duration of breastfeeding	Never	28	9
	≤6 mo	122	43
	>6 mo	135	48
Nature of admission†	Emergency	191	67
	Elective	94	33
Chronicity of illness†	Acute	105	37
	Chronic	180	63
Underlying medical diagnosis	Infections	89	31
	Hematology/oncology	86	30
	Surgery	28	10
	Central nervous system	26	9
	Gastrointestinal/liver	24	8
	Respiratory	11	4
	Cardiac	6	2
	Miscellaneous	15	5

* RM: Malaysian ringgit, on average USD 1 = RM 3.80 during the study period.

† Refer to the text for definitions of nature of admission (emergency and elective) and nature of illness (acute and chronic).

3.2. Medical diagnosis

The underlying medical diagnoses leading to hospitalization are shown in Table 1. Two major groups of medical conditions leading to hospitalizations were infectious diseases and hematology and oncology, reflecting the medical services provided by the hospital.

3.3. Distribution of the parameters on nutritional status

The distribution of various nutritional parameters is shown in Table 2. With the exception of distribution of for BMI S.D., all other nutritional parameters (S.D.S. for WFH, HFA, WFA, and TFT) showed a skew-to-the-right distribution. More patients had a lower S.D.S. (<-2) for the above nutritional parameters as compared to patients with an S.D.S. of $> +2$.

Using MUAC as an indicator for nutritional status, 21 patients (7%) had acute undernutrition (MUAC $<$ 12.5 cm); 15 patients (5.3%) had a MUAC measurement of between 11.5 cm and 12.5 cm (moderate acute undernutrition) while another six patients (2%) had an MUAC of $<$ 11.5 cm (severe acute undernutrition).

3.4. Prevalence of undernutrition

Of the 285 patients studied, 32 patients (11%) had acute undernutrition (WFH S.D.S. < -2, Table 3), 41 patients (14%) had chronic undernutrition (HFA S.D.S. < -2), and 47 (16%) were underweight (WFA S.D.S. < -2). Using the WHO definition of acute undernutrition (WFH S.D.S. < -2 and/or MUAC $<$ 12.5 cm), an additional eight patients ($n = 40$, 14%) were found to have acute undernutrition (MUAC $<$ 12.5 cm but a WFH S.D.S. > -2).

3.5. Undernutrition according to age

Using the WHO definition for acute undernutrition, 15% ($n = 24$) of children aged between 3 months and 60 months and 13% ($n = 16$) of children aged above 60 months were undernourished (Table 4).

Table 2 Distribution of various nutritional parameters in 285 children requiring hospitalization in Malaysia.

Parameters	Z-score, *n* (%)		
	≤ -2	-2 to $+2$	$\geq +2$
Weight-for-height z-score (acute wasting)	32 (11%)	253 (89%)	0 (0%)
Height-for-age z-score (chronic wasting, stunting)	41 (14%)	244 (86%)	0 (0%)
Weight-for-age z-score (underweight)	47 (17%)	236 (83%)	2 (1%)
Triceps skinfold thickness z-score	21 (7%)	260 (91%)	4 (1.5%)
Body mass index z-score	45 (16%)	217 (76%)	26 (9%)

Table 3 Prevalence of undernutrition in 285 children requiring hospitalization in Malaysia using different definitions of undernutrition.

Anthropometric measurements	Undernutrition	
	Present	Absent
WFH z-score ≤ -2 (wasting)	32 (11%)	253 (89%)
HFA z-score ≤ -2 (stunting)	41 (14%)	244 (86%)
WFA z-score ≤ -2 (underweight)	47 (17%)	238 (83%)
Triceps skinfold thickness z-score ≤ -2	21 (7%)	264 (91%)
Body mass index (BMI) z-score ≤ -2	45 (16%)	240 (76%)
WHO definition of undernutrition (WFH z-score and/or MUAC $\leq$ 12.5 cm)	40 (14%)	235 (86%)

HFA z-score: height-for-age z-score; MUAC: mid-upper arm circumference; WFA z-score: weight-for-age z-score; WFH z-score: weight-for-height z-score.

Table 4 Prevalence of undernutrition in 285 children requiring hospitalization according to age and underlying medical diagnoses.

	Undernutrition		
	Yes *n* (%)	No *n* (%)	All *n* (%)
Overall	40 (14%)	245 (86%)	285
Age group			
3–60 mo	24 (15%)	136 (85%)	
Above 60 mo	16 (13%)	109 (87%)	
Underlying medical diagnosis			
Infections	4 (4.5%)	85 (95.5%)	89
Hematology/oncology	15 (17%)	71 (83%)	86
Surgery	2 (7%)	26 (93%)	28
Central nervous system	4 (15%)	22 (85%)	26
Gastrointestinal/liver	5 (21%)	19 (79%)	24
Respiratory	2 (18%)	9 (82%)	11
Cardiac	2 (33%)	4 (67%)	6
Others	0 (0)	15 (100%)	15

Definition of undernutrition according to World Health Organization: WHO definition of undernutrition (WFH z-score and/or MUAC $\leq$ 12.5 cm).

3.6. Undernutrition according to medical diagnoses

Nutritional status of patients was analyzed according to the underlying medical diagnoses leading to hospital admission (Table 4). Briefly, children with underlying cardiac condition, or those with gastrointestinal or liver conditions were more likely to have undernutrition upon admission.

3.7. Risk factors for undernutrition

Various sociodemographic factors were analyzed to determine the risk factors leading to undernutrition in children requiring hospital care (Table 5). On univariate analysis, none of the factors analyzed were significantly associated

Table 5 Univariate analysis of risk factors leading to undernutrition in 285 children requiring hospital admission.

Factors		Undernutrition		χ^2	p
		Yes (n)	No (n)		
Gender	Male	26	138	1.06	0.303
	Female	14	107		
Age	3–60 mo	24	136	0.61	0.282
	>60 mo	16	109		
Father's education	Primary/secondary	26	153	1.32	0.160
	Tertiary	14	92		
Mother's education	Primary/secondary	26	141	1.21	0.111
	Tertiary	14	104		
Household income	≤RM 1500	10	48	0.62	0.431
	>RM 1500	30	197		
Vaccination status	Complete	38	233	0.01	0.978
	Incomplete	2	12		
Breast feeding for 6 mo	Yes	15	80	0.06	0.938
	No	2	10		
Chronicity of illness	Acute	10	136	2.804	0.094
	Chronic	30	109		

with the presence of undernutrition on admission (Table 5). However, there was a trend showing some association between having an underlying chronic medical illness and undernutrition ($p = 0.094$). Patients who were chronically unwell were more likely to be undernourished when they required hospital care as compared to those who were previously well.

4. Discussion

The present study was the first study conducted in Malaysia to ascertain the prevalence of acute and chronic undernutrition in hospitalized children. It was conducted in an academic pediatric center in Malaysia. It showed that approximately one in seven children (14%) who required hospital care had acute undernutrition, while 14% had chronic undernutrition upon admission. This figure is comparable to a similar study from Canada, where 8.8% of children admitted to a tertiary-care pediatric hospital were undernourished.[17] In Belgium, 7.7% of children were chronically undernourished, while between 2.4–9.8% were acutely undernourished on admission to hospital.[3] Undernutrition in children requiring hospitalization is a common finding, irrespective of whether the setting is resource-adequate or resource-limited.

It is well known that children with significant undernutrition stayed longer in hospital when they were admitted. Hecht et al[18] showed that children with a more severe degree of malnutrition (BMI < -3 S.D.S.) were associated with a 1.6 days longer length of stay. In addition, severely malnourished children were more likely to have a lower quality of life, and more frequent occurrence of diarrhea and vomiting.[18] Thus, it is important to identify children with moderate-to-severe undernutrition upon admission so that more intense nutritional support can be instituted.

It is thus imperative that all clinicians responsible for providing hospital care for children be aware of the prevalence of undernutrition in children upon admission to hospital. Attention should be paid to the anthropometric measurements in those who are undernourished; special attention, including nutritional support, should be instituted.

However, many researches in this area merely concentrated on the nutritional status upon hospital admission. What is equally of concern is that children may develop malnutrition whilst receiving hospital care.[8] Many researchers have attempted to identify certain at-risk groups of children who are more vulnerable than others to develop undernutrition while staying in hospital.[8] Hulst et al[8] showed that in children with certain "high risk disease" (such as anorexia nervosa, chronic liver disease), a more negative WFH S.D.S. upon admission and a prolonged hospitalization were risk factors for developing undernutrition in hospitalized children. Thus, nutritional intervention needs to be channeled not only to children who are malnourished upon hospital admission, but also to those who are at risk of developing undernutrition whilst receiving care in hospital.

MUAC has been proposed as an alternative index of nutritional status for use where the collection of height and weight measurements is difficult, including in emergency situations such as famines or refugee crises.[16] In this situation, low MUAC, based on a fixed cut-off point such as 12.5 cm, has been used as a proxy for low WFH or wasting. Comparisons of the two indicators, however, show that they are poorly correlated.[16] This is further confirmed in the present study, where 11% of the 285 children studied had a WFH S.D.S. of < -2, while only 7% had an MUAC of $<$ 12.5 cm. However, using the WHO definition of acute wasting where in addition to WFH S.D.S. of < -2, an MUAC of $<$ 12.5 cm in children aged 1–5 years was also used, an additional eight patients were identified as having acute wasting. Thus, WHO has proposed that MUAC should be used as an additional screening tool for acute malnutrition in nonemergency situations as well.[16]

There are several limitations to the present study. Firstly, this was a hospital-based study conducted in an

academic center. Cases were referred to this hospital for specialist care in areas such as oncology and various gastrointestinal diseases. Thus, the patients recruited in the present study may represent a more severe spectrum of illness as that which would have been expected in the setting of a general hospital.

Secondly, data on the duration of hospitalization were not collected. Thus, we were unable to ascertain any correlation between the length of hospital stay and nutritional status on admission. In addition, no follow-up data on the final outcome of the patients was available. Thus, we were unable to ascertain any correlation between final outcome of the patients and the nutritional status upon admission.

Nevertheless, the present study confirms that undernutrition is a common problem in children who require hospital care, be it in a resource-limited or resource-adequate setting. Every effort must be made to identify children at risk of developing significant undernutrition upon admission and provide necessary nutritional support. Of equal importance is identification of children who are at risk of developing undernutrition while being admitted to hospital and providing nutritional support.

In conclusion, both acute undernutrition and chronic undernutrition remain a frequent finding in hospitalized children in Malaysia. Strategies for systematic screening and provision of nutritional support in children at risk of undernutrition, as well as treatment of undernutrition in children requiring hospitalization, are needed.

Conflicts of interest

Both authors declare no conflict of interest.

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