Journal of Cardiovascular Disease Research
ISSN:0975-3583,0976-2833 VOL14,ISSUE03,2023

ORIGINAL RESEARCH

Effect of Weight on Mortality and Morbidity of patient in Pediatric Intensive Care Unit (PICU)

[1]Vijyant Kumar Sah, [2]NS Chithambaram, [3]Sajal Gupta

[1,3]Junior Resident, [2]Professor, Department of Pediatrics, Teerthankar Mahaveer Medical College and Research Center, Moradabad, U.P. India

Corresponding author
Vijyant Kumar Sah
Junior Resident, Department of Pediatrics, Teerthankar Mahaveer Medical College and Research Center, Moradabad, U.P. India
Email: vijyant108301@gmail.com

Abstract
Background: Studies have shown that the nutritional condition of critically sick children at the time of admission, as well as its likely decline while they are hospitalized, may be used as a predictor of outcomes that are less favourable. The present study was done to study the effect of weight on mortality in P.IC.U.
Materials and method: This Hospital based prospective observational study was done at TMMC & RC for a period of 18 months. The study included Children more than 1 month of age up to 18 years admitted to PICU were included in the study and Children with PICU stay of at least 24 hours were included in the study.
All the admitted patients underwent necessary blood investigations such as complete haemogram including white blood cell count, differential count, and platelet count. On the day of admission, to assess platelet count, venous EDTA samples were sent to haematology laboratory and analysed by SYSMEX XN 350 Automated Haematology Analyser and low platelet count was further evaluated by peripheral blood smear.
Results: The major symptoms were Fever (70.8%), Refusal to Feed (8.3%) and Edema (12.5%). Mortality was reported among 11.6% cases. The hemodynamic parameters (mean SBP, DBP and SPO_2) Length of Hospital stay and was significantly more among subjects with underweight compared to overweight which was significantly more than normal weight.
Conclusion: The current research demonstrated that critically sick children had a higher frequency of malnutrition than the general population. Children who are undernourished are more likely to need lengthy hospitalisation and ventilation.

Introduction

A critical disease is a life-threatening multisystem condition that requires the support of failing key organ systems. Without this support, survival would not be feasible, and the sickness also has the potential to result in considerable morbidity or fatality.[1] The treatment provided in paediatric intensive care units (PICUs) attempts to obtain rapid diagnosis and therapeutic measures with the purpose of managing organ dysfunction and regaining physiological stability. Children who are critically sick have a variety of organic changes as well as metabolic reactions that help to the preservation of the body's equilibrium. These metabolic responses also redirect nutritional substances toward other roles, which, at a later stage, may assist recovery.[2]
The interpretation of anthropometric data, such as weight and height, is an objective and quantitative component of the nutritional evaluation. It is also an essential component in determining a child's nutritional status and in determining whether or not she is growing and developing appropriately.[3] The examination helps to detect eating disorders, provides support for the diagnosis, and makes the prognosis easier, all of which are accomplished in a hospital environment, allowing for early and risk-free intervention.[4-7]
Children who are severely malnourished (weight below the third centile for their age) and children who are overweight (weight above the third centile for their age) have a much higher risk of passing away compared to children who are healthy. Furthermore, these children experience more severe disease episodes, which are associated with more complications, and also spend more time being ill for each episode.[2]
The study on the paediatric risk of mortality score known as PRISM found that there was a tendency toward a higher standard mortality ratio for severely malnourished children when these parameters were used. If a person's height for their age was less than 90 percent of what was predicted yet their weight for height ratio was normal, they were considered to have chronic malnutrition or stunting.[2]
In paediatric intensive care unit settings, it is recommended that weight and height be documented; however, very few studies have investigated the relationships between a variety of nutritional status categories (i.e. underweight, normal weight, overweight, and obese) and clinical outcomes in children who are critically ill.[8]

Documentation of weight and height is recommended in paediatric intensive care unit settings.[9-13] The quality of several of these studies has been hampered as a result of their retrospective design[12], single-center observations, or small sample size[9,12], as well as their determination of nutritional status based only on weight.[9]
It is of the utmost importance to evaluate the Pediatric Intensive Care Unit's nutritional profile because patients in the PICU who have a nutritional status that is inadequate have a higher risk of unfavourable outcomes, such as the need for mechanical ventilation (MV), mortality, a longer length of stay, and infection.[14] Obesity in children who have been injured is linked to an increased risk of sustaining abdominal injuries, most notably to the liver, however this does not negatively influence the results.[15]
Numa et al.[9] found that the death rate was strongly impacted by weight centile in a research that was carried out at a single centre over the course of many years. The death rate followed the form of a U or an inverted J with regard to the weight centile, with the lowest mortality rate occurring somewhere around the 75th weight-for-age centile. The mortality rate was shown to be higher in both groups of those who were underweight and those who were fat, according to a multicenter research taken from the database of Virtual PICU Systems. [16]The present study was done to study the effect of weight on mortality in P.IC.U.

Material and Methods
A Hospital based prospective observational study was done at TMMC&RC, to look for the effect of platelet count on mortality and morbidity in Paediatric intensive care unit (PICU). This study was done for a period of 18 months from 1st January 2021 till 30th June 2022.

Sample Size
The sample size calculation could not be done as the study was done during COVID Pandemic. Hence, all the patients admitted in paediatric intensive care unit during the period of 18 months were consecutively included in the study.

Study Population
The study included Children more than 1 month of age up to 18 years admitted to PICU were included in the study and Children with PICU stay of at least 24 hours were included in the study. The study excluded Patient attendants not giving written consent, Patient who left hospital against medical advice, Neonate age less than 1 month and Patients with gross congenital anomalies and genetic disorders.

Methodology
Demographic data, reason for hospitalisation, underlying chronic diseases, and initial platelet counts were recorded. A detailed history inclusive of maternal obstetric history, birth history, perinatal events, immunization history with a focus on history suggestive of bleeding manifestations & other associated symptoms was obtained as per the proforma.
All the admitted patients underwent necessary blood investigations such as complete haemogram including white blood cell count, differential count, and platelet count.On the day of admission, to assess platelet count, venous EDTA samples were sent to haematology laboratory and analysed by SYSMEX XN 350 Automated Haematology Analyser and low platelet count was further evaluated by peripheral blood smear.
Data was collected from haematology lab and analysed. Patient profile including his age, gender, vitals was recorded in Performa. Appropriate weight and height to be taken of patient through appropriate anthropometric measurement. Categorize the patient according to body mass index. Electrolytes, mechanical ventilation days, need for inotropes and blood transfusion, Data variables was also include complete blood count, serum electrolytes, mechanical
Data variables was also include complete blood count, serum electrolytes, mechanical ventilation days, need for inotropes and blood transfusion,duration of PICU stay and final outcome (discharge or death). PAEDIATRIC RISK OF MORTALITY SCORING (PRISM) was done at 24 hrs. of admission.Survival was considered primary outcome, while length of stay in PICU was the secondary outcome.The outcome was measured according to the length of hospital stay, child survival or death in the hospital.
The relationships between the initial platelet counts and invasive mechanical ventilation (IMV) support, noninvasive mechanical ventilation (NIV) support, the need for inotropic drugs, acute kidney injury (AKI) development, continuous renal replacement therapy (CRRT), sepsis, thrombocytopenia-associated m(CRRT), sepsis, thrombocytopenia-associted

Statistical analysis
Data was collected on initial day of admission and at time of discharge and then was entered in an excel sheet. After compilation of data, appropriate tests of significance was applied and statistical analysis was done using statistical package for social sciences (SPSS) version 24.0 and inference was drawn. Appropriate Statistical test was applied to draw the inference.

Results

Table 1: Distribution of study population according to age

		Frequency	Percent
Age (in yrs.)	< 1 year	37	30.8%
	1-3 years	18	15.0%
	3-6 years	24	20.0%
	7-12 years	23	19.2%
	> 12 years	18	15.0%
Gender	Female	49	40.8%
	Male	71	59.2%

The subjects belonged to < 1 year 37 (30.8%), 1-3 years (15.0%), 3-6 years (20.0%), 7-12 years (19.2%) and > 12 years (15.0%).There were 71 (59.2%) males and 49 (40.8%) females.

Table 2: Distribution of study population according to clinical symptom

	Frequency	Percent
Fever	85	70.8%
Refusal to Feed	10	8.3%
Lethargy	0	0.0%
Bleeding From Any Site	0	0.0%
Blood in Stool or Urine	0	0.0%
Rashes	0	0.0%
Easy Bruising	0	0.0%
Prolonged Bleeding from Minor Cuts	0	0.0%
Icterus	10	8.3%
Clubbing	3	2.5%
Cyanosis	4	3.3%
Lymphadenopathy	2	1.7%
Edema	15	12.5%
Rash	9	7.5%

There was Fever among 85 (70.8%,) Refusal to Feed among 10 (8.3%), Icterus among 10(8.3%), Clubbing among 3(2.5%), cyanosis among 4(3.3%), lymphadenopathy among 2 (1.7%), edema among 15(2.5%) and rash among 9 (7.5%) subjects.

Table 3: Distribution of study population according to mortality

Mortality	Frequency	Percent
Need for Mechanical Ventilation	28	23.3%
Mortality	14	11.6%
Shift to Ward	77	64.1%
Discharge	29	24.1%

Need for Mechanical Ventilation was reported among 23.3% cases.Mortality was reported among 11.6%% cases.

Table 4: Co-relation of study population between to Length of hospital stay and discharge weight.

		Discharge weight
Length of Hospital stay	Pearson Correlation	0.019
	p-value	0.839
PRISM score	Pearson Correlation	0.026
	p-value	0.776

There was no correlation between length of hospital stay with discharge weight.There was a significantly positive correlation of Weight on Discharge with PRISM score.It shows that PRISM score > 8 is seen more among underweight in comparison to obese and normal weight.

Table 5: Co-relation of study population according to mortality and nutritional status

	Nutritional Status			
	Under-weight	**Over-weight**	**Normal weight**	**p-value**
Need for Mechanical ventilation	10	7	11	**0.437**
	35.71%	25.00%	39.28%	
Mortality	7	4	3	**0.213**
	50%	28.5%	21.4%	
Shift to Ward	15	27	35	**0.036***
	19.4%	35.0%	45.5%	

There was no significant association in mortality between patients with different Nutritional status. There was no significant difference in Need for Mechanical ventilation between patients with different Nutritional status. Shift to Ward was significantly more among subjects with normal weight.

Table 6: Co-relation of study population according to wt on admission and discharge between different nutritional status.

	Normal weight		Underweight		Overweight		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p-value**
Weight on Admission	8.31	9.72	6.55	3.93	7.09	9.12	0.784
Weight on Discharge	8.27	9.58	6.72	3.94	7.10	8.90	0.798
Respiratory Rate	33.62	16.65	50.40	9.40	36.14	16.70	0.105
SBP	107.22	14.51	98.00	13.04	105.48	23.70	0.046*
DBP	74.54	10.64	64.00	8.94	68.99	16.41	0.041*
SPO2 in room air	88.22	13.16	98.00	11.85	93.68	9.77	0.033*
Length of Hospital stay	5.76	2.13	3.00	3.08	4.40	3.34	0.036*
PRISM score	46.70	28.59	58.80	18.43	49.55	26.86	0.024*

There was no significant difference in mean Weight on Admission and on Discharge between different Nutritional status.The mean SBP, DBP and SPO_2 in room air was significantly more among subjects with underweight compared to obese which was significantly more than Normal weight.The mean Length of Hospital stay was significantly more among subjects with underweight compared to obese which was significantly more than normal weight.The mean PRISM score was significantly more among subjects with underweight compared to obese which was significantly more than normal weight.

Discussion

Rapid diagnosis and treatment are hallmarks of the PICU's role in tertiary paediatric care for the sickest children. By intensively monitoring and caring for critically ill children who are deemed to be at a high risk of dying, the major purpose of the paediatric intensive care unit (PICU) is to prevent mortality and morbidity. In addition to clinical features, ICU efficiency, and facility, the patient's nutritional health is a factor in their death rate.[17]

Possible explanations for the link between undernutrition and worse outcomes include exhausted metabolic reserves, muscle loss that affects respiratory function,[18,19] decreased immunity linked to slower wound healing and a higher risk of infection,[18,20] and depleted metabolic reserves. Patients who are malnourished often get insufficient nourishment while in the PICU, which worsens their prognosis.[20,21]

Most of the studies rely on various growth references from the WHO,[22,23] CDC.[24], or the National Centre for Health Statistics[25] and employed either BMI percentiles or other z-score cut-offs.

The subjects belonged to < 1 year (30.8%), 1-3 years (15.0%), 3-6 years (20.0%), 7-1 years (19.2%) and > 12 years (15.0%). Chaitra et al.[2] found that the Mean and median age of the study population was 4.8 and 2.5±4.91 years respectively. Bechard et al.[26] reported that the mean Age (years) was 4.5±5.1. Costa et al.[27] stated that the mean Age (months) was 19.5 (5-77). de Castro et al.[28] found that the patients were divided into two groups: infants up to 24 months old (40.2%) and those older than 2 years (59.8%).

There were 59.2% males and 40.8% females. Chaitra et al.[2] stated that there were 78.6% were males and 21.4% females.Costa et al.[28] stated that males were 54.4% and females were 45.6%. Sharma et al.[29] observed that 795 were males and 652 were females.

In our study it is found that Need for Mechanical Ventilation was reported among 23.3% cases. Need for mechanical ventilation did not vary significantly across dietary adequacy categories.

Toh et al.[30] found no difference in duration of Mechanical ventilation and PICU between all three weight categories. Stephens et al.[31] reported no difference in MV requirement between obese and non-obese groups.Children who are underweight or overweight or obese have a greater risk of having to remain in the hospital for an extended period of time, according to research published by Chaitra et al.[2]. Children who were either underweight or overweight/obese were more likely to need a lengthy stay in the paediatric intensive care unit. Children with severe malnutrition sometimes needed extended ventilation assistance.

Chaitra et al.[2] reported a considerably increased likelihood of mechanical breathingwhen compared to normal was found to be underweight. According to a prospective cohort study of kids hospitalised to a Brazilian PICU by de Souza MF et al.[32] Malnutrition impairs muscular function, causing muscle fatigue and a drop in labour intensity of up to 75%, which leads to respiratory failure.[19]

Ayalon et al.[33] found that the patients who were underweight required mechanical ventilation more frequently. Bechard et al.[26] stated that in comparison to normal weight and overweight, being underweight was linked to 1.3 and 1.6 fewer ventilator-free days, respectively.

In our study it is found that the mean SBP, DBP and SPO_2 in room air was significantly more among subjects with underweight compared to overweight which was significantly more than normal weight patient . There was a significantly negative correlation of Weight on Discharge with Pulse and Respiratory Rate. There was a significantly positive correlation of Weight on Discharge with systolic and diastolic blood pressure. There was a significantly positive correlation of Weight on Discharge with SPO_2 in room air.

Our study revealed that the mean Length of Hospital stay was significantly more among subjects with normal weight compared to obese which was significantly more than underweight. There was no correlation of Weight on Discharge with Length of Hospital stay. Toh et al. [30] came to the conclusion that the duration of inpatient LOS did not substantially vary between any of the three distinct weight groups they examined.

According to the results of Stephens et al. [31], there was not a significant difference between obese and non-obese groups in terms of the length of time spent in the paediatric intensive care unit (PICU). Patients who were underweight had a longer time of stay in the critical care unit, as shown by the results of Ayalon et al.[33] A study that was carried out by Peterson and his colleagues.[34] discovered that obese-overweight patients and critically ill children of normal weight who had sepsis both had equal mortality rates and lengths of stay in the paediatric intensive care unit (PICU). According to the findings of the study that was carried out by Peterson and colleagues,[34] critically ill children of normal weight who were given a diagnosis of sepsis had hospital stays that were equivalent to those of obese-overweight patients.

Children who were either underweight or overweight/obese had a larger risk of needing to stay in the hospital for a longer amount of time, as shown by the results of Chaitra et al.[2] Children who were underweight, overweight, or obese had a larger chance of remaining longer in the paediatric critical care unit than children who were at a healthy weight (PICU). According to the findings of Costa et al.,[27] malnourishment in patients in the historical sample was considerably related with length of stay. This finding is comparable with the results that we discovered. Ayalon et al.[33] found that the patients who were underweight had longer stays in the ICU overall but not in the sepsis group. Bechard et al.[26] stated that Children who were underweight or obese had decreased hazard ratios for hospital discharge (hazard ratio, 0.81; $p = 0.04$).Our findings were also in similarity to the Nangula et al's research on a cohort of 400 children hospitalised to a tertiary care hospital in Ludhiana.[35]

Toh et al.[30] did not show a relationship between mortality, PICU length of stay, and entry nutrition status, most likely because nutritional evaluation and categorization used different methodologies. Children who are underweight may also have weakened immune systems, which might reduce their ability to fight off diseases.[36,37] Additionally, owing to sickness or obstacles to nutrient supply in the intensive care unit, children who are severely ill are at risk of additional nutritional deterioration throughout the duration of their illness.[35]

The mean PRISM score was significantly more among subjects with underweight compared to overweight which was significantly more than normal weight. There was a significantly positive correlation of Weight on Discharge with PRISM score. Chaitra et al.[2] stated that PRISM score was comparable among the groups.

In our study, mortality was reported among Mortality was reported among 11.6% cases and there was no significant association with the Nutritional status. Contrary to our findings, Toh et al.[30] observed in relation to the normally weighing children, underweight (OR = 1.32) and overweight/obese patients (OR = 1.10) did not have an increase risk in mortality. Stephens et al.[31] reported notmuch difference in the rate of death between obese and non-obese groups. According to Peterson et al.'s study,[34] the critically ill children of normal weight with sepsis and obese-overweight patients both had similar PICU mortality.

Malnourishment in patients in the historical sample was considerably connected with mortality, as reported by Costa et al.[27]As revealed by Ayalon et al.,[33] the adjusted OR for death was 1.6% greater in the obese than in the normal-weight group. The adjusted odds ratio (OR) for death was 1.8 in the overall population and 2.9 in the sepsis cohort, confirming the correlation between childhood underweight and increased mortality.

After taking into account other factors such as severity of disease and geographic location, Bechard et al.[26] showed that children who were underweight had a higher probability of dying within 60 days (odds ratio, 1.53). Children with both low and high body mass index had increased risks of hospital-acquired infections (1.88 and 1.64 times, respectively).

Malnutrition in the paediatric intensive care unit (PICU) population is often caused by long-term chronic disorders.[38] Malnourished children generally appear with symptoms similar to those observed in severely unwell adults, including low body weight, anorexia, muscle and fat loss, exhausted energy reserves, and a disrupted metabolic response to stress.[39]

These results highlight the prevalence of malnutrition in PICUs and the value of anthropometry in identifying high-risk critically ill children and targeting their care at the earliest possible stage. Previous research simply used weight for age Z-scores to categorise patients' nutritional condition. However, in the event of severe illness, when fluid shifts are usually visible, using weight alone as an indication of nutrition may be deceptive. Using a child's body mass index (BMI) may be a more reliable technique to measure their nutritional condition when they are critically unwell. This has also been considered as a vital measure of kids' health and development.[40]

Conclusion

By using Anthropometric measurement, we categorise the patient in underweight, overweight, & normal weight at time of admission irrespective of their clinical diagnosis. It is important to implement dietary strategies to improve their nutritional status. As well as appropriate therapies to treat underlying problems. Though future research we should focused and implement nutritional strategies to overcome morbidity and mortality of nutritionally affected children admitted in P.I.C.U.

Bibliography

1. Cannon, Walter. Wisdom of the body. United States: W. W. Norton and Company; 1932
2. Chaitra KM, Bhavya G, Harish S, Patel S, Anjum SK. Influence of nutritional status on clinical outcomes in critically ill children. Int J Contemp Pediatr 2018;5:462-6.
3. Cole TJ. The development of growth references and growth charts. Ann Hum Biol. 2012;39(5):382-94.
4. Delgado AF, Okay TS, Leone C, Nichols B, Del Negro GM, Vaz FA. Hospitalmalnutrition and inflammatory response in critically ill children and adolescents admitted to a tertiary intensive care unit. Clinics (Sao Paulo). 2008;63(3):357-62.
5. Péret Filho LA, Penna FG, Rodrigues FG, Santana DP, Hanan B, Oliveira GN,et al. Avaliação nutricional de crianças internadas em enfermaria geral deum hospital público. Pediatria (São Paulo). 2005;27:12-8.
6. Rocha GA, Rocha EJ, Martins CV. The effects of hospitalization on thenutritional status of children. J Pediatr (Rio J). 2006;82(1):70-4.
7. Sarni RO, Carvalho Mde F, Monte CM, Albuquerque ZP, Souza FI.Anthropometric evaluation, risk factors for malnutrition, and nutritionaltherapy for children in teaching hospitals in Brazil. J Pediatr (Rio J). 2009;85(3):223-8.
8. Mehta NM. Compher C, A.S.P.E.N. Board of Directors. A.S.P.E.N. clinical guidelines: nutrition support of the critically ill child. Journal of Parenteral and Enteral Nutrition. 2009; 33(3):260–276.
9. Numa A, McAweeney J, Williams G, Awad J, Ravindranathan H. Extremes of weight centile are associated with increased risk of mortality in pediatric intensive care. Crit Care. 2011;15(2):R106.
10. Bagri NK, Jose B, Shah SK, Bhutia TD, Kabra SK, Lodha R. Impact of Malnutrition on the Outcome of Critically Ill Children. Indian journal of pediatrics. 2015;82:601-5.
11. Briassoulis G, Zavras N, Hatzis T. Malnutrition, nutritional indices, and early enteral feeding in critically ill children. Nutrition. 2001; 17(7–8):548–557.

12. Delgado AF, Okay TS, Leone C, Nichols B, Del Negro GM, Vaz FA. Hospital malnutrition and inflammatory response in critically ill children and adolescents admitted to a tertiary intensive care unit. Clinics (Sao Paulo). 2008; 63(3):357–362.
13. Prince NJ, Brown KL, Mebrahtu TF, Parslow RC, Peters MJ. Weight-for-age distribution and case-mix adjusted outcomes of 14,307 paediatric intensive care admissions. Intensive Care Med. 2014; 40(8):1132–1139.
14. Costa CA, Tonial CT, Garcia PC. Association between nutritional status and outcomes in critically-ill pediatric patients - a systematic review. J Pediatr (Rio J). 2016;92(3):223-9.
15. Vaughan N, Tweed J, Greenwell C, et al. The impact of morbid obesity on solid organ injury in children using the ATOMAC protocol at a pediatric level I trauma center. J Pediatr Surg. 2017; 52(2): 345–348.
16. Ross PA, Newth CJ, Leung D, et al. Obesity and mortality risk in critically ill children. Pediatrics 2016; 137(3): e20152035.
17. Pollack MM, Cuerdon TT, Patel KM, Ruttimann UE, Getson PR, Levetown M. Impact of quality-of-care factors on pediatric intensive care unit mortality. JAMA. 1994;272:941-6.
18. Corish CA, Kennedy NP. Proteineenergy undernutrition in hospital in-patients. Br J Nutr 2000;83(6):575e91.
19. Mota EM, Garcia PC, Piva JP, Fritscher CC. The influence of poor nutrition on the necessity of mechanical ventilation among children admitted to the Pediatric Intensive Care Unit. J Pediatr 2002;78(2):146e52.
20. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. Clin Nutr 2008;27(1):5e15.
21. Tume L, Latten L, Darbyshire A. An evaluation of enteral feeding practices in critically ill children. Nurs Crit Care 2010;15(6):291-9.
22. Bechard LJ, Duggan C, Touger-Decker R, Parrott JS, Rothpletz-Puglia P, Byham-Gray L, et al. Nutritional status based on body mass index is associated with morbidity and mortality in mechanically ventilated critically ill children in the PICU. Crit Care Med 2016;44(8):1530e7.
23. Lim C, Lim J, Ong C, Nakao M, Tan TH, Lee JH. The impact of pre-operative nutritional status on outcomes following congenital heart surgery. Pediatr Crit Care Med 2019;19(6):14.
24. Anton-Martin P, Papacostas M, Lee E, Nakonezny PA, Green ML. Underweight status is an independent predictor of in-hospital mortality in pediatric patients on extracorporeal membrane oxygenation. J Parenter Enteral Nutr. 2018;42(1):104-11.
25. Vivanco-Munoz N, Buendia-Hernandez A, Pina JOT, Juanico-Enriquez A, Peralta PC. Impact of nutritional support on length of hospitalization and mortality in children after open heart surgery. Bol Med Hosp Infant Mex. 2010;67(5):430-8.
26. Bechard LJ, Duggan C, Touger-Decker R, et al. Nutritional status based on body mass index is associated with morbidity and mortality in mechanically ventilated critically ill children in the PICU. Crit Care Med 2016; 44(8): 1530–1537.
27. Costa CAD, Garcia PCR, Cabral DD, Tonial CT, Bruno F, Enloft PR, et al. Reducing malnutrition in critically ill pediatric patients. Revista Brasileira de terapia intensiva 2018;30(2):160-5.
28. de Castro GT, Kaufer-Horwitz M, Carrillo-López HA, Klünder-Klünder M, Jarillo-Quijada A, García-Hernández HR. Nutritional status of children in critical condition at admission to pediatric intensive care units. BoletínMédicodel Hospital Infantil de México. 2013;70(3): 216-21.
29. Sharma K, Raszynski A, Totapally BR. The impact of body mass index on resource utilization and outcomes of children admitted to a pediatric intensive care unit. SAGE Open Med. 2019 Jan 22;7:2050312119825509.
30. Toh S, Ong C, Sultana R, Kirk AHP, Koh JC, Lee JH. Association between admission body mass index and outcomes in critically ill children: A systematic review and meta-analysis. Clinical Nutrition. 2021;40(5):Pages 2772-2783.
31. Stephens K, Barker P, Bergeron E, Miller JL, Hagemann TM, Lewis TV, Neely S, Johnson PN. Comparison of Clinical Outcomes and Medication Use of Obese Versus Nonobese Children Admitted to the Pediatric Intensive Care Unit. Hosp Pharm. 2021 Aug;56(4):287-295.
32. de Souza Menezes F, Leite HP, Koch Nogueira PC. Malnutrition as an independent predictor of clinical outcome in critically ill children. Nutrition. 2012 Mar;28(3):267-70.
33. Ayalon I, Woo JG, Basu RK, et al. Weight as a Risk Factor for Mortality in Critically Ill Patients. Pediatrics. 2020;146(2):e20192829

34. Peterson LS, Gállego Suárez C, Segaloff HE, Griffin C, Martin ET, Odetola FO, Singer K. Outcomes and Resource Use Among Overweight and Obese Children With Sepsis in the Pediatric Intensive Care Unit. J Intensive Care Med. 2020 May;35(5):472-477.
35. Nangalu R, Pooni PA, Bhargav S, Bains HS. Impact of malnutrition on pediatric risk of mortality score and outcome in Pediatric Intensive Care Unit. Indian J Crit Care Med. 2016;20:385-90.
36. Joosten KFM, Hulst JM. Malnutrition in pediatric hospital patients: Current issues. Nutr. 2011;27(2):133-7.
37. Reid M, Badaloo A, Forrester T, Morlese JF, Heird WC, Jahoor F. The acute-phase protein response to infection in edematous and nonedematous protein-energy malnutrition. Am J Clin Nutr. 2002;76(6):1409-15.
38. Diamanti A, Cereda E, Capriati T, et al. Prevalence and outcome of malnutrition in pediatric patients with chronic diseases: focus on the settings of care. Clin Nutr. 2019;38(4):1877–1882.
39. Emery PW. Metabolic changes inmalnutrition. Eye (Lond). 2005;19(10):1029–1034
40. Becker PJ, Carney NL, Corkins MR, Monczka J, Smith E, Smith SE, et al. Consensus statement of the Academy of Nutrition and Dietetics/American Society for parenteral and enteral nutrition: indicators recommended for the identification and documentation of pediatric malnutrition (undernutrition). J Acad Nutr Dietetics. 2014;114(12):1988-2000.