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Association of malnutrition with renal function in children with kidney disease

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Abstract

Background: Malnutrition is a serious and lasting burden worldwide. Woman, infants, children, and adolescents are at particular risk of malnutrition. Prevalence of malnutrition children under 5 years in 2020 was 45 million were estimated to be wasted, and 38.9 million were overweight or obese. Around 45% of deaths among children under 5 years old were related to undernutrition, especially in low- and middle-income countries. Children with kidney disease was a risk factor to become a malnutrition. Malnutrition increases morbidity and mortality in children with kidney disease. Earlier studies showed a high prevalence rate of malnutrition in children with chronic kidney disease.

Objectives: The aim of the study to associate malnutrition with renal function in children with kidney disease.

Methods: A cross-sectional study was conducted on children with kidney disease aged 2-17 years who met the inclusion criteria who were hospitalized at the Inpatient Department/SMF Department of Child Health Sciences, Dr. Hospital. Soetomo, Surabaya from October to December 2020 after taking approval from parents and institutional ethics committee in the department of Pediatrics. Detailed anthropometric measurements were taken and grading of malnutrition was calculated according to WHO, CDC, and Waterlow criteria. Serum creatinine was measured for each sample.

Results: There were 157 samples met the inclusion criteria. Sex between male and female almost balanced (54.8%:45.2%) and the median age was 13 years-old. The most frequent diagnosis in this group was lupus nephritic (68%). Forty eight percent of total samples were malnutrition, which most of them were moderate malnutrition. Estimated glomerular filtration rate of moderate malnutrition was normal in 12 (23.5%) cases, decreased in 39 (76.5%) cases. A significant statistically was showed between malnutrition with severe estimated glomerular filtration rate (P 0.000)

Conclusions: Malnutrition was a common finding in nutritional status of children with kidney disease. There was a correlation between nutritional status and renal function in children with kidney disease.

Keywords: Malnutrition; Children; Renal function; Kidney disease

1. Introduction

Malnutrition is a widespread healthy problem globally. It was a serious and lasting burden for individuals and their families, communities, and countries. Around 45% of deaths among children under 5 years old in low- and middle-income countries were related to undernutrition. Woman, infants, children, and adolescents are at risk of malnutrition. Malnutrition is defined as deficiency, excess, or imbalance in a person's intake of energy and/or nutrients. It is divided

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into 3 groups: undernutrition, micro-related malnutrition, overweight, obesity and diet-related noncommunicable disease [1].

Prevalence of malnutrition children under 5 years in 2020 was 149 million children were estimated to be stunted, 45 million were estimated to be wasted, and 38.9 million were overweight or obese. World Health Organization (WHO) aims for a world free of all forms of malnutrition through its Sustainable Developmental Goal (SDG) by 2030, put 2 points on number 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) and number 3 (ensure healthy live and promote wellbeing for all at all age) to focus on this issue [1].

Children with kidney disease was a risk factor to become a malnutrition. It is characterized by protein energy wasting and micronutrient deficiency. Earlier studies showed a high prevalence rate of malnutrition in children with chronic kidney disease. Mechanisms that cause syndromes of wasting, malnutrition, inflammation in Acute Kidney Injury (AKI) and Chronic Kidney Disease (CKD) is increasing energy expenditure, hormonal and metabolic derangement, inappropriate nutritional intake, and dialysis-related abnormalities [2].

Malnutrition increases the risk of morbidity and mortality in children with kidney disease. A nutritional support is a part of comprehensive strategy in patient with chronic kidney disease. An early identification of malnourished children with chronic kidney disease could prevent further complication and makes better outcome, especially those who lives in developing countries [3].

This study is meant to give additional information about nutritional profile in patient with chronic kidney disease and its correlation with renal function.

2. Material and methods

2.1. Study Design

The present study used an analytical observational research approach with a cross-sectional design. This study analyzed the validity of proteinuria examination in children with glomerulopathy. The subjects were all children aged 2-18 years old with glomerulopathy inpatient at the Division of Pediatric Nephrology, Dr Soetomo general hospital Surabaya. The study was approved by the Ethical Committee of Dr Soetomo general hospital (No. 0062 / KEPK / IX / 2020).

2.2. Diagnosis of nutritional status

The diagnosis of nutritional status was defined based on WHO 2006, CDC 2000, and Waterlow criteria. In children below 5 years old, the nutritional status was based on WHO 2006 criteria. Waterlow and CDC 2000 criteria was used to diagnose the nutritional status in children above 5 years old. The eGFR was determined using Schwartz formula by dividing creatinine serum to body height then multiply with empirical constant based on age and sex.

2.3. Statistical analysis

Statistical measurement (e.g. mean, standard deviation, and frequency distribution table) were presented in the form of descriptive analysis. The data were processed using SPSS version 21.0. The results were analyzed by contingency coefficient test with P value 0.05 remain as statistically significant.

3. Results

3.1. Characteristic of patients

The subjects were 157 children with glomerulopathy aged from 2 to 18 years. Table 1 shows characteristic of patients [Table 1]. The results of this study showed that a total sample of 157 subjects who were hospitalized at Department of Child Health Dr Soetomo general hospital Surabaya. Gender between men and women are almost equal. The underlying diagnosis in this study was lupus nephritis, 68.8%, with a median glomerular filtration rate of 71.45.

Characteristics of the patients are shown separately by sex and level of eGFR I table 1 and 2. In all patients combined, the mean age was 12,74 ± 4,58 (median 13.75 years, range, 2-18). Fifty-four of the individuals were male. The causes of kidney disease recorded at the initial baseline assessment were lupus nephritis in 68%, idiopathic nephrotic syndrome 11.5%, RPGN 6.4%, HSP nephritis 5.1%, C3 glomerulopathy 3.8%, IgA nephropathy 2.5%, and MPGN 1.9%. Table 1 considers 5 ranges of GFR based n KDIGO: less than 15 mL/min/1.73 m^2 (15 patients), 15-29 mL/min/1.73 m^2 (14

patients), 30-44 mL/min/1.73 m^2 (13 patients), 45-59 mL/min/1.73 m^2 (15 patients), 60-89 mL/min/1.73 m^2 (61 patients), and equal or greater than 90 mL/min/1.73 m^2 (35 patients).

Table 1 Subjects Characteristic

Characteristics	
Age	
Mean ± SD (years)	12.74 ± 4.58
Median (min. – max) (years)	13.75 (2-18)
Sex	**N (%)**
Male	86 (54.8)
Female	71 (45.2)
Diagnosis	**N (%)**
HSP Nephritis	8 (5.1)
Lupus Nephritis	108 (68.8)
membranoproliferative glomerulonephritis (MPGN)	3 (1.9)
rapidly progressive glomerulonephritis (RPGN)	10 (6.4)
idiopathic nephrotic syndrome	18 (11.5)
others	10 (6.3)
Glomerular filtration rate (GFR)	
Mean ± SD	75.94 ± 52.92
Median (min. – max.)	71.45 (4.26-264.32)
GFR classification (ml/min/1.73 m^2)	**N (%)**
G1 (≥ 90)	35 (24)
G2 (60-89)	61 (38.9)
G3a (45-59)	15 (9.6)
G3b (30-44)	13 (8.3)
G4 (15-29)	14 (8.9)
G5 (<15)	15 (9.6)
Nutritional status	**N (%)**
Normal	81 (51.59)
Malnutrition	
Moderate malnutrition	52 (33.12)
Overweight	12 (7.64)
Obese	12 (7.64)

SD: Standard deviation; GFR: glomerular filtration rate; HSP: Henoch-Schönlein purpura

Of the 157 patients for whom data are available, 76 patients reported that they had malnutrition problem, 52 patients were moderate malnutrition, 12 patients were overweight, and 12 patients were obese.

Table 2 Nutritional status in sex, diagnosis, and eGFR classification

	Obese (n)	Overweight (n)	Normal (n)	Moderate Malnutrition (n)
Sex				
Male	12	4	41	29
Female		8	41	22
Diagnosis				
Lupus Nephritis	1	10	56	41
C3 glomerulopathy			6	
HSP Nephritis	3			5
IgA nephropathy			1	3
MPGN		2	1	
RPGN	4		4	2
Idiopathic Nephrotic Syndrome	4		14	
GFR classification (ml/min/1.73 m^2)				
G1 (≥ 90)	4	3	21	12
G2 (60-89)	7	8	36	9
G3a (45-59)	1		10	4
G3b (30-44)		1	5	7
G4 (15-29)			2	13
G5 (<15)			8	7

C3: Complement 3; GFR: glomerular filtration rate; HSP: Henoch-Schönlein purpura; IgA: Immunoglobulin A; MPGN: *membranoproliferative glomerulonephritis*; RPGN: *rapidly progressive glomerulonephritis*

3.2. Nutritional status in children with kidney disease

51.59% patient with kidney disease was in normal nutritional status. In the other hand, almost half of the subjects were in malnutritional status. 33.12% was moderate malnutrition, obese and overweight was 7.64% each. In 52 patients with moderate malnutrition, 39 patients (76.5%) had decreased of eGFR, while 48.7% was severe decreased of eGFR. Moderate malnutrition related to severe glomerular filtration rate in children with kidney disease (P 0.000).

Table 3 Malnutrition in decreased eGFR

	Not severe eGFR n (%)	Severe eGFR n (%)	P value
Malnutrition	20 (51.3)	19 (48.7)	.000
Normal nutritional status	52 (83.9)	10 (16.1)	

eGFR: estimated glomerular filtration rate

4. Discussion

Malnutrition is related to deficiency, excess, or imbalance in a person's intake of energy and/or nutrients [1]. There are four requirements (biochemical criteria; low body weight, reduced total body fat, or weight loss; decrease in muscle mass; and low protein or energy intakes) should meet the criteria for diagnosing protein energy wasting Protein energy wasting is a decreased body stores of protein and energy fuels. Protein energy wasting cannot be corrected solely by increasing energy intake [3]. In childhood period, nutrition is one of the most important factors determines growth and development [1].

Anthropometric measurements of malnutrition below age 5 years in this study, using World Health Organization (WHO), define as falling of 2 standard deviations below the normal weight for age (underweight), height for age (stunting) and weight for height (wasting). In children above 5 years old, the measurement, using Centers for Disease Control and Prevention (CDC) growth chart. Malnutrition is defined using Waterlow criteria as shown in table 4 [5]. In this study, almost half of patient was malnutrition (48.41%), most of the malnourished patients are moderate malnutrition (33.12%). Previous study from Turkey (2010) showed the main diagnosis of kidney disease who suffered from malnutrition was glomerulopathy [6]. Malnutrition impacts kidney's growth and function as kidney function to do excretory and synthetic function as well as normal homeostasis. The impact is not shown at initial examination of the patient sometimes but further later [4].

Table 4 Nutritional status based on Waterlow criteria, WHO 2006, and CDC 2000 [5]

Nutritional status	BW/BH (% median)	BW/BH (WHO 2006)	BMI (CDC 2000)
Obese	>120	>+3	>P95
Overweight	>110	>+2 until +3 SD	P85-P95
Normal	>90	+2 SD until -2 SD	
Moderate malnutrition	70-90	<-2 SD until -3 SD	
Severe malnutrition	<70	<-3 SD	

Renal function in malnourished children with kidney disease is affected mostly by infection or imbalanced nutrition whether undernourished or over-nourished. Malnutrition in patient with kidney disease associated with impaired growth and development in children [6]. Renal function is best measured as glomerular filtration rate (GFR). It refers to volume of glomerular filtrated each minute by all nephrons in both kidneys. It also estimates how much blood passes through the glomeruli. These filter protein with molecular weight less than 40kDa [7]. Glomerular filtration was begun at 6th week of fetal life, although the function was done by placenta for the homeostatic function. The formation of nephron is completed by 35-36 weeks of gestational age then GFR increased right after birth until 18-20 years. Children older than 3 years old were approximate adult value [4].

Creatinine is derived from muscle metabolism. The production is relatively constant throughout the day in healthy person. Serum creatinine is excreted in kidney through glomerular and tubular filtration. The serum creatinine is an insensitive way to measure kidney function because it could detect the abnormality if GFR falls by 30-40%. It is affected by sex, height, muscle mass, bilirubin, and not secreted by renal tubules under any conditions [4]. Based on KDIGO 2013, there are 6 stages of chronic kidney disease. These stages are categorized based on GFR, as shown on table 1 above. In this study, in 51 malnourished children, 39 patients (76.5%) decreased in kidney function. While in normal nutritional status patients, it were 75.3% patient decreased in kidney function. Study from USA (2000) showed a relation between protein-energy nutritional status and decline of GFR [8].

Pathological mechanism of malnutrition is a complex and multifactorial. In children with chronic kidney disease involved decreased of appetite and nutrient intake, hormonal derangements, metabolic imbalances, inflammation, increased of catabolism, decreased anabolism, and dialysis related abnormalities [4]. The factors that could lead to malnutrition in CKD is a chronic inflammation such as peritonitis, sepsis, or an inadequate protein intake. In chronic inflammatory state in CKD, there's increased in resting energy expenditure [6].

This cross-sectional study revealed that moderate malnutrition had relation with severe decreased of eGFR statistically significant (P 0.000). Many studies report that there's high prevalence of protein-energy malnutrition in patient with kidney disease, especially in dialysis patients [9]. The trend for most of the parameters was for a worsening of nutritional status as the GFR declined. A study in India (2019) compared children between moderate malnutrition and severe malnutrition had the same percentage cases of decreased in GFR [4]. A cohort study in Turkey (2018), with sample of children with kidney disease showed that 45% patients were malnutrition, and more than half were in severe GFR [6]. Other studies that similar without study were study in USA (1998) and in Guatemala (1961). It showed that malnourished children had decreased GFR as remarked with fall renal clearance [10, 11]. On the other hand, study from Mexico (1980) found that GFR was normal in all malnourished children, whether its marasmus nor kwashiorkor type [12].

5. Abbreviations

AKI: Acute kidney injury
BH: Body height
BMI: Body mass index
BW: Body weight
C3: Complement 3
CDC: Centers for Disease Control and Prevention
CKD: Chronic kidney disease
Da: Dalton
GFR: Glomerular filtration rate
HSP: Henoch-Schönlein purpura
IgA: Immunoglobulin A
KDIGO: Kidney Disease Improving Global Outcomes
MPGN: Membranoproliferative glomerulonephritis
RPGN: Rapidly progressive glomerulonephritis
SD: Standard deviation
SDG: Sustainable Developmental Goal
USA: United State of America
WHO: World Health Organization

6. Conclusion

Malnutrition had correlation with renal function in children with kidney disease.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors declare that there is no conflict of interest

Statement of ethical approval

This study obtained permission from the ethics committee. Ethical approval was obtained from the Institutional Ethical Committee of Dr. Soetomo general hospital (No. 0062 / KEPK / IX / 2020). All procedures performed were in accordance with the ethical standards and with the 1964 Helsinki Declaration and its later amendments. Before the subject recruitment, an explanation of general research information was carried out to the subjects and their parents for getting their consent.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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