e-ISSN 2830 5442

APGHN

Archives of Pediatric Gastroenterology, Hepatology, and Nutrition

Volume 2 / No. 4

November 2023

www.apghn.com

Published by
Indonesian Society of Pediatric Gastroenterology, Hepatology, and Nutrition

e-ISSN 2830 5442

Volume 2, No. 4, November 2023

APGHN

Archives of Pediatric Gastroenterology, Hepatology, and Nutrition

EDITORIAL BOARD

Editor-in-Chief

Fatima Safira Alatas

Editorial Team

Alpha Fardah Athiyyah

Ninung RD Kusumawati

Yudith Setiati Ermaya

James Guoxian Huang

Yoga Devaera

Kouji Nagata

COVER ILLUSTRATION

Hadasa Arum Ranti

Archives of Pediatric Gastroenterology, Hepatology, and Nutrition (APGHN) is the official journal issued by the Indonesian Society of Pediatric Gastroenterology, Hepatology, and Nutrition.
Contact us: apghnjgai@gmail.com

e-ISSN 2830 5442

Volume 2, No. 4, November 2023

APGHN

Archives of Pediatric Gastroenterology, Hepatology, and Nutrition

TABLE OF CONTENT

Archives of Pediatric Gastroenterology, Hepatology, and Nutrition (APGHN) is the official journal issued by the Indonesian Society of Pediatric Gastroenterology, Hepatology, and Nutrition.
Contact us: apghnjgai@gmail.com

Original Article

Analysis of the Impact of Continuous Ambulatory Peritoneal Dialysis on Nutritional Status in Pediatric Chronic Kidney Disease

Putri Amirah[1], Henny Adriani Puspitasari[2], Cut Nurul Hafifah[3]

[1]Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia

[2]Department of Nephorology, Faculty of Medicine Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

[3]Department of Nutrition and Metabolic Diseases, Faculty of Medicine Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

This work is licensed under **Creative Commons Attribution - Non Commercial 4.0 International License.**

e-ISSN: 2830-5442

Corresponding author:
Henny Adriani Puspitasari
puspitasarihenny@yahoo.com

Published:
30th November 2023

DOI:
https://doi.org/10.58427/apghn.2.4.2023.1-10.

Citation:
Amirah P, Puspitasari HA, Hafifah CN. Analysis of the Impact of Continuous Ambulatory Peritoneal Dialysis on Nutritional Status in Pediatric Chronic Kidney Disease. *Arch Pediatr Gastr Hepatol Nutr.* 2023;2(4).1-10.

Abstract:

***Background*:** Chronic kidney disease (CKD) is a serious problem for all age groups, particularly in children. Several studies have shown that patients with CKD who underwent dialysis, including Continuous Ambulatory Peritoneal Dialysis (CAPD), experienced malnutrition, short stature and growth retardation. This study aimed to evaluate the correlation between the indicators of CAPD regiments with the nutritional status of pediatric patients with CKD and factors that influence it.

***Method*:** We conducted a cross-sectional study by collecting secondary data from medical records such as disease stage and duration, the most recent CAPD regimen, etiology, and comorbidities. Data on nutritional status was then obtained by measuring body weight, height, and upper arm circumference. The measurement was then plotted using the WHO anthropometry application or the CDC growth chart. Demographic data such as the education level of father and mother, family economic status, age, and gender were obtained by filling out the Case Report Form (CRF).

Result: A total of fifteen respondents were included in this study. Children with CKD who underwent CAPD primarily had normal nutritional status with very short stature. Furthermore, no significant association was found between the CAPD regiments with the nutritional status of children with chronic kidney disease who are undergoing CAPD ($p>0.05$).

Conclusion: Children with CKD who underwent CAPD primarily had normal nutritional status with very short stature. There was no correlation between the parameters of CAPD regiments with the nutritional status of CKD patients who underwent CAPD. This indicates that the regiment used in this study is already quite satisfactory as it does not impact the nutritional status of those patients.

Keywords: children, continuous ambulatory peritoneal dialysis, end-stage renal disease, nutritional status

Introduction

Chronic kidney disease (CKD) is a serious problem for all age groups.[1] Children, in particular, have a remarkably high prevalence of CKD. In Europe, the incidence of CKD in pediatric patients reached around 11-12 per one million population, while the prevalence was 1.5-3.0 per one million.[2] Despite no national data, in Indonesia, specifically in the national referral center, the pediatric chronic kidney disease incidence was 150 children in 2007-2009, with 13 transplant procedures conducted in 2017-2018.[3]

Growth and development are the main differences between children and adults.[4] Children with chronic kidney disease may experience negative impacts on their growth and development, such as stunting and growth retardation during their first year of life. CKD may also cause secondary complications that significantly impact the patient's growth, development, and quality of life. Furthermore, children with CKD may also present symptoms such as pallor due to anemia, bone abnormalities, dyspnea, recurrent fever, and fatigue.[1, 3, 5] Dialysis is a treatment choice for treating pediatric CKD patients. It functions as a kidney replacement, particularly in removing body waste and water from the blood. There are two types of dialysis: hemodialysis and continuous ambulatory dialysis (CAPD). CAPD uses a semipermeable peritoneal membrane, which functions as a filter to eliminate excess body waste towards the dialysate liquid.[6] However, the use of CAPD may lead to the kidneys' inability to maintain the body's nutritional balance during the dialysis procedure.[7, 8] Several studies have shown that adult patients with CKD who underwent dialysis, including CAPD, experienced malnutrition. Dialysis was seen as the leading cause of inadequate nutritional intake, such as carbohydrates and protein, indicating a relation between dialysis, including CAPD, and the nutritional status of adult patients with CKD.[9-11] Considering the strong relation between severe malnutrition and child mortality, malnutrition due to CAPD might cause severe consequences in children.[12] Thus, this research aimed to evaluate the correlation between the indicators of CAPD regiments with the nutritional status of pediatric patients with CKD and factors that influence it.

Method

A cross sectional study was conducted between September to October 2022 in a tertiary, national-referral teaching hospital in Jakarta, Indonesia. The research was ethically approved by the local ethics committee with the approval number: KET-915/UN2.F1/ETIK/PPM.00.02/2022. Subjects included in this study were children aged 0-18 years old with terminal kidney failure who underwent CAPD for a minimum of 3 months. Inform consent was taken before the patients were enrolled in this study. Patients who undertook a combination of CAPD and hemodialysis, who had undergone kidney transplants, could not do body weight and height measurements with the standardized methods, and whose parents did not consent to be included in the research were excluded.

The research was carried out by collecting secondary data such as stage of disease, duration of CAPD, CAPD cycle, CAPD dwell time, CAPD filling volume, types of CAPD fluid, primary etiological factors, and comorbidities. The data were taken from the medical records one week prior to the nutritional status measurement. The nutritional status was then obtained by measuring body weight, height, and upper arm circumference performed when abdomen was emptied; using a Seca® type 763 digital weighing and measuring station and an upper arm circumference measuring tape. The measurement was then plotted using the WHO anthropometry application or the CDC growth chart. Demographic data such as parents' educational level, family economic status, age, and gender were acquired from the Case Report Form (CRF).

Statistical analysis in this study was performed using SPSS. Descriptive analysis was used to analyze the sociodemographic of this study. Normality test was conducted using Kolmogorov-Smirnov if the total subjects were under 50 or Saphiro-Wilk if the total subjects were above 50. The correlation between nutritional status and CAPD duration, cycle, dwell time, and fill volume were assessed through bivariate analysis using the Pearson correlation test if the data distribution was normal and the Spearman test if the data distribution was abnormal. Furthermore, the correlation between nutritional status with the types of CAPD liquid was performed using independent sample t-test for normally distributed data or Mann-Whitney for the data with abnormal distribution. If possible, multivariate analyses were also conducted.

Result

A total 21 pediatric patients with chronic kidney disease were eligible for this study. However, 6 patients were excluded as they were not residing in Java Island, thus unable to undergo standardized anthropometry measurement. Overall, fifteen participants were included in this study.

Characteristics of participant could be seen in **Table 1**. Based on the demographic characteristics, majority of the subjects were male (73.3%), with the average age of 13 ± 3.64 years old. Most of the participants came from lower-middle class family (66.7%). Among the primary etiologies, congenital anomalies of the kidneys and urinary tract (CAKUT) were the main etiology between the participants of this study (66.67%), followed by chronic glomerulonephritis (13.3%), other primary causes (13.3%), and Steroid-Resistant Nephrotic Syndrome or SRNS (6.7%). Comorbidities identified among the patients were anemia (93.3%), hypertension (53.3%), and bone mineral disorder (3.3%). Based on the CAPD regiments, the patients underwent 4-7

CAPD cycles with the duration of 4-6 hours. The dwell time was 4-6 hours, and the fill volume were approximately 500 – 1300 ml/BSA. All patients conducted the dialysis outside of the hospital and only came once per month for routine check-up unless multiple visitations were considered needed.

Table 1. Characteristics of participants

Parameters	**n (%)**
Age (years)*	13.00 ± 3.64
Gender	
Male	11 (73.3)
Female	4 (26.7)
Family Economic Status	
Upper middle class	5 (33.3)
Lower middle class	10 (66.7)
Father's Level of Education	
High school or equivalent	8 (53.3)
University	7 (46.7)
Mother's educational level	
High school or equivalent	12 (80.0)
University	3 (20.0)
Etiologies of CKD	
CAKUT	10 (66.7)
SRNS	1 (6.7)
Chronic glomerulonephritis	2 (13.3)
Other	2 (13.3)
Comorbidities	
Hypertension	8 (53.3)
Anemia	14 (93.3)
Bone mineral disorder	2 (3.3)
CAPD Regiment	
CAPD Duration (hours)**	6 (4 - 6)
CAPD Cycle per Day (times)**	4 (4 - 7)
CAPD Dwell Time**	6 (4 - 6)
CAPD fill volume (mL/m2 BSA)*	926.70 ± 212.02
Types of CAPD solution	
Dianeal® 1.5%	14 (93.3)
Dianeal® 2.5%	1 (6.7)
Nutritional Status (BMI for Age)	
Malnourished	5 (33.3)
Normal	9 (60.0)
Overweight	1 (6.7)

Length / Height for Age	
Severely stunted	6 (40.0)
Stunted	5 (33.3)
Normal	4 (26.7)

*Data is presented in mean ± standard deviation. **Data is presented in median (IQR). CKD: chronic kidney disease, CAKUT: congenital anomaly of kidney and urinary tract, SRNS: steroid-resistant nephrotic syndrome, CAPD: continuous ambulatory peritoneal dialysis. BSA: body surface area.

Among 15 participants, 9 of the patients had a normal nutritional status (60.0%), while 5 of them were malnourished (33.3%), and only 1 patient was classified as overweight (6.7%). The range of BMI in this study were 13.9-20.9 kg/m^2. Meanwhile, based on the length or height for age, 6 (40%) patients were categorized as severely stunting, while 5 of the participants (33.3%) were stunted.

The correlation between the regiments of CAPD with the nutritional status of CKD children was explained in **Table 2**. Based on our research, none of CAPD indicators were significantly correlated with the nutritional status of the participants. Furthermore, the use of different CAPD solution were not associated with the nutritional status of the patients.

Table 2. Correlation between CAPD duration, cycle, dwell time, and fill volume with nutritional status

	Weight for Age (n=15)	**Length / Height for Age (n=15)**	**BMI for Age (n=15)**
CAPD duration	r: -0.142 p: 0.613*	r: -0.247 p: 0.374*	r: -0.155 p: 0.582*
CAPD cycle	r: 0.236 p: 0.397*	r: 0.277 p: 0.317*	r: 0.216 p: 0.440*
CAPD dwell time	r: -0.142 p: 0.613*	r: 0.247 p: 0.374*	r: -0.155 p: 0.582*
CAPD fill volume	r: -0.08 p: 0.756*	r: 0.106 p: 0.708**	r: -0.126 p: 0.655**

*Analyzed using Spearman correlation coefficient. **Analyzed using Pearson correlation coefficient. BMI: body mass index, CAPD: continuous ambulatory peritoneal dialysis.

Discussion

CAPD is one of the dialysis methods which functions as kidney replacement in patients with chronic kidney disease. CAPD is a preferred method due to the flexibility of the procedures which allows patient to undergo dialysis from home.[6] Based on the previous research in our hospital, 25% of the adult patients who underwent CAPD were underweight.[13] Another study in pediatric patients demonstrated that protein deficiency was one of the most common complications of CAPD, causing growth disturbances. Furthermore, the duration of CAPD was correlated with the nutritional status of the patients. Pediatric patients who underwent CAPD had significantly lower prevalence of malnutrition during the first 6 months of age. However, the number increased after 12 months of therapy. The study also suggested that the addition of calorie intake for children who underwent CAPD, including those who had received higher calorie intake, to ensure the adequate intake of calorie. In addition, inadequate dialysis with less aggressive clearance may influence the nutritional status in children with CKD.[14]

Our study revealed that 33.3% of the patients who underwent CAPD were malnourished, while 11 out of 15 patients were considered as severely stunted (40.0%) and stunted (33.3%). Based on a previous study, patients with CKD tend to experience protein energy wasting (PEW) caused by the deficit of energy and protein storage due to metabolic stress. Furthermore, patients who underwent dialysis usually experience micronutrient loss due to many factors such as nephrotic syndrome, inflammation, decrease of appetite and poor nutrition consumption.[15] In relation with CAPD, a subsequent study had suggested that CKD patients undergoing CAPD had greater protein loss through the dialyzing solution which caused by the electrolyte imbalance.[16] However, due to the limitation of this study, further examination using handgrip strength measurements, documentation of food consumption over the past 3 days or the last 24 hours (Food Recall), completion of the Subjective Global Assessment scale questionnaire, as well as other laboratory parameters such as albumin serum, transferrin, and prealbumin tests should be conducted to confirm the malnutrition occurring in CKD patient who underwent CAPD.[17]

Several comorbidities were identified in this study. Interestingly, majority of the participants (93.3%) experience anemia. This finding aligns with a prior study indicating a high prevalence of anemia in CKD patients across all stages of disease.[18] Patients with the end stage of CKD commonly suffer from anemia due to a diminished level of erythropoietin resulting from kidney failure.[2] Furthermore, the severity of anemia tends to escalate alongside the progression of the disease.[19] To manage the occurrence of anemia in children with CKD, it is recommended to implement a systematic, long-term monitoring of hemoglobin levels, particularly in patients with hemoglobin levels below the fifth percentile based on the patient's age and gender.[20]

In addition, the occurrence of anemia in patients undergoing CAPD may cause symptoms such as weakness, fatigue, and growth inhibition which caused by insufficient nutritional intake, recurrent infections, and low oxygen in the cartilage. Thus, the prescription and administration of erythropoietin (EPO) are deemed crucial medications. However, it is imperative to maintain a balance in EPO administration, ensuring it is complemented by a proper diet, sufficient dialysis, controlled blood pressure, absence of bleeding, and optimal levels of iron, folic acid, and Vitamin B in the blood.[21]

Besides anemia, other comorbidities such as hypertension (53.3%) and bone mineral disorder (3.3%) were also identified in this study. Hypertension in patients with CKD develop due to the progressive kidney damage, which cause fluid overload and production of vasoactive hormones, leading to the increase of blood pressure. ACE inhibitor is the therapy of choice for this condition and is administered in patient with blood pressure above the 95th percentile based on age, height, and gender. In addition to this therapy, fluid and salt restriction is implemented with the aim of reducing blood pressure.[22] Bone mineral disorders commonly manifest in individuals with CKD due to the imbalance of calcium and phosphorus within the bloodstream. This disruption exerts consequential effects on the skeletal, vasculature, and cardiac system, arising from the progressive decline in renal function.[21] Similarly, other research also stated that this condition is the subsequent outcome of CKD, resulting from the accumulation of phosphate in the patient's body due to hindered excretion and decreased levels of calcitriol owing to the diminished renal mass in CKD patients.[23]

The indicators of CAPD regiments such as the duration, cycle, dwell time, fill volume, and the types of dialysis solution were noted in this study. Majority of the patients underwent CAPD procedures in the duration of 6 hours, with the total cycle of 4 times a day, a dwell time of 6 hours, a filling volume of 1000 ml, and using the CAPD solution of Dianeal® 1.5%. The regiment is in accordance with the guideline suggested by Indonesian Society of Nephrology (PERNEFRI) and Indonesian Ministry of Health, which suggested a total cycle of 3-4 times a day or more based on the body weight.[20, 24]

Based on our analysis, all indicators of CAPD regiments were not significantly correlated with the nutritional status of the patients with CKD. Despite the absence of previous studies that directly assessed the correlation between the duration of CAPD and the nutritional status of children with CKD, a similar result was reported by Adriyan et. al. which investigated the correlation between the use of Tenchkoff catheter (one of the tools in the CAPD procedure) with the nutritional status of pediatric patients with CKD. The study suggested that the use of Tenchkoff catheter were not significantly associated with the level of nutritional status in children with

CKD. Furthermore, the study also reported similar nutritional status on the population study, with the majority of the participants had normal nutritional status with short stature.[25] This may suggest that the duration of CAPD had no direct influence towards the nutritional status in pediatric patients with CKD. However, the study noted that the use of Tenchkoff catheter for more than 150 days may increase the risk of infection.[25] The occurrence of infection or other complications had been observed to affect the nutritional status of patients who underwent peritoneal dialysis. Furthermore, protein deficiency which caused malnutrition is associated with the risk of infection in patients who undertake CAPD.[26] Thus, despite having no direct influence towards the nutritional status, the duration of CAPD may trigger malnutrition through the occurrence of infection, particularly if the use of CAPD exceed 150 days.

This study also revealed that there was no correlation between the cycle of CAPD with the nutritional status of the patients. This is in contrast with the previous research which suggested that the increase of CAPD cycle was associated with the albumin loss, an indicator for malnutrition.[27] However, the regiment used in this study is in accordance with the guideline.[20] Furthermore, there is still no clear mechanism on how CAPD cycle affecting the nutritional status of patients with CKD. Thus, further study is still needed to determine the mechanism underlying the association between CAPD cycle and nutritional status of children with CKD.

Dwell time is known as the amount of duration a dialysis solution remain inside the abdominal cavity during the CAPD process. The dwell time in dialysis regimens is determined by the peritoneal membrane permeability of the patient, assessed through the Peritoneal Equilibration Test (PET) and categorized into 2 groups; high and low transporter status. In adult patients, high transporter status is linked with poorer prognosis. Meanwhile, in pediatric patients, high transporter status is associated with the higher level of C-Reactive Protein (CRP) and lower level of albumin serum which occur concurrently with the decrease of longitudinal growth.[28] In contrast, our study reported that the amount of dwell time was not significantly correlate with the nutritional status of the children with CKD. However, as our study did not differentiate between patients with high and low transporter status, further analysis is required to see the association between the transporter status with the nutritional status of children with CKD.

The relation between fill volume and the types of dialysis solution of CAPD were also examined in this study. The result exhibited that there was no correlation between the amount of fill volume as well as the type of solution used in CAPD procedures with the nutritional status of children with CKD.

Based on the findings of this study, it can be concluded that the regimens administered to the patients was effective, and did not compromise the nutritional status of the patients with CKD.

Conclusion

In conclusion, children with CKD who underwent CAPD primarily had normal nutritional status with very short stature. Furthermore, majority of the participants experienced anemia as the complication of CKD. Majority of the patients in this study underwent CAPD procedures in the duration of 6 hours, with the median total cycle of 4 times a day, the median dwell time of 6 hours, the mean filling volume of 926.70 ml/m2 BSA, and using the CAPD solution of Dianeal® 1.5%. There was no correlation between the parameters of CAPD regiments with the nutritional status of CKD patients who underwent CAPD. This indicates that current CAPD regiment did not impact the nutritional status of CAPD children.

Conflict of Interest

None declared

Funding Statement

The authors received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

References

1. IDAI. Mengenal penyakit ginjal kronik pada anak: IDAI; 2016 [cited 2022 9 Jun]. Available from: https://www.idai.or.id/artikel/seputar- kesehatan-anak/mengenal-penyakit-ginjal-kronik-pada-anak.
2. Becherucci F, Roperto RM, Materassi M, Romagnani P. Chronic kidney disease in children. Clinical Kidney Journal. 2016;9(4):583–91. https://doi.org/10.1093/ckj/sfw047
3. Hidayati, EL. Gangguan ginjal pada anak: KEMENKES; 2018 [cited 2022 9 Jun]. Available from: http://p2ptm.kemkes.go.id/uploads/VHcrbkVobjRzUDN3UCs4eUJ0dVBndz09/2018/11/Paparan_dr_Eka_Laksmi_IDAI_Media_Briefing_Kenali_Gangguan_Ginjal_Pada_Anak_13_November_2018.pdf
4. Greenbaum LA, Warady BA, Furth SL. Current advances in chronic kidney disease in children: growth, cardiovascular, and neurocognitive risk factors. Semin Nephrol. 2009;29(4):425-34. https://doi.org/10.1016/j.semnephrol.2009.03.017
5. Silverstein DM. Growth and Nutrition in Pediatric Chronic Kidney Disease. Front Pediatr. 2018;6:205. https://doi.org/10.3389/fped.2018.00205
6. Vadakedath S, Kandi V. Dialysis: A Review of the Mechanisms Underlying Complications in the Management of Chronic Renal Failure. Cureus. 2017;9(8):e1603. https://doi.org/10.7759/cureus.1603
7. National Institute of Diabetes and Digestive and Kidney Disease. Eating & nutrition for peritoneal dialysis: NIDDK; 2018 [cited 2022 9 Jun]. Available from: https://www.niddk.nih.gov/health-information/kidney-disease/kidney-failure/peritoneal-dialysis/eating-nutrition.
8. Paglialonga F, Edefonti A. Nutrition assessment and management in children on peritoneal dialysis. Pediatr Nephrol. 2009;24(4):721-30. https://doi.org/10.1007/s00467-007-0719-4
9. Dewi RTK, Putranto W, Susanto A, Suseno A, Purwanto B, Mangesti RD, et al. Hubungan Kualitas Hidup dan Status Nutrisi pada Pasien Penyakit Ginjal

Kronik dengan Tipe Dialisis. Jurnal Penyakit Dalam Indonesia. 2020;7(1). https://doi.org/10.7454/jpdi.v7i1.381
10. Kiebalo T, Holotka J, Habura I, Pawlaczyk K. Nutritional Status in Peritoneal Dialysis: Nutritional Guidelines, Adequacy and the Management of Malnutrition. Nutrients. 2020;12(6). https://doi.org/10.3390/nu12061715
11. Satirapoj B, Limwannata P, Kleebchaiyaphum C, Prapakorn J, Yatinan U, Chotsriluecha S, et al. Nutritional status among peritoneal dialysis patients after oral supplement with ONCE dialyze formula. Int J Nephrol Renovasc Dis. 2017;10:145-51. https://doi.org/10.2147/IJNRD.S138047
12. World Health Organization. Analisis lengkap kajian negara Indonesia. 2010.
13. Yulianti M, Suhardjono S, Kresnawan T, Harimurti K. Faktor-faktor yang Berkorelasi dengan Status Nutrisi pada Pasien Continuous Ambulatory Peritoneal Dialysis (CAPD). Jurnal Penyakit Dalam Indonesia. 2017;2(1). https://doi.org/10.7454/jpdi.v2i1.59
14. Ekim M, Ikinciogullari A, Ulukol B, Bakkaloglu SA, Ozkaya N, Kendirli T, et al. Evaluation of Nutritional Status and Factors Related to Malnutrition in Children on CAPD. Peritoneal Dialysis International: Journal of the International Society for Peritoneal Dialysis. 2003;23(6):557-62. https://doi.org/10.1177/089686080302300607
15. Nelms CL, Shaw V, Greenbaum LA, Anderson C, Desloovere A, Haffner D, et al. Assessment of nutritional status in children with kidney diseases-clinical practice recommendations from the Pediatric Renal Nutrition Taskforce. Pediatr Nephrol. 2021;36(4):995-1010. https://doi.org/10.1007/s00467-020-04852-5
16. Ponton-Vazquez C, Vasquez-Garibay EM, Hurtado-Lopez EF, de la Torre Serrano A, Garcia GP, Romero-Velarde E. Dietary Intake, Nutritional Status, and Body Composition in Children With End-Stage Kidney Disease on Hemodialysis or Peritoneal Dialysis. J Ren Nutr. 2017;27(3):207-15. https://doi.org/10.1053/j.jrn.2016.12.007
17. Iorember FM. Malnutrition in Chronic Kidney Disease. Front Pediatr. 2018;6:161. https://doi.org/10.3389/fped.2018.00161
18. Yuniarti W. Anemia in Chronic Kidney Disease Patients. Journal Health & Science : Gorontalo Journal Health and Science Community. 2021;5(2):341-7. https://doi.org/10.35971/gojhes.v5i2.11632
19. Patrick FM, Umboh ORH, Rotty LWA. Hubungan Kadar Hemoglobin dengan Laju Filtrasi Glomerulus pada Pasien Penyakit Ginjal Kronik Stadium 3 dan 4 Di RSUP Prof. Dr. R. D. Kandou Manado Periode Januari 2017 - Desember 2018. e-CliniC. 2019;8(1). https://doi.org/10.35790/ecl.v8i1.27190
20. Roesli RMA, Bawazier LA, Lubis HR, Prodjosudjadi W, Pranawa, Suhardjono. Konsensus dialisis. 1 ed. Jakarta: PERNEFRI; 2003.
21. Komunitas Pasien Cuci Darah Indonesia. Mengapa penting bagi pasien CAPD untuk minum obat yang diresepkan? : KPCDI; 2021 [cited 2022 13 Nov]. Available from: https://kpcdi.org/2020/04/01/mengapa-penting-bagi-pasien-capd-untuk-minum-obat-yang-diresepkan/.
22. Ervina L, Bahrun D, Lestari HI. Tatalaksana penyakit ginjal kronik pada anak. Majalah Kedokteran Sriwijaya. 2015;47(2):144-9. https://doi.org/https://doi.org/10.36706/mks.v47i2.2758
23. Suwitra K. Gangguan mineral dan tulang pada penyakit ginjal kronik patogenesis, diagnosis, dan modalitas terapi: Universitas Udayana; 2015.
24. Direktorat Jenderal Bina Pelayanan Medik. Pedoman pelayanan hemodialisis di sarana pelayanan kesehatan. Jakarta: Departemen Kesehatan RI; 2008.
25. Ardiyan T, Fitriana EI, Dastamuar S, Maritska Z. Hubungan antara Lama Terpasang Kateter Tenchkoff, Status Gizi, Jenis Pembedahan, dan Komplikasi pada Anak dengan Continous Ambulatory Peritoneal Dialysis. Sari Pediatri. 2022;24(1). https://doi.org/10.14238/sp24.1.2022.36-43
26. Al Mokali K, Al Sannaa Z, Al Mutairi F, Ahmed AE. Factors influencing occurrence of peritonitis in Saudi children on peritoneal dialysis. BMC Pediatr. 2020;20(1):42. https://doi.org/10.1186/s12887-020-1936-2
27. Honda M, Kamiyama Y, Kawamura K, Kawahara K, Shishido S, Nakai H, et al. Growth, development and nutritional status in Japanese children under 2 years on continuous ambulatory peritoneal dialysis. Pediatr Nephrol. 1995;9(5):543-8. https://doi.org/10.1007/BF00860924
28. Schmitt CP, Zaloszyc A, Schaefer B, Fischbach M. Peritoneal dialysis tailored to pediatric needs. Int J Nephrol. 2011;2011. https://doi.org/10.4061/2011/940267

Original Article

The Relationship Between Nutritional Status, Vegetable Consumption and Physical Activity with Age of Menarche in Adolescent Girls

Rachelya Nurfirdausi Islamah[1], Dwiana Ocviyanti[2]

[1]Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia

[2]Department of Obstetrics and Gynecology, Faculty of Medicine Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

This work is licensed under **Creative Commons Attribution - Non Commercial 4.0 International License.**

e-ISSN: 2830-5442

Corresponding author:
Rachelya Nurfirdausi Islamah
rachelsangster1@gmail.com

Published:
30th November 2023

DOI:
https://doi.org/10.58427/apghn.2.4.2023.11-23

Citation:
Islamah RN, Ocviyanti D. The Relationship Between Nutritional Status, Vegetable Consumption and Physical Activity with Age of Menarche in Adolescent Girls. *Arch Pediatr Gastr Hepatol Nutr*. 2023;2(4).11-23

Abstract:

Background: Menarche is the first menstrual period and marks the maturity of an adolescent girl's body. In the last decade, there has been an increase in nutritional status of children and adolescents which is often associated with an accelerated age of menarche. Several studies have shown a strong relationship between physical activity, body mass index (BMI) with the age at which menarche occurs in teenage girls. The habit of consuming certain foods such as meat and fast food is proven to accelerate the age of menarche due to an increase in fat levels. This study aims to evaluate the relationship between age of menarche with BMI, physical activity, and vegetable consumption.

Methods: This research was conducted using cross-sectional study design. Participants had been filtered by inclusion criteria and exclusion criteria. Selected participants then had their height and weight measured, and filled out an online questionnaire regarding menarche and physical activity. Participants also underwent a 24-hour recall interview to determine their vegetable consumption.

Results: Fifty-two participants were recruited in this study. Most of them were 12 and 13 years of age (42.3% each). Based on the results of Kruskal-Wallis test, there was no relationship between age of menarche and BMI ($p = 0.071$), between age of menarche and physical activity ($p=0.251$) and between age of menarche and vegetable consumption ($p=0.753$)

Conclusion: In conclusion, based on the results of this study, we did not find any correlation between the age of menarche and BMI, physical activity and vegetable consumption among adolescent girls in West Java region.

Keywords: children, menarche, nutritional status, physical activity, vegetable consumption

Introduction

Menarche is the first menstrual period and marks the maturity of an adolescent girl's body.[1] Menstruation is a monthly cycle that occurs due to the shedding of the functional lining of the uterine endometrium during ovulation when not followed by fertilization. The average age of menarche varies between different ethnicities and races. Globally, the average age of menarche in adolescents is 12.4 years old.[1] In America, the average age of menarche is 12.43 years old while in Asian regions such as Hong Kong and Japan, the average age of menarche is 12.38 and 12.2 years old respectively.[2, 3] Meanwhile, in Indonesia, the average age of menarche is 12.96 years old.[4]

Several studies have shown a strong relationship between physical activity, body mass index (BMI), socio-economic factors, and the mother's history of menarche with the age at which menarche occurs in teenage girls. Furthermore, the habit of consuming certain foods such as meat and fast food is proven to accelerate the age of menarche due to an increase in fat levels.[5] On the contrary, consuming fruits and vegetables are known to be able to delay the onset of menarche.[6] The way foods influencing the age of menarche is thought to be due to estrogen hormone in the hypothalamus-hypophysis axis (HPA) that is easily affected by nutritional status of an individual. Furthermore, the HPA axis is also influenced by the body's fat percentage which is reflected by the BMI. Therefore, the BMI of an adolescent girl is strongly correlated with earlier age of menarche. Higher body's fat percentage is associated with higher serum leptin hormone level which also correlated with the age of menarche.[7] On the other hand, physical activity is an effective way to reduce fat mass and therefore may suppress the reproductive function and delay the onset of menarche.[8]

In the last decade, there has been an increase in nutritional status of children and adolescents which is often associated with an accelerated age of menarche.[1] In Indonesia, the age of menarche in adolescents is occurring earlier from time to time. The average age of menarche for female adolescents in Indonesia between 1961-1965 period was 14.43 years old. However, after 1970, this figure decreased steadily from 14.43 to 13.63 years old in 2010. It is predicted that the average age of menarche will continue to decrease with the rate of 0.0245 years annually.[9]

Meanwhile, according to the 2007 *Survey Data Kependudukan Indonesia* (SDKI), the number of early marriage cases in Indonesia reached 50 million people with West Java being one of the provinces with the highest rate of early marriage with an astonishing rate of 36%.[10] The decreasing age of menarche has increased the tendency for early marriage which is also associated with numerous health risks. Early marriage can result in several health impacts such as early pregnancy, sexually transmitted diseases and sexual violence. Moreover, early pregnancy can also negatively impact the health and increase the risk of pregnancy, such as ectopic pregnancy, low birth weight babies and premature babies.[9] Therefore, the age of menarche for adolescent girls in Bandung Regency needs more attention. Moreover, early age of menarche (menarche before 12 years of age) is correlated with adiposity, metabolic syndrome, and an increased risk of breast cancer. This is partly caused by increased exposure to estrogen in life.[11] Early or late menarche is also associated with an increased risk of experiencing coronary heart disease.[12] However, the majority of the population of Bandung Regency is from the Sundanese tribe who have a penchant for eating fresh vegetables. Fresh vegetables are vegetables that can be consumed raw or cooked after eating the main meal. This habit can affect BMI and also slow down the age of menarche, thereby overcoming the concerns about the trend of accelerating age of menarche.[13] Therefore, research is needed to obtain the average age of menarche of adolescent girls living in Bandung Regency. This study also aims to evaluate the relationship between age of menarche with BMI, physical activity, and vegetable consumption.

Methods

This research was conducted using cross-sectional study design. Participants had been filtered by inclusion criteria and exclusion criteria. Selected participants then had their height and weight measured, and filled out an online questionnaire regarding menarche and physical activity. This was done to determine the nutritional status, physical activity and age at menarche of the subject. After that, participants underwent a 24-hour recall interview to determine their vegetable consumption. The data collection process was carried out following the COVID-19 protocol in Indonesia as this study was conducted during the pandemic era. This study was conducted at several primary and middle high schools in Bandung, West Java, Indonesia from February to September 2021.

Inclusion criteria were adolescent girls aged 9-15 years who were attending primary high school class 5,6 or secondary high school class 7 and who experienced menarche within 13 months prior to the study. Participants also agreed to participate in this study by signing the informed consent form. Exclusion criteria were adolescent females with chronic diseases or consuming any drugs that may interfere with normal menstrual cycle and those with precocious puberty.

Nutritional status was determined based on the Center for Disease Control and Prevention (CDC) growth chart classification. If the Waterloo classification of body weight was more than 110% of the ideal body weight then the Body Mass Index Chart was used to determine the nutritional status of the participants. Nutritional status was classified based on BMI-for-age chart with the following classification: participants with BMI value within 5^{th}-85^{th} percentiles were categorized as good nutritional status, those who were below 5^{th} percentiles were categorized as wasted and those above 85^{th}

percentiles were categorized as overweight/obese. Physical activity was classified as following: good physical activity when respondents exercised at least 60 minutes of moderate or vigorous activity per day, insufficient physical activity was defined when respondents exercised less than recommended and poor physical activity was defined when respondents did not exercise at all.[14, 15] Vegetable consumption was categorized as following: good vegetable consumption when respondents consumed at least 2 cup of vegetable per day, insufficient vegetable consumption when respondents consumed less than 2 cup of vegetable per day and poor vegetable consumption when respondents did not consume any vegetable at all based on 24-hour food recall questionnaire.[16]

Statistical analysis was conducted by using SPSS version 24.0. Data were first analyzed to obtain an overview of demographic data as well as the factors that might influence the age of menarche. Then, bivariate data analysis was carried out on the dependent variable and independent variables to see the relationship between BMI, physical activity, and vegetable consumption habits with the age of menarche. Bivariate data analysis was carried out using the Kruskal-Wallis test because the data distribution was not normal.

Results

Fifty-two participants were recruited in this study. Most of them were 12 and 13 years of age (42.3% each). Most participants' father and mother were high school graduate (57.7% and 59.6% respectively). Mean age of menarche from all participants was 11.4 years with minimum age of 9 years and 13.7 years. Baseline characteristics of all participants were presented in **Table 1**.

Table 1. Baseline characteristics of participants

Variables	Frequency (n (%))
Age (years)	
10	1 (1.9)
11	7 (13.5)
12	22 (42.3)
13	22 (42.3)
Father's education level	
Primary school	1 (1.9)
Middle high school	6 (11.5)
Senior high school	30 (57.7)
Bachelor	15 (28.8)
Mother's education level	
Primary school	0 (0)
Middle high school	6 (11.5)

Senior high school	31 (59.6)
Bachelor	15 (28.8)
Parents' occupation	
Unemployed	7 (13.5)
Private employees	38 (73.1)
Government employees	7 (13.5)
Parental income	
Under 1,990,000 rupiah	15 (28.8)
Above 1,990,000 rupiah	37 (71.2)

Based on BMI classification, 33 participants (63.4%) had good nutritional status, 6 participants (11.5%) were wasted and 12 participants (23.1%) were overweight/obese. Meanwhile, based on physical activity classification, 43 participants (82.6%) were classified as insufficient physical activity, 5 participants (9.6%) were classified as poor physical activity and only 3 participants (5.8%) had good physical activity. On the other hand, only 46 patients underwent 24-hour food recall to determine the amount of vegetable consumed. Twenty-one participants (45.6%) were classified as insufficient vegetable consumption, 17 (36.9%) participants were classified as poor vegetable consumption and only 8 (4.3%) participants were classified as good vegetable consumption.

In this study, several statistical tests were performed. First, in order to assess the normality of the data, the Kolmogorov-Smirnov test was carried out. In this study, the normality test value obtained was p = 0.000 for numerical data, including data on age of menarche. This value indicated that the distribution was not normal. Next, statistical tests were carried out to assess the relationship between age of menarche as the dependent variable and several independent variables such as BMI, physical activity and vegetable consumption. Each of these independent variables was categorized into 3 categories. Therefore, to assess each relationship between the dependent and independent variables with abnormal data distribution, the Kruskal-Wallis test was conducted. Bivariate analysis results were presented in **Table 2**.

Table 2. Bivariate analysis between age of menarche and several independent variables.

Variables	Frequency (n (%))	p-value
Body mass index		
Wasted	6 (11.5)	
Good	33 (63.5)	0.071
Overweight/obese	12 (23.1)	
Physical activity		
Poor	5 (9.6)	0.251

Insufficient	43 (82.7)	
Good	3 (5.8)	
Vegetable consumption		
Poor	17 (32.7)	
Insufficient	21 (40.4)	0.753
Good	8 (15.4)	

Based on the results of Kruskal-Wallis test regarding the relationship between age of menarche and BMI, the results were $p > 0.05$, indicating no significant difference ($p = 0.071$). **Figure 1** depicts the correlation between age of menarche and BMI based on the results obtained from each sample with inclusion criteria. Next, Mann-Whitney analysis was performed to evaluate whether there was a difference of age of menarche between two BMI groups. Based on the results, there was no significant difference of the age of menarche between participants in normal BMI group and wasted group, nor the age of menarche in the normal BMI group and overweight/obese group ($p = 0.051$).

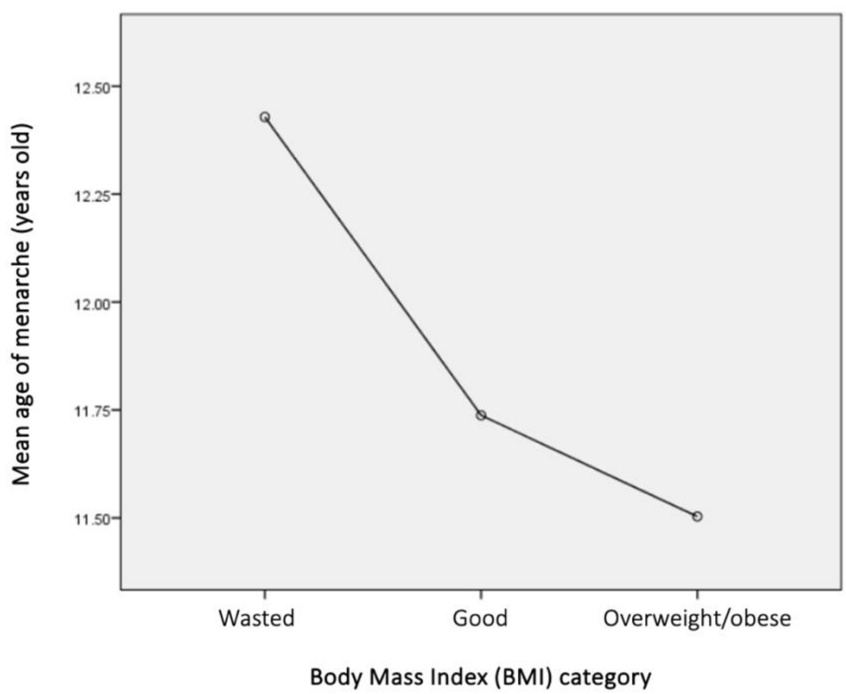

Figure 1. Correlation between age of menarche and body mass index category.

Based on the results of Kruskal-Wallis test, there was no significant relationship between age of menarche and physical activity ($p=0.251$). **Figure 2** illustrates the correlation between age of menarche and physical activity. In theory, physical activity can reduce the acceleration of the age of menarche because it can reduce BMI. However, based on Chi-Square analysis, it was found that respondents with good physical activity had a higher BMI. However, this result was not statistically significant ($p = 0.443$).

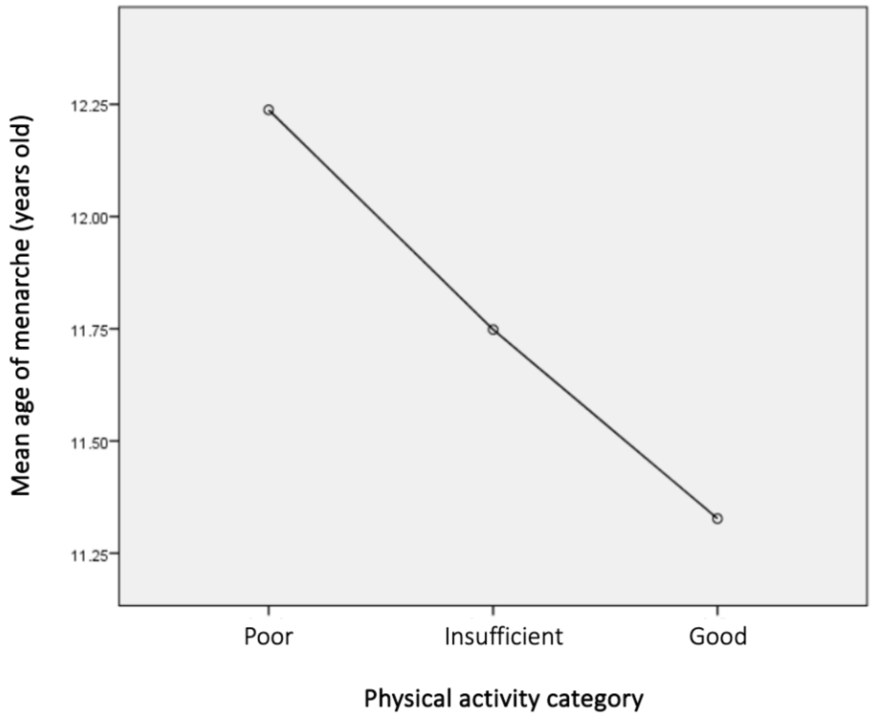

Figure 2. Correlation between age of menarche and physical activity category.

Figure 3. depicts the correlation between age of menarche and vegetable consumption. There was a trend that showed respondents who consumed at least 2 cups of vegetable experienced menarche at earlier age compared to those with insufficient or poor vegetable consumption.

To evaluate whether there was a relationship between age of menarche and other factors besides the independent variables that were focused in this research, we also conducted Mann-Whitney test to assess the relationship between age of menarche and parental income. Respondents with parents earning more than IDR 1,990,000 had a later age of menarche. From this test, the results obtained were $p > 0.05$ so the results indicated no significantly difference ($p = 0.777$).

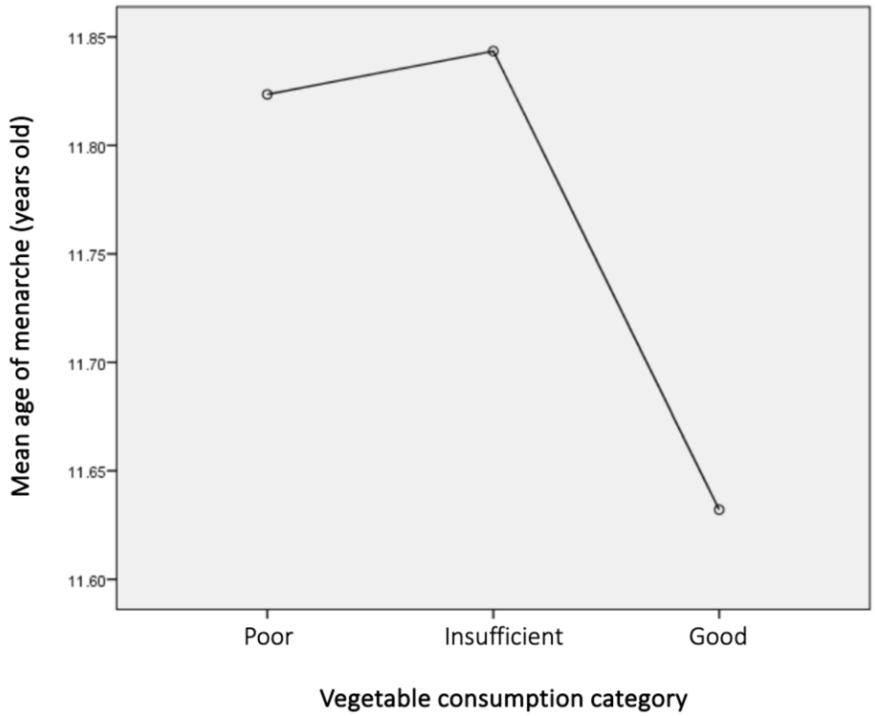

Figure 3. Correlation between age of menarche and vegetable consumption category.

Discussion

The age of menarche for adolescent girls in Indonesia is occurring earlier from time to time. The increasingly early age of menarche can escalate the tendency for early marriage as well as the various health risks it poses. Several factors are known to influence the age at which menarche occurs, including physical activity, body mass index (BMI), and nutrition. The habit of consuming meat and fast food can also accelerate the onset of menarche, due to an increase in fat levels. High levels of fat in the body's adipose tissue cause high blood leptin level which correlates with the occurrence of menarche.[7] The fat content of adipose tissue is best depicted through BMI measurement. Physical activity can influence the age of menarche by reducing adiposity and decreasing reproductive function. Both of these things occur due to decreasing leptin levels when there is insufficient adipose tissue.[8]

On the other hand, consuming vegetables and fruit can slow down the age of menarche. This occurs due to several mechanisms that may regulate reproductive hormones by consuming more vegetables such as changes in enterohepatic estrogen circulation, reduction of estrogen bioavailability and suppression of gonadotropin production contribute to delayed age of menarche.[17-21]

In this study, we identified one dependent variable, namely age at menarche and three independent variables including BMI, physical activity, and vegetable consumption.

Each of these independent variables is grouped into 3 categories ordinally. From the results of the statistical test analysis in this study, there was no significant relationship between age of menarche and physical activity, BMI, or vegetable consumption.

Based on statistical analysis of BMI and age of menarche in our study, there was a tendency that menarche occurred at earlier age in adolescent girls who had higher BMI. However, this result was not statistically significant ($p>0.05$). This is further supported by a study conducted by Fitriany et al. in which it was reported that there was no significant relationship between age of menarche and BMI.[22] Furthermore, this result is also in line with research conducted by Himes et al. who reported that BMI is not the only factor that determines the age of menarche.[23] Garn et al. and Sherar et al. also stated that there was no clear evidence between body fat mass or body weight and its effect on age of menarche.[24, 25]

On the other hand, analysis of statistical tests regarding the relationship between age of menarche and physical activity resulted in no significant correlation ($p>0.05$). This result is in line with research conducted by Khoshnevisasl et al. who also reported no significant relationship between age of menarche and physical activity.[26] Furthermore, Tehrani et al. stated that physical activity does not directly affect the age of menarche, but instead, it plays a role in reducing BMI and exert secondary effects on the hypothalamic and pituitary axis.[27] Further evaluation in this study revealed that respondents with higher physical activity had lower BMI, although this finding was also not statistically significant ($p=0.443$).

Statistical test analysis regarding the relationship between age of menarche and vegetable consumption showed different results between the three groups. The group with poor vegetable consumption experienced menarche at an earlier age than the group with less vegetable consumption. This is in accordance with the theory regarding the relationship between vegetable consumption and age at menarche. However, this difference is not statistically significant ($p > 0.05$). Collecting data on vegetable consumption using 24-hour recall interviews can also cause bias due to errors in sample recall. Based on the results, there was no significant relationship between vegetable consumption and the BMI of our participants.

There are similarities between the results of this study and research conducted by Rogers et al., where there was no significant relationship regarding the age of menarche between vegetarian and non-vegetarian teenagers.[28] In addition, although some research evidence suggests that vegetables can reduce weight in a short time, there are still inconsistencies in the results obtained.[28] A meta-analysis study concluded that the impact of increasing vegetable and fruit intake was miniscule and not significant if there were no instructions to limit energy from other foods. This suggests that increasing certain foods such as vegetables may not result in weight loss if overall dietary intake is not taken into account.[29] Another meta-analysis that independently investigated vegetables consumption did not find any significant association between increased vegetable consumption and weight loss, but there was an association with a reduced risk of adiposity.[30]

The results of statistical test analysis regarding the relationship between age of menarche and parental income show differences in results between the two groups. The group with parents earning more than IDR 1,990,000 had a later age of menarche and a lower BMI than the group with parents earning less than IDR 1,990,000. However, the results of this relationship analysis were not significant. Theoretically, socio-economic factors in a young woman's family can influence the age of menarche. However, from the results of the analysis the relationship between parental income and children's BMI was not significant ($p > 0.05$). The results obtained from this study are in accordance with research conducted by Afkhamzadeh et al, in which no significant relationship was found between the socio-economic status of the respondent's parents and age at menarche ($p = 0.722$).[31] This might occur due to parents with higher incomes tend to have broader insight and knowledge, but have less time to discuss and spend time with their children. Meanwhile, parents such as housewives have more free time with their children, and have the opportunity to discuss and also monitor their daughters' nutritional status better.[31] Apart from that, parents' openness regarding their family's income can influence information about the family's social and economic status. However, other factors may have a greater influence on the age of menarche, such as genetic factors and nutritional status that were not included in this study.

In addition, based on the results of the Chi-Square test analysis, it is known that the sample group with low-income parents has a higher BMI. This is in accordance with research conducted by Morgenstern et al., which concluded that students with lower socio-economic backgrounds have a higher risk of being overweight due to higher television viewing habits.[32]

The limitation of this research is the lack of samples used in the statistical test process. The samples obtained were still less than the minimum target sample size required. This occurred due to the ongoing COVID-19 pandemic, so research had to be carried out remotely. The series of research processes carried out remotely also caused for lost to follow up for respondents who have met the inclusion criteria, hence the sample obtained was even fewer. The absence of a relationship obtained from the results of this study is mostly due to the influence of other factors, especially genetic factors, which greatly influence the age of menarche. There is a close relationship found between the age of menarche of mothers and their daughters, and also between a daughter and her sisters. Other things that certainly influence the age of menarche are socio-economic factors, past illnesses, and also nutritional factors.

Conclusion

In conclusion, based on the results of this study, we did not find any correlation between the age of menarche and BMI, physical activity and vegetable consumption among adolescent girls in West Java region. Furthermore, there was no significant differences of age of menarche between all categorical groups of each BMI, physical activity and vegetable consumption.

In future research, additional respondents should be recruited to meet the minimum standards required. Apart from that, changes should be made to the method of assessing vegetable consumption data as well as extending the period of food recall, in order to better reflect vegetable consumption habits. Furthermore, future research should also consider controlling other factors that can influence the age of menarche. Study design should also be improved to a more long-term study, such as by using randomized controlled trial or cohort design. We also suggest that data collection in further research should be performed offline, so that researchers can interact directly with respondents and increase their compliance in filling in the required data.
From this study, we suggest that the government should increase public awareness of vegetable consumption and physical activity among the community. Because although in this study there were no significant results between age of menarche and BMI, physical activity and vegetable consumption, these three things certainly need to be considered to achieve overall physical health.

Conflict of Interest

None declared.

Funding Statement

The authors received no specific grant from any funding agency when conducting this research.

References

1. Lacroix AE, Gondal H, Shumway KR, Langaker MD. Physiology, Menarche. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2023, StatPearls Publishing LLC.; 2023.
2. Chumlea WC, Schubert CM, Roche AF, Kulin HE, Lee PA, Himes JH, et al. Age at menarche and racial comparisons in US girls. Pediatrics. 2003;111(1):110-3.https://doi.org/10.1542/peds.111.1.110

3. Karapanou O, Papadimitriou A. Determinants of menarche. Reprod Biol Endocrinol. 2010;8:115.https://doi.org/10.1186/1477-7827-8-115
4. Sudikno S, Sandjaja S. USIA MENARCHE PEREMPUAN INDONESIA SEMAKIN MUDA: HASIL ANALISIS RISKESDAS 2010. Jurnal Kesehatan Reproduksi. 2020;10:163-71.https://doi.org/10.22435/kespro.v10i2.2568
5. Munda SS. Hubungan antara IMT dengan usia menarche pada siswi SD dan SMP di Kota Manado. e-CliniC. 2013;1(1)
6. Cheng G, Buyken AE, Shi L, Karaolis-Danckert N, Kroke A, Wudy SA, et al. Beyond overweight: nutrition as an important lifestyle factor influencing timing of puberty. Nutr Rev. 2012;70(3):133-52.https://doi.org/10.1111/j.1753-4887.2011.00461.x
7. Malina RM. Menarche in athletes: a synthesis and hypothesis. Ann Hum Biol. 1983;10(1):1-24.https://doi.org/10.1080/03014468300006141
8. Wade GN, Jones JE. Neuroendocrinology of nutritional infertility. Am J Physiol Regul Integr Comp Physiol. 2004;287(6):R1277-96.https://doi.org/10.1152/ajpregu.00475.2004
9. Wahab A, Wilopo SA, Hakimi M, Ismail D. Declining age at menarche in Indonesia: a systematic review and meta-analysis. Int J Adolesc Med Health. 2018;32(6).https://doi.org/10.1515/ijamh-2018-0021
10. Demografi S. Kesehatan Indonesia (SDKI). 2007. Data Pernikahan Dini Di Indonesia.
11. Apter D, Vihko R. Early menarche, a risk factor for breast cancer, indicates early onset of ovulatory cycles. J Clin Endocrinol Metab. 1983;57(1):82-6.https://doi.org/10.1210/jcem-57-1-82
12. Canoy D, Beral V, Balkwill A, Wright FL, Kroll ME, Reeves GK, et al. Age at menarche and risks of coronary heart and other vascular diseases in a large UK cohort. Circulation. 2015;131(3):237-44.https://doi.org/10.1161/circulationaha.114.010070
13. Chavarro J, Villamor E, Narváez J, Hoyos A. Socio-demographic predictors of age at menarche in a group of Colombian university women. Ann Hum Biol. 2004;31(2):245-57.https://doi.org/10.1080/03014460310001652239
14. Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, et al. The physical activity guidelines for Americans. Jama. 2018;320(19):2020-8
15. Kemenkes R. Ayo bergerak lawan obesitas. Kementrian Kesehatan Republik Indonesia. 2017:37
16. Gidding SS, Dennison BA, Birch LL, Daniels SR, Gillman MW, Lichtenstein AH, et al. Dietary recommendations for children and adolescents: a guide for practitioners: consensus statement from the American Heart Association. Circulation. 2005;112(13):2061-75.https://doi.org/10.1161/circulationaha.105.169251
17. Goldin BR, Adlercreutz H, Gorbach SL, Warram JH, Dwyer JT, Swenson L, et al. Estrogen excretion patterns and plasma levels in vegetarian and omnivorous women. N Engl J Med. 1982;307(25):1542-7.https://doi.org/10.1056/nejm198212163072502
18. Shultz TD, Howie BJ. In vitro binding of steroid hormones by natural and purified fibers. Nutr Cancer. 1986;8(2):141-7.https://doi.org/10.1080/01635588609513887
19. Adlercreutz H, Höckerstedt K, Bannwart C, Bloigu S, Hämäläinen E, Fotsis T, et al. Effect of dietary components, including lignans and phytoestrogens, on enterohepatic circulation and liver metabolism of estrogens and on sex hormone binding globulin (SHBG). J Steroid Biochem. 1987;27(4-6):1135-44.https://doi.org/10.1016/0022-4731(87)90200-7
20. Mammalian Lignans and Phyto-oestrogens Recent Studies on their Formation, Metabolism and Biological Role in Health and Disease2012.
21. de Ridder CM, Thijssen JH, Van 't Veer P, van Duuren R, Bruning PF, Zonderland ML, et al. Dietary habits, sexual maturation, and plasma hormones in pubertal girls: a longitudinal study. Am J Clin Nutr. 1991;54(5):805-13.https://doi.org/10.1093/ajcn/54.5.805
22. Fitriany J, Maulina F, Witanti C. HUBUNGAN INDEKS MASSA TUBUH DENGAN USIA MENARCHE PADA SISWI SMP DI KOTA LHOKSEUMAWE. AVERROUS: Jurnal Kedokteran dan Kesehatan Malikussaleh. 2018;4:26.https://doi.org/10.29103/averrous.v4i1.802
23. Himes JH, Park K, Styne D. Menarche and assessment of body mass index in adolescent girls. J Pediatr. 2009;155(3):393-7.https://doi.org/10.1016/j.jpeds.2009.03.036
24. Garn SM, LaVelle M, Pilkington JJ. Comparisons of fatness in premenarcheal and postmenarcheal girls of the same age. J Pediatr. 1983;103(2):328-31.https://doi.org/10.1016/s0022-3476(83)80379-5
25. Sherar LB, Baxter-Jones AD, Mirwald RL. The relationship between body composition and onset of menarche. Ann Hum Biol. 2007;34(6):673-7.https://doi.org/10.1080/03014460701660502
26. Khoshnevisasl P, Sadeghzadeh M, Mazloomzadeh S, Ahmadiafshar A, Babri L. Age at Menarche and its Related Factors among School Girls, in Zanjan, Iran. International Journal of Pediatrics. 2017;5:4755-62.https://doi.org/10.22038/ijp.2017.21178.1779
27. Dewi AK, Febrian AS. Hubungan antara aktifitas fisik dengan umur menarche. Tarumanagara Medical Journal. 2018;1(1):14-20
28. Rogers IS, Northstone K, Dunger DB, Cooper AR, Ness AR, Emmett PM. Diet throughout childhood and age at

menarche in a contemporary cohort of British girls. Public Health Nutr. 2010;13(12):2052-63.https://doi.org/10.1017/s1368980010001461
29. Tapsell LC, Dunning A, Warensjo E, Lyons-Wall P, Dehlsen K. Effects of vegetable consumption on weight loss: a review of the evidence with implications for design of randomized controlled trials. Crit Rev Food Sci Nutr. 2014;54(12):1529-38.https://doi.org/10.1080/10408398.2011.642029
30. Schwingshackl L, Hoffmann G, Kalle-Uhlmann T, Arregui M, Buijsse B, Boeing H. Fruit and Vegetable Consumption and Changes in Anthropometric Variables in Adult Populations: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. PLoS One. 2015;10(10):e0140846.https://doi.org/10.1371/journal.pone.0140846
31. Afkhamzadeh A, Rahmani K, Habibi A, Faraji O. Menarche Age and Its Association to Body Mass Index and Socioeconomic Status Among School Girls in Sanandaj in North-West of Iran. Shiraz E-Medical Journal. 2018;In Press.https://doi.org/10.5812/semj.69802
32. Morgenstern M, Sargent JD, Hanewinkel R. Relation between socioeconomic status and body mass index: evidence of an indirect path via television use. Arch Pediatr Adolesc Med. 2009;163(8):731-8.https://doi.org/10.1001/archpediatrics.2009.78

Case Report

Endoscopic Retrograde Cholangiopancreatography with an Ultra-Slim Forward-Viewing Gastroscope in a 3.8 kg Infant: A Case-Report

Maria Inês Canha[1], Rita Prata[1], Pedro Martins[1], Gonçalo Ramos[1], Rui Alves[2], Isabel Afonso[3], António Mateus Dias[1], João Coimbra[1]

[1]Gastroenterology Department, Centro Hospitalar Universitário de Lisboa Central, Lisbon, Portugal

[2]Pediatric Surgery Department, Centro Hospitalar Universitário de Lisboa Central, Lisbon, Portugal

[3]Pediatric Gastroenterology Department, Centro Hospitalar Universitário de Lisboa Central, Lisbon, Portugal

This work is licensed under **Creative Commons Attribution - Non Commercial 4.0 International License.**

e-ISSN: 2830-5442

Corresponding author:
Maria Inês Canha
m.inescanha@gmail.com

Published:
30th November 2023

DOI:
https://doi.org/10.58427/apghn.2.4.2023.24-9

Citation:
Canha MI, Prata R, Martins P, Ramos G, Alves R, Afonso I, et al. Endoscopic retrograde cholangiopancreatography with an ultra-slim forward-viewing gastroscope in a 3.8 kg infant: a case-report. Arch Pediatr Gastr Hepatol Nutr. 2023;2(4).24-9.

Abstract:

Background: Experience with pediatric endoscopic retrograde cholangiopancreatography (ERCP), particularly in infants, is limited. The lower incidence of biliopancreatic disorders in infants and the discontinuation of pediatric duodenoscopes raise concerns regarding ERCP's technical efficacy and safety in this vulnerable population, for whom conventional duodenoscopes are not recommended.

***Case*:** We report the case of a low-weight infant with short bowel syndrome under parenteral nutrition, who was referred for ERCP due to choledocholithiasis with progressive jaundice. We opted for an ultra-slim forward viewing gastroscope (5.4-mm distal end outer diameter and 2.2-mm working channel) with a needle knife sphincterotome (1.8-mm outer sheath diameter). This allowed sphincterotomy with adequate gallstone removal and complete normalization of cholestasis parameters without associated complications.

***Discussion and conclusion*:** The decreasing availability of pediatric duodenoscopes challenges the important role of ERCP as a diagnostic and therapeutic tool in infants, making their management a challenge. With this case we aimed to describe a previously unreported approach to a low-weight infant with gallstone disease requiring ERCP, which proved to be safe and effective.

Keywords: children, choledocholithiasis, ERCP, intestinal failure-associated liver disease, pediatric

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) has a well-recognized role in the treatment of biliopancreatic diseases in children[1]. However, experience with ERCP in children, particularly in infants, is limited[2,3]. The relatively lower incidence of biliary and pancreatic disorders in the pediatric population, improvements in magnetic resonance cholangiopancreatography in diagnosis and concerns regarding ERCP's safety and outcomes in children have challenged its widespread use in pediatrics. Additionally, pediatric duodenoscopes stopped being manufactured in 2014, so most of the duodenoscopes used are the ones designed for adults[4]. This lack of appropriately sized duodenoscopes and accessories makes ERCP technically more difficult to perform, particularly in small children. We report a case of a 3.8 kg infant who underwent ERCP with an ultra-slim forward-viewing gastroscope with favorable outcomes.

Case

A 6-month-old female infant weighing 3.8 kg was referred to our department for ERCP. She was born at 25 weeks of gestational age (extreme preterm), to a G1P0 33-year-old mother who had an unmonitored pregnancy. The mother was admitted in spontaneous labor and an emergent cesarian section was performed due to fetus in breech position. There was no time for fetal lung maturation. The baby was born with 636 g, with an Apgar score 4/5/5, and was immediately admitted to the neonatal intensive care unit.

The newborn presented with neonatal distress syndrome requiring invasive mechanical ventilation and hemodynamically instability requiring fluid replacement and vasoactive amines. Surfactant was administrated on the first and third days and empirical prophylactic antibiotic treatment with ampicillin and gentamicin was given since day one. She was also jaundiced (with a maximum value of total bilirubin of 7.59 mg/dL on the third day due its unconjugated fraction) for which she did phototherapy for 2 weeks, with improvement of total bilirubin values down to 2.10 mg/dL. Due to delayed sepsis with blood cultures on the 8th day positive for *Staphylococcus haemolyticus* and *Staphylococcus epidermidis*, she was treated according to antibiotic susceptibility testing with piperacillin-tazobactam, vancomycin and amikacin.

By the end of the first month of age, she developed septic shock with necrotizing enterocolitis complicated with perforation and pneumoperitoneum. She was transferred with 32 days to our center for surgical intervention. Laparotomy showed multiple perforations in the ileum and ascending colon, the first one 15-cm from the angle of Treitz. She underwent a large resection of the ileum, ileocecal valve, and ascending colon, being left with a jejunostomy which was later reconstructed as a jejuno-colic anastomosis. The infant was under parenteral nutrition (PN) since her birth, which was maintained due to her short bowel syndrome (45-cm of remaining bowel).

At three months of age, she developed cholestasis, considered related to intestinal failure-associated liver disease (IFALD). Despite multiple PN adjustments, laboratory values were progressively worsening, reaching total/direct bilirubin values up to 15.39/10.70 mg/dL by six months of age (**Table 1**). On abdominal ultrasound, there was sludge in the gallbladder, intrahepatic and extrahepatic bile duct dilation and choledocholithiasis.

Table 1. Changes in laboratory results before and three months after treatment.

Laboratory parameters (units)	Normal range	Day before ERCP	3 months after ERCP
Total bilirubin (mg/dL)	0.20-1.20	15.39	0.51
Direct bilirubin (mg/dL)	0.05-0.30	10.70	0.26
Aspartate aminotransferase (IU/L)	20-67	138	34
Alanine aminotransferase (IU/L)	5-33	90	25
Gamma-glutamyl transferase (IU/L)	8-127	46	23
Alkaline phosphatase (IU/L)	134-518	691	349
International normalized ratio	0.96-1.04	1.68	1.36

ERCP: Endoscopic retrograde cholangiopancreatography

She underwent an ERCP under general anesthesia in the operating room by an experienced endoscopist trained in adult ERCP, who routinely performs more than 250 ERCPs per year. We used an ultra-slim forward viewing gastroscope with a 5.4-mm distal end outer diameter and 2.2-mm working channel (GIF-H190N, *Olympus* ®) with a needle knife sphincterotome (1.8-mm outer sheath diameter, *Endotec* ®).

Upper endoscopy was unremarkable, except for a protruded duodenal papilla. Sphincterotomy led to the spontaneous extrusion of a 5-mm stone (**Figure 1**), followed by abundant drainage of biliary sludge. Fluoroscopy showed slightly dilated intrahepatic and extrahepatic bile ducts on opacification, without filling defects. The gallbladder was dilated, with multiple filling defects. By the end of the procedure, the bile ducts were clear, with adequate drainage. There were no procedure or anesthesia-related complications.

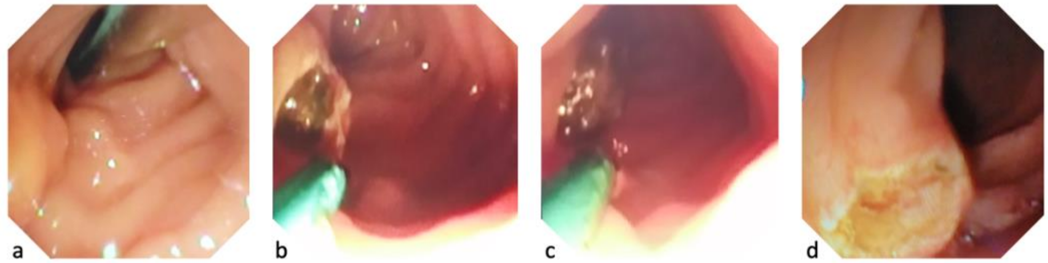

Figure 1. Upper endoscopy using an ultra-slim forward-viewing 5.5-mm gastroscope. **a.** Protruded duodenal papilla. **b.** Needle-knife sphincterotomy showing an impacted bile duct stone. **c.** Gallstone removal. **d.** Duodenal papilla after sphincterotomy.

In the following weeks, multiple PN adjustments were done, and she had a gradual decline in the cholestasis parameters, up to their complete normalization after three months (**Table 1**).

Discussion

Cholestasis is a significant complication in children on PN, with an overall incidence estimated in 29.9%[5]. Premature infants and children with intestinal failure or short bowel syndrome are susceptible to IFALD, characterized by progressive cholestasis, liver fibrosis, biliary cirrhosis, portal hypertension and cholelithiasis[6,7]. The pathogenesis of IFALD is complex and related to many factors, including prematurity, low birth weight, enzyme deficiencies, genetic alterations, anatomic features, and PN-related factors such as its composition[5,7]. PN was encountered as a risk factor in 10-17.6% children with gallstones[7], with greater risk if started at a younger age, without enteral feeding, and in cases of motility disorders with a stoma[8].

Gallbladder and biliary disease remain the most frequent indication for pediatric ERCPs, corresponding to 48% of the ERCPs performed in a US nationwide assay from 2005-2014[2], which included 11,060 patients under 20 years of age. However, only 5% of them were under the age of four.

In fact, there are few guidelines addressing the indications and optimal utilization of therapeutic ERCP in infants and neonates. The European Society of Gastrointestinal Endoscopy (ESGE) and European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) guidelines on endoscopy in children[1] recommend that therapeutic ERCP in pediatric patients (>1 year old) should be considered for common bile duct stones, bile leaks, benign/malignant biliary strictures, primary sclerosing cholangitis and parasitosis, and that diagnostic ERCP can be used in neonates and infants with cholestatic hepatobiliary disease in the diagnosis of biliary atresia. In children above 10 kg, therapeutic duodenoscopes are considered safe, but in neonates, infants and children weighing less than 10 kg, a pediatric 7.5-mm duodenoscope with a 2-mm working channel is recommended, thus limiting the instruments and accessories that can be used with it.

In a retrospective study on 856 ERCPs performed in 626 pediatric patients between 1999-2018[3], 219 were under 1 year of age, 5% of whom with choledocholithiasis. In these patients, a pediatric duodenoscope was used and a 5-Fr biliary stent inserted without papilla sphincterotomy. They had conservative treatment with ursodeoxycholic acid up to 1-year of age, when the stent was removed and sphincterotomy done, with extraction of the choledocholithiasis.

Furthermore, since 2014, the only existing pediatric 7.5-mm duodenoscopes (PJF 7.5, PJF 160 and PJF 240 duodenoscopes by *Olympus* ®) stopped being supported for maintenance by the manufacturer and no new pediatric duodenoscopes have been produced, contributing to the disappearance of ERCP facilities in certain centers[4] and turning this procedure a real challenge in infants in whom adult duodenoscopes cannot be used, like in our case, making it necessary to consider different options in their management.

This decreasing availability of pediatric duodenoscopes and facilities is an unwanted development, as infant ERCP is an indispensable diagnostic and therapeutic tool[4], being at risk if the production of these duodenoscopes is not restored. Efforts by the worldwide endoscopic community to drain and centralize care in high-volume centers with experience in ERCP and assure continuing production and maintenance of pediatric duodenoscopes should be done. Additionally, sharing experience with the scientific community and conducting prospective multicentric studies on ERCP in infants would be desirable, to improve the quality of infant ERCP and offer these patients the best possible care.

Conclusion

In conclusion, therapeutic ERCP is expected to be increasingly needed at an early age, considering the greater number of children surviving with conditions like short bowel syndrome who require PN and develop choledocholithiasis. The lack of specific equipment for neonates and infants can challenge the safety and technical success of the procedure, creating the need to find and adapt solutions to this vulnerable population.

We aimed to describe a possible approach to a low-weight infant with gallstone disease requiring ERCP, allowing adequate drainage of the biliary tract and complete normalization of cholestatic parameters without associated complications. To the best of our knowledge, this is the first reported case in the literature of an ERCP with sphincterotomy using an ultra-slim forward-viewing scope in an infant of such weight.

Conflict of Interest

None declared.

Funding Statement

The authors received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Parental Consent

The grandmother (child's guardian) provided informed consent regarding the publication of this article.

References

1. Thomson M, Tringali A, Dumonceau JM, et al. Paediatric gastrointestinal endoscopy: European society for paediatric gastroenterology hepatology and nutrition and European society of gastrointestinal endoscopy guidelines. J Pediatr Gastroenterol Nutr. 2017;64(1):133–53. https://doi.org/10.1097/MPG.0000000000001408
2. Barakat MT, Cholankeril G, Gugig R, et al. Nationwide Evolution of Pediatric Endoscopic Retrograde Cholangiopancreatography Indications, Utilization, and Readmissions over Time. J Pediatr. 2021;232:159-165.e1. https://doi.org/10.1016/j.jpeds.2020.11.019
3. Keil R, Drábek J, Lochmannová J, et al. ERCP in infants, children, and adolescents—Different roles of the methods in different age groups. PLoS One. 2019;14(1):1–12. https://doi.org/10.1371/journal.pone.0210805
4. Koot BGP, Kelly DA, Hadzic N, et al. Endoscopic Retrograde Cholangiopancreatography in Infants: Availability Under Threat: A Survey on Availability, Need, and Clinical Practice in Europe and Israel. J Pediatr Gastroenterol Nutr. 2020;71(2):e54–8. https://doi.org/10.1097/MPG.0000000000002752
5. Lauriti G, Zani A, Aufieri R, et al. Incidence, prevention, and treatment of parenteral nutrition-associated cholestasis and intestinal failure-associated liver disease in infants and children: A systematic review. J Parenter Enter Nutr. 2014;38(1):70–85. https://doi.org/10.1177/0148607113496280
6. Lee WS, Chew KS, Ng RT, et al. Intestinal failure-associated liver disease (IFALD): insights into pathogenesis and advances in management. Hepatol Int. 2020;14(3):305–16. https://doi.org/10.1007/s12072-020-10048-8
7. Zdanowicz K, Daniluk J, Lebensztejn DM, et al. The Etiology of Cholelithiasis in Children and Adolescents - A Literature Review. Int J Mol Sci. 2022;23(21):13376. https://doi.org/10.3390/ijms232113376
8. Pichler J, Watson T, McHugh K, et al. Prevalence of gallstones compared in children with different intravenous lipids. J Pediatr Gastroenterol Nutr. 2015;61(2):253–9. https://doi.org/10.1097/MPG.0000000000000761

Case Report

Ulcerative Colitis with Henoch Schonlein Purpura in Pediatric Patient: A Case-Report

Ninung RD Kusumawati[1], Juwita Pratiwi[1], Sonya Leonardy Low[1], Dyan Ajeng Paramitha[1], Wahyu Aditya Prawirasatra[1], Nindya Riesmania Pratiwi[1], Adinda Ratna Puspita[1]

[1]Departement of Pediatrics, Faculty of Medicine, Diponegoro University, Semarang, Indonesia

This work is licensed under **Creative Commons Attribution - Non Commercial 4.0 International License.**

e-ISSN: 2830-5442

Corresponding author:
Ninung RD Kusumawati
roseadhiani@yahoo.co.id

Published:
30th November 2023

DOI:
https://doi.org/10.58427/apghn.2.4.2023.30-5

Citation:
Kusumawati NRD, Pratiwi J, Low SL, Paramitha DA, Prawirasatra A, Pratiwi NR, et al. Ulcerative Colitis with Henoch Schonlein Purpura in Pediatric Patient. *Arch Pediatr Gastr Hepatol Nutr.* 2023;2(4).30-5.

Abstract:

Background: Inflammatory bowel disease (IBD) is defined as idiopathic disorder which associated with inflammation of gastrointestinal tract. Ulcerative colitis (UC) and Chron's disease are the predominant forms of IBD. Henoch Schonlein Purpura and UC share some similar symptoms and can mimic each other especially in children. In this case report, we present an eight-year-old boy who had main complaint of recurrent bloody stools and abdominal pain. Diagnosis was made through history taking, physical examination, laboratory examination and colonoscopy in this patient.

***Case*:** A boy aged 8 years and 1 month had main complaint of bloody stools with fluid consistency. This complaint was accompanied by abdominal pain all over the abdominal region and vomiting. Upon physical examination, the child was in pain. The vital signs were within normal limits. Laboratory examination showed leukocytosis. The routine stool examination showed malabsorption of fat, protein, and carbohydrates, followed with positive erythrocytes, leukocytes, epithelium, bacteria, and yeast cells; but the stool culture was sterile. Gastroscopy and colonoscopy were performed which showed erosive gastritis, duodenitis, and proctitis.

***Discussion*:** The relationship between ulcerative colitis and HSP remains unknown. Recent research showed overproduction of IgA may induce chronic inflammation in the intestinal. While HSP is IgA/immune complex mediated, IBD is thought to be predominantly T-cell driven. Recently, in IBD patients especially those with ulcerative colitis, IgA were found in their histopathologic biopsy result.

Conclusion: The relationship between ulcerative colitis and HSP remains unknown. Recent research has shown that the overproduction of IgA may induce chronic inflammation in the intestinal. As such, symptoms of both diseases may mimic each other as seen in our patients.

Keywords: children, Henoch Schonlein Purpura, inflammatory bowel disease, ulcerative colitis

Introduction

Inflammatory bowel disease (IBD) is defined as idiopathic disorder which associated with inflammation of gastrointestinal tract. Ulcerative colitis (UC) and Chron's disease are the predominant forms of IBD. Broad variation is found in the incidence rates ranging from 0.5 to 23 per 100000 for IBD, 0.3 to 15 per 100000 for ulcerative colitis and 0.1-13.9 per 100000 for Chron's disease in pediatric patients.[1] Ulcerative colitis is defined as part of IBD, marked by mucosal inflammation affecting the rectum and proximal colon.[2] Diarrhea, hematochezia, abdominal pain, constipation, weight lost are the most common symptoms in pediatric.[2] Abdominal examination may show focal tenderness on children. Perforation and abscess must also be excluded before diagnosing ulcerative colitis. Anemia, thrombocytosis, hypoalbuminemia, and increased in inflammatory markers are common findings in children. Esophagogastroduodenoscopy and ileocolonoscopy with biopsy remain the standard criteria for the diagnosis and classification of IBD in children.[3]

Henoch Schonlein Purpura (HSP) is the most common vasculitis in children with incidence rate of 8-20 per 100.000 in pediatric patient. This is a self-limiting disease and resolves in 6-8 weeks. Sixty-six percent of children experience gastrointestinal symptoms such as abdominal pain (44%), intestinal bleeding (22%), or intussusception (≤ 3%). According to Bin Lu et al, HSP and UC share some similar symptoms and can mimic each other especially in children. The relationship between HSP and UC are still unknown. There is a hypothesis that explain the overproduction of IgA that may lead to chronic inflammation in the intestine.

In this case report, we present an eight-year-old boy who had main complaint of recurrent bloody stools and abdominal pain. Diagnosis was made through history taking, physical examination, laboratory examination and colonoscopy in this patient.

Case

A boy aged 8 years and 1 month had main complaint of bloody stools with fluid consistency. This complaint was accompanied by abdominal pain all over the abdominal region and vomiting. There was no fever, joint pain, or red eyes. The child was brought by his parents to the emergency room at regency hospital for treatment. The child was then diagnosed with lower gastrointestinal bleeding and referred to the dr. Kariadi Hosptial, Semarang to seek for further diagnosis.

Upon physical examination, the child was in pain. The vital signs were within normal limits. Anthropometry examination showed the impression of malnutrition with normal stature. The abdomen looked convex, no palpable liver and spleen. Abdominal tenderness was found on the entire abdominal region.

Laboratory examination showed leukocytosis (19.300/ µL). The routine stool examination showed malabsorption of fat, protein, and carbohydrates, followed with positive erythrocytes, leukocytes, epithelium, bacteria, and yeast cells; but the stool culture was sterile. Abdominal CT scan was also performed which showed minimal thickening of the rectal wall (maximum thickness ± 1.45 cm, length ± 4.59 cm) with inhomogeneous enhancement after contrast injection (suspect an inflammatory process); minimal fluid collection in the pelvic cavity; and multiple lymphadenopathies in the paraaortic region, right left mesenteric and left right inguinal (largest size ± 1.44 x 0.56 cm in left mesenteric).

After 4 days of treatment, abdominal pain in the children was decreased and PUCAI score was 5. Gastroscopy and colonoscopy were performed. The results showed erosive gastritis, duodenitis, and proctitis. (**Figure 1**)

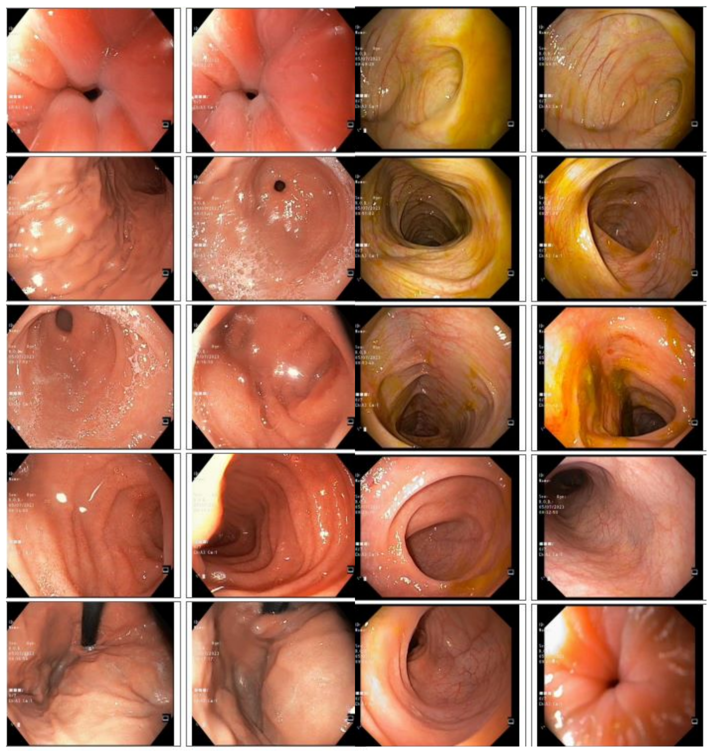

Figure 1. Gastroscopy and colonoscopy features of the patient.

The result of the colonoscopy biopsy showed active chronic colitis and active chronic proctitis, while the result of the gastroscopy biopsy showed chronic, non-atrophic, non-metaplastic, non-dysplastic gastritis with negative Helicobacter pylorii.

Further evaluation of patient's symptoms after discharged was assessed in our clinic. The patient was treated with 5-aminosalicylic acid (5-ASA) as anti-inflammatory medication on the intestinal mucosa via oral route. Main symptoms in Henoch

Schonlein Purpura were found in this patient with palpable purpura, abdominal pain and gastrointestinal bleeding. (**Figure 2**) The patient was then referred to Allergic Immunology Clinic and being diagnosed with Henoch Schonlein Purpura (HSP).

Figure 2. Clinical features of palpable purpura in the patient.

Discussion

The patient main complaint was bloody stools with abdominal pain. This manifestation was initially thought to be part of ulcerative colitis clinical manifestation. However, HSP clinical manifestation was also found in this patient with palpable purpura and abdominal pain. Ulcerative colitis is defined as part of IBD, marked by mucosal inflammation affecting rectum and proximal colon.[2] Diarrhea, hematochezia, abdominal pain, constipation and weight loss were the most common symptoms in pediatric patients and similar to those presented in our patient.[1]

Esophagogastroduodenoscopy and ileocolonoscopy were performed in our patient, which was in line with a study conducted by Bradley et al. They stated that esophagogastroduodenoscopy and ileocolonoscopy with biopsy is the gold standard for the diagnosis and classification of IBD in children.[3] The patient was treated with 5-ASA according to the recommendation to exert anti-inflammatory effect on the intestinal mucosa. This medication may be administered in form of oral formulation that release the active moiety 5-aminosalicylic acid (5-ASA) in the ileum and colon, or topically via enema or suppository.[3] A large observational study showed that 30% of children with UC will maintain remission with administration of 5-ASA drugs alone.[4]

The diagnosis of HSP is determined by the presence of palpable purpura with lower limb predominance in addition to 1 or more of the following 4 findings including:

diffuse abdominal pain, arthritis or arthralgia, renal involvement (proteinuria, decreased in renal function), positive histopathologic findings (leukocytoclastic vasculitis with predominant IgA deposits on skin biopsy, or proliferative glomerulonephritis with predominant IgA deposit on kidney biopsy).[5] Moreover, IgA1-dominant immune deposits which affects small vessels (predominantly capillaries, venules, or arterioles) was commonly found in pediatric patients.[6] Clinical manifestation of IgA vasculitis due to HSP are often non- specific and can mimic those of other GI disorders, including nonspecific gastroenteritis, infectious gastroenteritis, and IBD (particularly Crohn disease). To confirm the diagnosis, endoscopic findings according to some research is recommended. Endoscopic findings may show mucosal congestion, nodular changes, redness, petechiae, ulcers, or hematoma-like protrusions reflecting intramural hemorrhage.[6] This condition is self-limiting and resolves in 6-8 weeks.

The relationship between ulcerative colitis and HSP remains unknown. Recent research showed overproduction of IgA may induce chronic inflammation in the intestinal. While HSP is IgA/immune complex mediated, IBD is thought to be predominantly T-cell driven. However, the link between T-cell- and IgA-mediated immunity has been studied in secondary IgA nephropathy due to hepatic and intestinal inflammation. Recently, in IBD patients especially those with ulcerative colitis, IgA were found in their histopathologic biopsy result. [7]

Conclusion

The relationship between ulcerative colitis and HSP remains unknown. Recent research has shown that the overproduction of IgA may induce chronic inflammation in the intestinal. As such, symptoms of both diseases may mimic each other as seen in our patients.

Conflict of Interest

None declared

Funding Statement

There is no specific grant from any funding agency involved in this study.

References

1. Sýkora J, Pomahačová R, Kreslová M, Cvalínová D, Štych P, Schwarz J. Current global trends in the incidence of pediatric-onset inflammatory bowel disease. World J Gastroenterol. 2018;24(25):2741-63. https://doi.org/10.3748/wjg.v24.i25.2741
2. Bradley GM, Oliva-Hemker M. Pediatric ulcerative colitis: current treatment approaches including role of

infliximab. Biologics. 2012;6:125-34.https://doi.org/10.2147/btt.S31833
3. Rosen MJ, Dhawan A, Saeed SA. Inflammatory Bowel Disease in Children and Adolescents. JAMA Pediatr. 2015;169(11):1053-60.https://doi.org/10.1001/jamapediatrics.2015.1982
4. Zeisler B, Lerer T, Markowitz J, Mack D, Griffiths A, Bousvaros A, et al. Outcome following aminosalicylate therapy in children newly diagnosed as having ulcerative colitis. J Pediatr Gastroenterol Nutr. 2013;56(1):12-8.https://doi.org/10.1097/MPG.0b013e31826ac41a
5. Ruperto N, Ozen S, Pistorio A, Dolezalova P, Brogan P, Cabral DA, et al. EULAR/PRINTO/PRES criteria for Henoch-Schönlein purpura, childhood polyarteritis nodosa, childhood Wegener granulomatosis and childhood Takayasu arteritis: Ankara 2008. Part I: Overall methodology and clinical characterisation. Ann Rheum Dis. 2010;69(5):790-7.https://doi.org/10.1136/ard.2009.116624
6. Louie CY, Gomez AJ, Sibley RK, Bass D, Longacre TA. Histologic Features of Gastrointestinal Tract Biopsies in IgA Vasculitis (Henoch-Schönlein Purpura). Am J Surg Pathol. 2018;42(4):529-33.https://doi.org/10.1097/pas.0000000000001036
7. Hong JG, Levy J, Stokar E. Henoch-Schönlein purpura and crohn's disease: Expanding the range of association in pediatric patients. Clin J Gastroenterol. 2021;14(5):1392-5.https://doi.org/10.1007/s12328-021-01456-w

APGHN
Archives of Pediatric Gastroenterology, Hepatology, and Nutrition

Literature Review

Pediatric Nutritional Assessment

Helisa Rachel Patrice Sianipar[1], Jully Neily Kasie[2], Yuda Satrio Wicaksono[3]
[1]Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia
[2]Department of Child Health, Rumah Sakit Umum Persahabatan, Jakarta, Indonesia
[3]Gastrohepatology Division, Department of Child Health, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

This work is licensed under **Creative Commons Attribution - Non Commercial 4.0 International License.**

e-ISSN: 2830-5442

Corresponding author:
Helisa Rachel Patrice Sianipar
helisarachel.dr@gmail.com

Published:
30th November 2023

DOI:
https://doi.org/10.58427/apghn.2.4.2023.36-46

Citation:
Sianipar HRP, Kasie JN, Wicaksono YS. Pediatric Nutritional Assessment. *Arch Pediatr Gastr Hepatol Nutr.* 2023; 2(4):36-46.

Abstract:

Background: Pediatric nutrition plays a vital role in the growth and development of children. It not only meets the daily nutritional needs of healthy children but also supports their normal growth. In contrast, for unhealthy children, it aims to prevent growth delays and developmental issues, especially in cognitive functions. The situation in Indonesia presents a unique challenge with the coexistence of undernutrition and overnutrition, both having significant short-term and long-term health impacts.

Discussion: In the realm of pediatric nutrition, malnutrition manifests in various forms. Nutritional deficiencies such as wasting, stunting, and being underweight arise from inadequate dietary intake. Additionally, there are concerns about micronutrient malnutrition, which includes both deficiencies and excesses of vital nutrients. Overnutrition, leading to obesity and associated chronic diseases, is also a significant problem. The approach to pediatric nutritional care is multi-faceted, involving the assessment of nutritional status, determination of individual caloric needs, and selecting the appropriate method for nutrition delivery, whether it be oral, enteral, or parenteral. Monitoring and evaluating the effectiveness of these interventions is a critical ongoing process. An important aspect of preventive care includes educating parents about proper feeding techniques, such as establishing regular meal times and understanding the child's hunger and satiety signals, to avoid feeding difficulties. For cases like Failure to Thrive (FTT), where children do not meet standard growth metrics, careful management is necessary to ensure adequate nutrition and to prevent complications like refeeding syndrome.

Conclusion: Effective pediatric nutrition requires a holistic and personalized approach. It is crucial in addressing the dual burden of undernutrition and overnutrition in Indonesia. By implementing proper nutritional care and structured feeding practices, children's health outcomes can be significantly improved, supporting their growth and developmental processes.

Keywords: Assessment, Nutrition, Pediatric

Introduction

Pediatric nutrition is essential for both healthy and sick children. In healthy children, the primary goal of nutrition is to optimize growth and development and to provide appropriate daily needs.[1] Conversely, in unhealthy children, nutrition serves not only daily needs but also to prevent delayed growth and irreversible effects on development, particularly cognitive function.[1] Nutrition plays a significant role in a child's growth and development.[2] Proper nutrition, initiated early, supports normal growth and development by meeting nutritional needs and preventing nutrient deficiencies.[1] In infants, good nutrition aids in preventing diseases such as infections by boosting immunity and optimizing neurological and cognitive development.[2] During the school-age and teenage years, nutrition plays a further role in preventing non-communicable diseases like obesity, diabetes, and cardiovascular diseases, thereby enabling better health in adulthood.[2]

In Indonesia, nutritional disorders or malnutrition represent a dual burden, where the prevalence of undernutrition or malnutrition remains high, while the prevalence of obesity or overnutrition is simultaneously increasing. Both have negative short-term and long-term impacts, necessitating attention for the resolution of these nutritional issues. According to the Riskesdas (Health Research and Development Survey) results from 2007, 2010, and 2013, there has been no improvement in addressing undernutrition.[3] The province with the lowest percentage of severely malnourished toddlers is Bali at 13.2%, while the highest is NTT (East Nusa Tenggara) at 33%. Moreover, the percentage of stunted toddlers in Indonesia is high at 37.2% according to Riskesdas 2013, showing no improvement from the 2007 and 2010 surveys.[3] Riau province has the lowest percentage of stunted toddlers, with NTT having the highest.

Definition and Classification of Malnutrition

Malnutrition refers to a deficiency, excess, or imbalance in a person's intake of energy and/or nutrients. Such nutritional deficiencies make children particularly vulnerable to diseases and death. The term "malnutrition" covers three major groups of conditions[4]:

- Nutritional deficiencies, which include wasting (low weight-for-height), stunting (low height-for-age), and underweight (low weight-for-age).
- Micronutrient-related malnutrition, which includes micronutrient deficiencies (lack of essential vitamins and minerals) or excess micronutrients.
- Overweight, obesity, and diet-related non-communicable diseases (such as heart disease, stroke, diabetes, and certain types of cancer).

Low weight-for-height, known as wasting, typically indicates acute and severe weight loss, often due to insufficient food intake and/or infectious diseases like diarrhea causing weight loss. A moderately or severely wasted child has an increased risk of mortality but can be managed effectively. Low height-for-age, known as stunting, results from chronic or repeated nutritional deficiency, often related to poor socio-economic conditions, inadequate maternal health and nutrition, frequent illnesses, and/or improper infant and child feeding and care practices in early life. Stunting hinders children from reaching their full physical and cognitive potential. Children with low weight-for-age are known as underweight. An underweight child may be stunted, wasted, or both.[4]

Micronutrient-related malnutrition can be a deficiency or excess of vitamins and minerals. Micronutrients are needed by the body to produce enzymes, hormones, and other substances, so a lack of micronutrient intake can hinder optimal growth and development. The most common micronutrient malnutrition includes deficiencies of iodine, vitamin A, and iron. Iodine, vitamin A, and iron are globally significant for public health; their deficiencies are a major threat to the health and development of populations worldwide, especially children and pregnant women in low-income countries.[4]

Overweight and obesity occur when an individual's weight is too high for their height. Abnormal or excessive fat accumulation can impair health. Body Mass Index (BMI) is a common weight-for-height index used to classify overweight and obesity. BMI is defined as an individual's weight in kilograms divided by the square of their height in meters (kg/m^2).

In adults, overweight is defined as a BMI of 25 or more, while obesity is a BMI of 30 or more. Overweight and obesity result from an imbalance between consumed (excess) and expended (insufficient) energy. Globally, this often occurs with the consumption of energy-dense foods (high in sugar and fat) and engagement in less physical activity.[4]

Pediatric Nutritional Care

To evaluate and provide adequate and appropriate nutrition to children, several steps known as pediatric nutritional care should be undertaken, encompassing assessment and diagnosis, determination of needs, method of administration, monitoring, and evaluation.[5]

Assessment

The assessment is conducted to determine nutritional status and clinical diagnosis, whether the patient suffers from malnutrition or has adequate nutritional supply. Nutritional status can be assessed through anthropometry and physical examination.

Anamnesis should include dietary intake, eating patterns, food tolerance, oromotor, fine motor, and gross motor development, weight change, social, cultural, and religious factors, and clinical conditions affecting intake.[5]

After physical examination, nutritional status is determined based on weight relative to the patient's length or height. The WHO 2006 charts are used as a reference for children under 5 years of age, and the CDC 2000 charts are used for patients over 5 years. The WHO 2006 charts are preferred for ages 0-5 due to superior methodology compared to CDC 2000. The subjects in the WHO 2006 study were from five continents and had environments conducive to optimal growth. For ages 5-18, the CDC 2000 charts are used, considering that the WHO 2007 charts (5-18 years) do not include weight-for-height data and the WHO 2007 data is a smoothing of the NCHS 1981 data. Nutritional status is determined using the WHO 2006 Z score cut off for ages 0-5 and the Waterlow criteria for ideal body weight percentage for children over 5 years.[5]

Table 1. Interpretation of nutritional status according to Waterlow, WHO 2006, and CDC 2000[6]

WfH CDC 2000	WfH WHO 2006	Interpretation
< 70%	Z < -3 SD	Severely Wasted
70 – 90%	-3 SD < Z < -2 SD	Wasted
90 – 110%	-2 SD < Z < +2 SD	Normal
110 – 120%	+2 SD < Z < +3 SD	*Overweight*
> 120%	Z > +3 SD	Obese

WfH = Weight for Height

In assessing children at risk of overweight, marked by a weight-for-height above +1 SD on the WHO 2006 curve or >110% on the CDC curve, plotting against the respective BMI curve is necessary. A patient is considered overweight if the plotting falls between +2 SD < Z < +3 SD on the WHO 2006 curve or between the 85th and 95th percentiles on the CDC 2000 curve, and is considered obese if it falls at Z > +3 SD on the WHO 2006 curve or above the 95th percentile on the CDC 2000 curve. For 1-5 year olds, the upper-arm circumference (UAC) can be interpreted according to Table 2 below.[5]

Table 2. Upper arm circumference interpretation

UAC (cm)	Interpretation
< 11,5	Severely wasted
11,5-13,5	Wasted
> 13,5	Normal

If a patient is found to be overweight or obese, the measurement is shifted to using the Body Mass Index (BMI), which compares weight to total body surface area and then plots against an age line. For children under 2 years, the WHO 2006 charts, which have a Z value > 2 for overweight and > 3 for obesity, can be used.[5] (**Figure 1**)

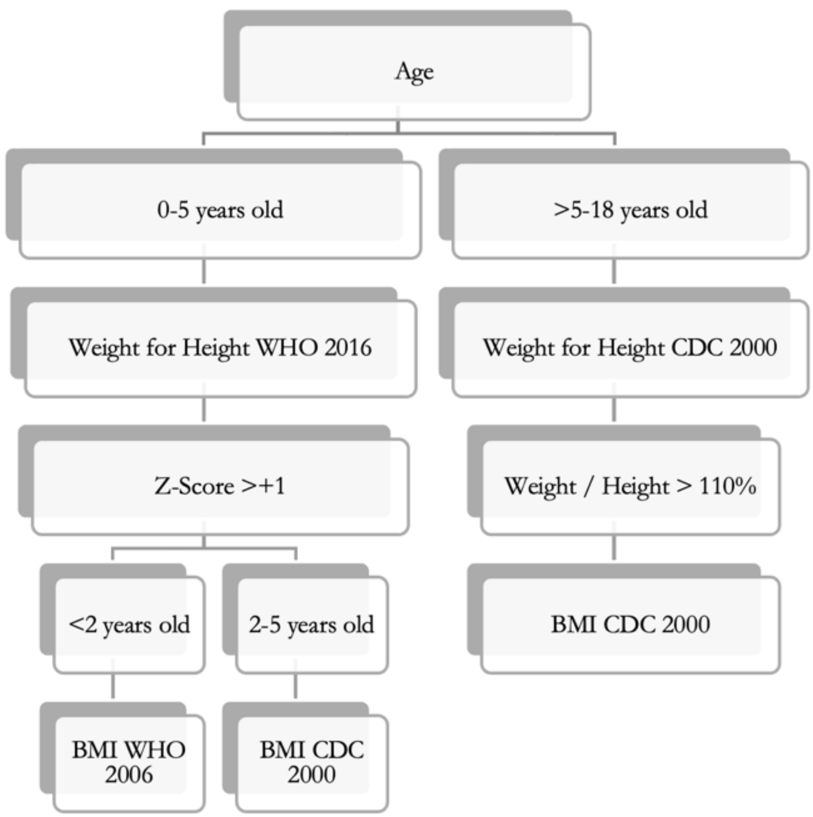

Figure 1. Algorithm for children at risk of overweight and obesity

Determining nutritional need

After determining the nutritional status of a patient, the next step is to obtain their caloric needs. These needs include three different areas: replacement of deficient nutrients, maintenance requirements, and additional needs due to loss or for the repair of diseased tissue. Ideally, caloric needs should be determined using indirect calorimetry; however, this method is impractical and expensive. The calculation of caloric needs is adjusted according to the illness condition of the child.[5]

In non-critically ill patients, caloric needs are calculated by multiplying the ideal body weight by the recommended dietary allowance (RDA) according to height age. This calculation is applicable for good nutrition, malnutrition, and obesity. However, the portion of calories provided differs between malnutrition and obesity. Patients with poor nutrition are initially given 50-75% of the target calorie requirement to avoid refeeding syndrome. In contrast, for obesity, calorie provision does not immediately meet the target requirement but is gradually reduced until the target is achieved.[5]

Formula for calculating the caloric need is as following:

Ideal weight x RDA based on height age

With height age being the child's age on p50 of height the growth chart

Table 3. Caloric requirements based on age group

Age (years)	**Caloric need (kkal/BW/day)**
0 – 1	100 – 120
1 – 3	100
4 – 6	90
7 – 9	80
10 – 12	Male: 60 – 70
	Female: 50 – 60
12 – 18	Male: 50 – 60
	Female: 40 – 50

Refeeding syndrome is a metabolic complication of nutritional support in severely malnourished patients, characterized by hypophosphatemia, hypokalemia, and hypomagnesemia. This occurs due to a shift in the body's primary metabolic source, from fats during starvation to carbohydrates provided as part of nutritional support, leading to increased insulin levels and the shift of electrolytes needed for intracellular metabolism. Clinically, patients may experience arrhythmias, heart failure, acute respiratory failure, coma, paralysis, nephropathy, and liver dysfunction. Therefore, nutritional support in malnourished patients must be provided gradually, with intake increased over 4-7 days until the target calorie intake is reached.[7]

Choosing route of administration

In providing nutrition, oral nutrition is the ideal and preferred route. If there are certain conditions that still allow the patient to receive oral nutrition but they cannot, are not advised to, or are not permitted to consume solid food, oral nutrition can be provided in a semi-solid or liquid consistency. If oral administration is not possible, there are two alternatives: enteral nutrition or parenteral nutrition.[5] (**Figure 2**)

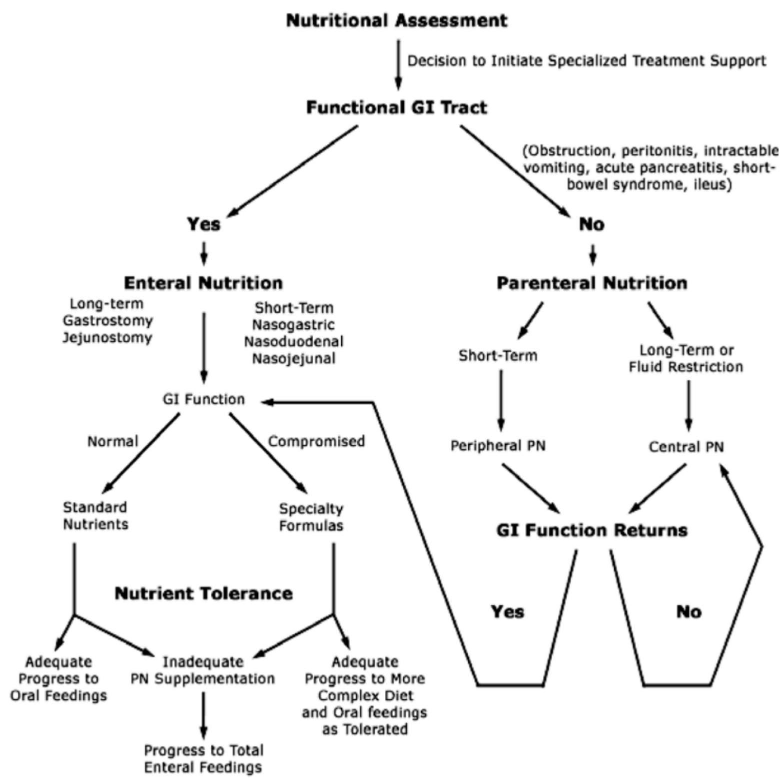

Figure 2. Algorithm to choose between parenteral and enteral route[1]

Enteral nutrition is given when oral feeding is not possible, but the intestinal function is still good. Compared to the parenteral route, enteral feeding has advantages such as lower cost, safer use, a physiological form with a complete nutrient composition, and the ability to maintain intestinal function.[5]

Choosing food type

The determination of food type is influenced by two factors: patient factors (age, medical diagnosis, medical conditions requiring special nutrition, and gastrointestinal function) and formula factors (osmolality, renal solute load, calorie concentration and thickness, nutrient composition, and product availability). In the administration of enteral formulas, the child's age is classified into infants (<1 year), 1-10 years, and over 10 years. The differences between these three preparations are that in the enteral formula for 1-10 years, the calorie composition is denser compared to the enteral formula for children under 1 year. The composition of protein, sodium, potassium, chloride, and magnesium is higher compared to the adult enteral formula (>10 years). The composition of iron, zinc, calcium, phosphorus, and vitamin D is higher compared to the adult enteral formula.[5] (**Figure 3**)

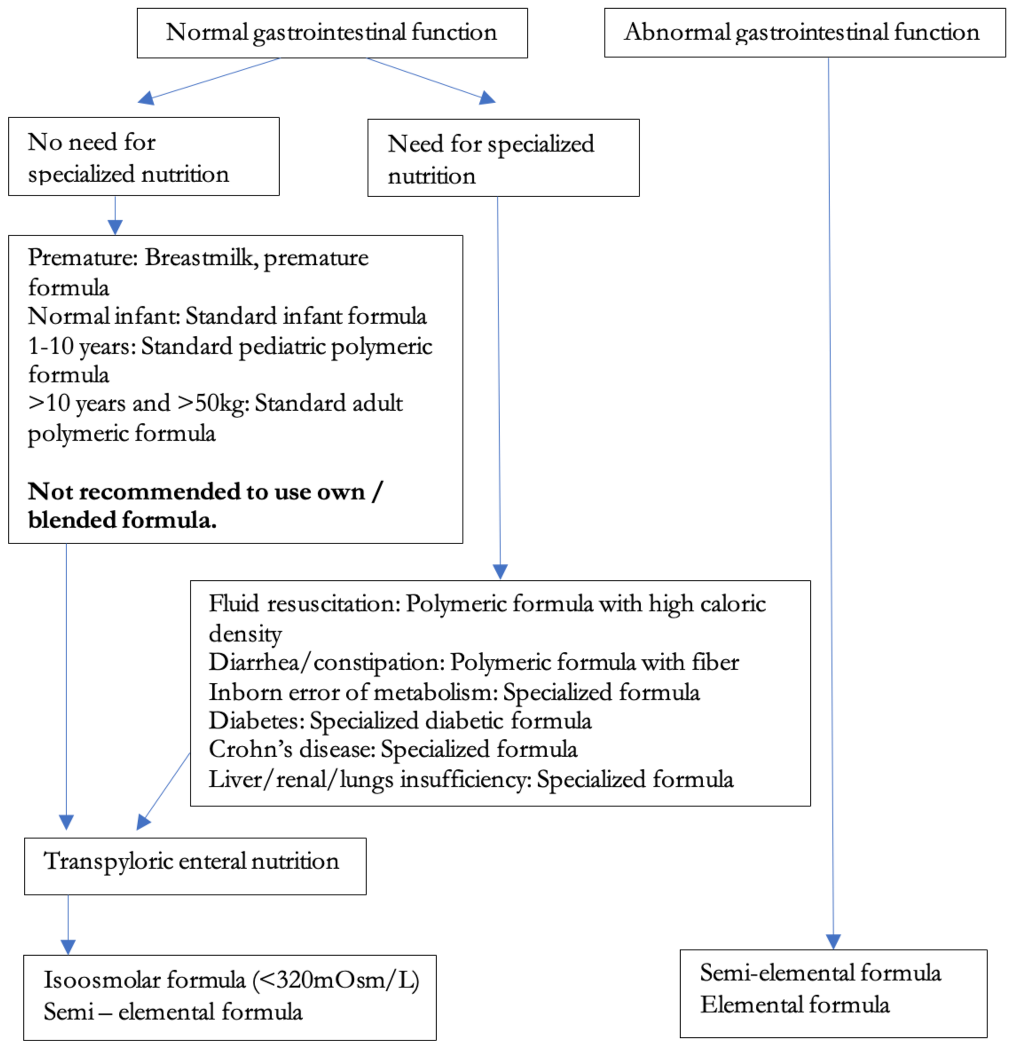

Figure 3. Algorithm for choosing enteral formula

Monitoring and Evaluation

The monitoring and evaluation of nutritional therapy provision is conducted in two phases: short-term and long-term. Short-term monitoring assesses the acceptance of food, tolerance to food, and the impact of food on the gastrointestinal tract. Long-term monitoring evaluates disease recovery and child growth.[5]

Basic Feeding Rules

The Indonesian Pediatric Society (IDAI) has adapted the Basic Feeding Rules from Bernard-Bonnin's "Feeding problems of infants and toddlers".[8] It is crucial that parents are first informed about the basic feeding rules applicable to all young children. Parents should control what, when, and where their children eat. Children should be allowed to regulate how much they eat to learn internal meal regulation, based on physiological hunger and satiety signals. In case of feeding difficulties, several steps recommended by Bonnin[8] should be followed:

Scheduling

- Regular scheduling of main meals and snacks.
- Mealtime should not exceed 30 minutes.
- Avoid offering other snacks during meals except for drinks.

Environment

- Ensure a pleasant environment without coercion to eat.
- Use a napkin as a base for dining to maintain cleanliness.
- Eliminate distractions (toys, television, electronic devices) during meals.
- Refrain from using food as a reward.

Procedure

- Serve food in small portions.
- Begin with the main meal, followed by drinks.
- Encourage self-feeding.
- If the child shows signs of not wanting to eat (clenching mouth, turning head, crying), offer food again neutrally, without coaxing or forcing.
- End the meal if the child refuses to eat after 10-15 minutes.
- Clean the child's mouth only after the meal is complete.

In Indonesia, many parents struggle with these aspects due to inadequate understanding. Parents/caregivers often resort to coaxing and comforting the child in various ways to encourage eating, which can interfere with the child's concentration on eating. If the child refuses to eat, parents frequently substitute the meal with an excessive amount of formula, leading to the child being constantly full and further complicating the development of correct eating behavior.[8]

Early prevention of feeding difficulties involves the proper implementation of feeding behaviour rules. The introduction to food must also fulfil four criteria:[5]

- Timely introduction when breast milk is insufficient for the baby's nutritional needs.
- Adequacy in nutritional content suitable for the baby's age.
- Safety in food preparation and storage.
- Proper feeding, mindful of the child's hunger and satiety signals.

Implementing these feeding rules is expected to address feeding difficulties in infants, enhancing their growth and development. If a child persistently has difficulty eating, consulting a nutritionist or pediatric specialist is recommended.[5]

Failure to Thrive

The term "failure to thrive" (FTT) is used to describe infants or children who do not achieve weight gain in accordance with normal growth curves or experience weight loss. However, this terminology is somewhat inaccurate since growth encompasses several parameters such as weight, length/height, and head circumference. The term failure to thrive is more accurately used in anthropometric measurements to denote a hindrance in achieving appropriate weight gain, more aptly referred to as weight faltering. Prolonged failure to achieve adequate weight gain can impact a child's length and ultimately head circumference. Failure to thrive is more a sign or symptom of an underlying issue in a patient, rather than a diagnosis or a degree of illness. It indicates an anthropometric observation, hence does not necessarily mean malnutrition or poor nutrition, which are conditions determined at a single observation point.[9]

To diagnose a patient with failure to thrive, at least two points of observation on the weight-for-age and gender curve are required. Using the WHO 2006 charts, the criteria for failure to thrive are if the line connecting these two points diverges from the curve above it (indicating weight faltering). When using the CDC 2006 curves, the criteria are if the line connecting the two observation points crosses two major percentile lines (75th, 50th, 25th, 10th, 5th, 3rd) for weight according to age. Causes of failure to thrive can be classified into inadequate calorie intake, inadequate calorie absorption, and increased calorie needs.[9]

In managing a child with failure to thrive, it is necessary to evaluate the history of food intake, previous medical history, family medical history, and socio-economic background. Physical and supportive examinations are required to rule out medical conditions as per the complaints presented by the child's guardian. The management of failure to thrive involves the provision of adequate nutrition with calories as per the Recommended Dietary Allowance (RDA) multiplied by the ideal body weight, accompanied by regular evaluations. Management should be mindful to avoid refeeding syndrome, particularly in cases of acute malnutrition.[9]

Conclusion

Pediatric nutrition is a crucial aspect of child health care, particularly important in both healthy and unhealthy children. It serves to optimize growth and development in healthy children by meeting daily nutritional needs and plays a vital role in preventing growth delays and cognitive development issues in unhealthy children. In Indonesia, the challenge is intensified due to the dual burden of undernutrition and obesity, each carrying significant health implications. Addressing these nutritional disorders requires a comprehensive approach, encompassing assessment, diagnosis, determination of nutritional needs, appropriate administration methods, and continuous monitoring and evaluation. This approach tailors interventions to individual needs, whether for managing malnutrition, obesity, or other health conditions.

Furthermore, the implementation of basic feeding rules, adapted by the Indonesian Pediatric Society, is essential in establishing healthy eating habits and preventing feeding difficulties from an early age. These guidelines emphasize regular meal scheduling, creating a positive eating environment, and understanding children's hunger and satiety cues. Managing conditions like Failure to Thrive necessitates careful evaluation and tailored nutritional intervention to ensure adequate growth and development. Overall, effective pediatric nutrition management requires a multifaceted approach, combining direct nutritional interventions with education and preventive care, crucial for improving the health and well-being of children, especially in diverse nutritional landscapes like Indonesia.

Conflict of Interest

None declared.

References

1. Sjarif DR, Lestari ED, Mexitalia M, Nasar SS. Buku ajar nutrisi pediatrik dan penyakit metabolik. Jakarta: Badan Penerbit IDAI. 2014:36-49, 128-60.
2. Marcdante K, RM K. Nelson essentials of pediatrics 9th ed. Philadelphia: Saunders Elsevier; 2022.
3. Indonesian Ministry of Health. Infodatin. Pusat data dan Informasi Kementerian Kesehatan RI, Situasi Gizi di Indonesia, ISSN. 2016:2442-7659.
4. World Health Organization. Malnutrition. Fact Sheet 2020.
5. IDAI. Asuhan nutrisi pediatrik. UKK Nutrisi dan Penyakit Metabolik Ikatan Dokter Anak Indonesia. 2011.
6. Higashiyama Y, Kubota M, Oshima S, Mibu M, Yasui Y, Nagai A. Assessment of Japanese healthy children's nutritional status using Waterlow classification. 2012. https://doi.org/10.4236/health.2012.411158
7. Sjarif DR, Lestari ED, Mexitalia M, Nasar SS. Prinsip Asuhan Nutrisi pada Anak. In: Buku ajar nutrisi pediatrik dan penyakit metabolik. Jakarta: Badan Penerbit IDAI 2014.
8. Bernard-Bonnin A-C. Feeding problems of infants and toddlers. Canadian Family Physician. 2006;52(10):1247-51.
9. Homan GJ. Failure to thrive: a practical guide. American family physician. 2016;94(4):295-9.

APGHN

Archives of Pediatric Gastroenterology, Hepatology, and Nutrition

www.apghn.com

Volume 2 / No. 4
November 2023

ISSN 2830-5442

9 772830 544009

Published by
Indonesian Society of Pediatric Gastroenterology, Hepatology, and Nutrition