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Literature Review: Correlation of decreased glomerular filtration rate to malnutrition risk in pre-dialysis chronic kidney disease patients

Studi Literatur: Hubungan penurunan laju filtrasi glomerulus terhadap risiko malnutrisi pada pasien penyakit ginjal kronik pre-dialisis

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Abstract

Chronic kidney disease (CKD) is a condition characterized by a decreased glomerular filtration rate (GFR), which can cause the breakdown of protein reserves, resulting in malnutrition. This study aimed to determine the mechanism underlying the relationship between decreased GFR and the risk of malnutrition in pre-dialysis CKD patients. Scoping review method using PubMed, ScienceDirect, and SpringerLink databases with the criteria of articles published from 2014 to 2024 and using RCTs or cross-sectional studies. Relevant articles were selected through the PRISMA method. The results showed that a decrease in GFR was strongly associated with malnutrition in pre-dialysis CKD through three main mechanisms: increased protein catabolism, decreased serum creatinine/cystatin C ratio, and increased number and diversity of drug prescriptions. Malnutrition due to changes in GFR can be observed through BMI, MUAC, muscle and fat mass, and handgrip strength. In conclusion, the lower the GFR, the higher the risk of malnutrition in pre-dialysis CKD and the lower the BMI value and MUAC size, reduced muscle mass and fat, and decreased handgrip strength and worsening kidney function, as indicated by the lower GFR.

Keywords: Protein catabolism, pre-dialysis CKD, serum creatinine ratio, cystatin C, risk of malnutrition

Abstrak

Penyakit ginjal kronik (PGK) merupakan kondisi penurunan fungsi ginjal yang ditandai menurunnya laju filtrasi glomerulus (LFG), sehingga dapat menyebabkan pemecahan cadangan proteinsecara terus-menerus hingga mengakibatkan malnutrisi. Tujuan studi untuk mengetahui mekanisme hubungan antara penurunan LFG dengan risiko malnutrisi pada PGK pre-dialisis. Metode melalui scoping review menggunakan database PubMed, ScienceDirect, dan SpringerLink dengan kriteria artikel terbit dari 2014 sampai 2024, serta menggunakan RCT atau cross-sectional study. Artikel relevan diseleksi melalui metode PRISMA.. Hasil, menunjukkan penurunan LFG berhubungan kuat dengan malnutrisi pada PGK pre-dialisis melalui tiga mekanisme utama berupa peningkatan katabolisme protein, penurunan rasio serum creatinine/cystatin C, peningkatan jumlah dan keberagaman jenis peresepan obat. Malnutrisi akibat perubahan LFG dapat dilihat melalui IMT, LiLA, massa otot dan lemak, dan kekuatan genggam tangan. Kesimpulan, semakin rendah LFG maka semakin tinggi risiko malnutrisi pada PGK pre-dialisis dam semakin rendahnya nilai IMT dan ukuran LiLA, berkurangnya massa otot dan lemak, serta menurunnnya kekuatan genggam tangan dan semakin memburuknya fungsi ginjal yang ditunjukkan oleh semakin rendahnya LFG.

Kata Kunci: Katabolisme protein, PGK pre-dialisis, rasio serum creatinine, cystatin C, risiko malnutrisi

Introduction

The high death rate in Indonesia is most closely associated with the incidence of non-communicable diseases, including chronic kidney disease (CKD). CKD is one of the 10 highest causes of death in Indonesia in 2023 along with other non-communicable diseases such as stroke, heart and blood vessel disease, diabetes and cancer (Kementerian Kesehatan RI, 2023). CKD is a condition of kidney damage or a slow decline in kidney function, generally within 3 months, which can progressively get worse over time (Ozturk & Toprak, 2019). Decreased kidney function can be caused by foreign objects in the kidney, pathological kidney abnormalities, or functional kidney abnormalities which can be accompanied by other non-threatening diseases such as diabetes mellitus, hypertension, heart disease, etc (Lubis et al., 2018).

Kidney functional abnormalities are generally synonymous with decreased glomerular filtration rate (GFR). The condition of CKD is generally not obvious at the beginning of the diagnosis, but the symptoms will become more severe as the GFR decreases (Gliselda, 2021). In certain conditions, when kidney function has decreased significantly, it will cause terminal kidney failure, where the individual will ultimately need kidney support therapy in the form of dialysis (Putri et al., 2023).

Decreased kidney function causes changes in daily energy and protein requirements. Adults are given a low-protein diet as a form of compensation to deal with decreased kidney function. Providing a low-protein diet is expected to help improve the quality of life of CKD individuals without aggravating kidney function which is currently decreasing (Nareswari et al., 2023). This is done to prevent worsening of the kidney condition, especially to prevent a more rapid decrease in the GFR. A decrease in GFR causes a decrease in energy and protein intake in adults through increased protein catabolism and urea production (Moreno-González et al., 2024). Increased urea production causes changes in appetite in the form of anorexia, where adults lose their appetite and consume much less food than their daily diet. If these poor dietary changes persist for a long time, they can increase the risk of malnutrition (Ozturk & Toprak, 2019).

Malnutrition is one of the most common conditions with a prevalence of 28-65% which can result in decreased quality of life and increased mortality and morbidity rates in CKD, especially in conditions before hemodialysis, commonly called pre-dialysis (Sheikh et al., 2022). Malnutrition in pre-dialysis CKD further reduces quality of life and increases the risk of death in pre-dialysis CKD patients by decreasing GFR values, indicating worsening kidney function. To help prevent the increased risk of malnutrition that has a negative impact on pre-dialysis CKD patients, a literature review is needed to describe the mechanism of decreased GFR values in pre-dialysis CKD patients with an increased risk of malnutrition. Various recent studies have focused on the risk of malnutrition with pre-dialysis CKD conditions that are already accompanied by other comorbidities. This study is needed to prevent the risk of malnutrition in pure pre-dialysis CKD, which can cause complications of other non-communicable diseases that can further increase the risk of death in patients with pre-dialysis CKD.

The mechanism of malnutrition in CKD generally begins with nausea and decreased appetite, which results in an imbalance between daily protein energy requirements and food intake (Satti et al., 2021). Malnutrition in CKD can be seen through anthropometric aspects in the form of weight loss, decreased body mass index (BMI), decreased muscle mass and upper arm circumference and decreased screening score through Subjective Global Assessment (SGA) (Anggraini & Adelin, 2023).

Malnutrition in CKD is closely related to decreased GFR, especially in predialysis CKD patients. The risk of malnutrition increases as GFR decreases in predialysis CKD. (Sheikh et al., 2022). Based on various studies related to decreased GFR in pre-dialysis CKD patients with malnutrition, this study aimed to provide a comprehensive picture of the relationship between changes in GFR and malnutrition in CKD. Specifically, this literature study aims to determine the mechanism underlying the relationship between decreased GFR and the risk of malnutrition in pre-dialysis CKD patients.

Methods

Data Sources and Search Strategy

This literature review was conducted using a scoping review approach with the aim of providing a descriptive explanation regarding the relationship

between decreased LFG and increased risk of malnutrition in pre-dialysis CKD conditions based on various existing studies without conducting a meta-analysis/statistical combination process, which is the main drawback of the scoping review approach.

The data sources used were searched using three databases: PubMed, ScienceDirect, and SpringerLink using the keywords "Glomerular Filtration Rate" AND "Malnutrition" OR "Chronic Kidney Disease" AND "Malnutrition" OR "Glomerular Filtration Rate" AND "Chronic Kidney Disease" AND "Malnutrition" Malnutrition. The strategy for searching relevant data sources was carried out through screening, which included the following PICOS standards.

Population
Adult CKD individuals (>18 years) with GFR ≤60 mL/minute/1,73 m2 who met one of the following four criteria: BMI in kg/m2, decreased muscle mass and upper arm circumference in cm, signs of decreased muscle mass or fat mass, or decreased handgrip strength.

Intervention
Pre-dialysis PGK individuals without other comorbidities who had never received any form of kidney support therapy, hemodialysis, CAPD, or kidney transplantation.

Comparison
Differences in malnutrition status indicators included BMI, upper arm circumference size, decreased muscle and fat mass, and decreased handgrip strength based on changes in GFR values in predialysis CKD patients.

Outcomes
There is an increased incidence of malnutrition in predialysis CKD individuals without comorbidities, as seen from BMI indicators, LiLA size, decreased muscle and fat mass, or decreased handgrip strength.

Type of Study
The study was conducted using a randomized controlled trial (RCT) or cross-sectional study method on human subjects.

Eligibility Criteria
The abstracts and titles of the articles will be screened to identify articles that meet the requirements set by the authors. The inclusion criteria were full-text study articles published in 2014-2024 in both Indonesian and English. The articles used refer to the last 10 years because the latest research explains more about the relationship between decreased GFR accompanied by other comorbidities, where the condition of the comorbidity contributes to worsening the condition of malnutrition, so that it cannot be seen clearly regarding the relationship between pre-dialysis CKD conditions that are purely related to the risk of malnutrition.

Meanwhile, the exclusion criteria were duplicate articles (two articles of the same study found in two keywords or two databases) and CKD individuals who were overweight, obese, or had signs of increased fat mass.

Data extraction
Based on the keywords that have been set, thousands of articles that are appropriate were found through skimming article titles in three databases: PubMed, ScienceDirect, and SpringerLink. From the three databases, 2914 relevant articles were found, which were then assessed based on the previously set inclusion and exclusion criteria. Relevant articles that met the inclusion criteria were then extracted using the PRISMA method, which is displayed through an illustration of the PRISMA flow diagram scheme, the details of which are displayed in a table form. The data extraction process using PRISMA is illustrated in Figure 1.

After six articles met the inclusion criteria using the PRISMA method, a quality assessment was carried out based on the research design using the JBI Critical Appraisal Tools. The six study articles that met the inclusion criteria consisted of two with a randomized controlled trial (RCT) research design and four with a cross-sectional study design. After an assessment was carried out based on the RCT research design quality checklist, the two study articles that had been found met the 13 criteria for a good RCT. Meanwhile, based on the cross-sectional study research design quality assessment checklist, the four study articles that were found met eight criteria for a good cross-sectional study.

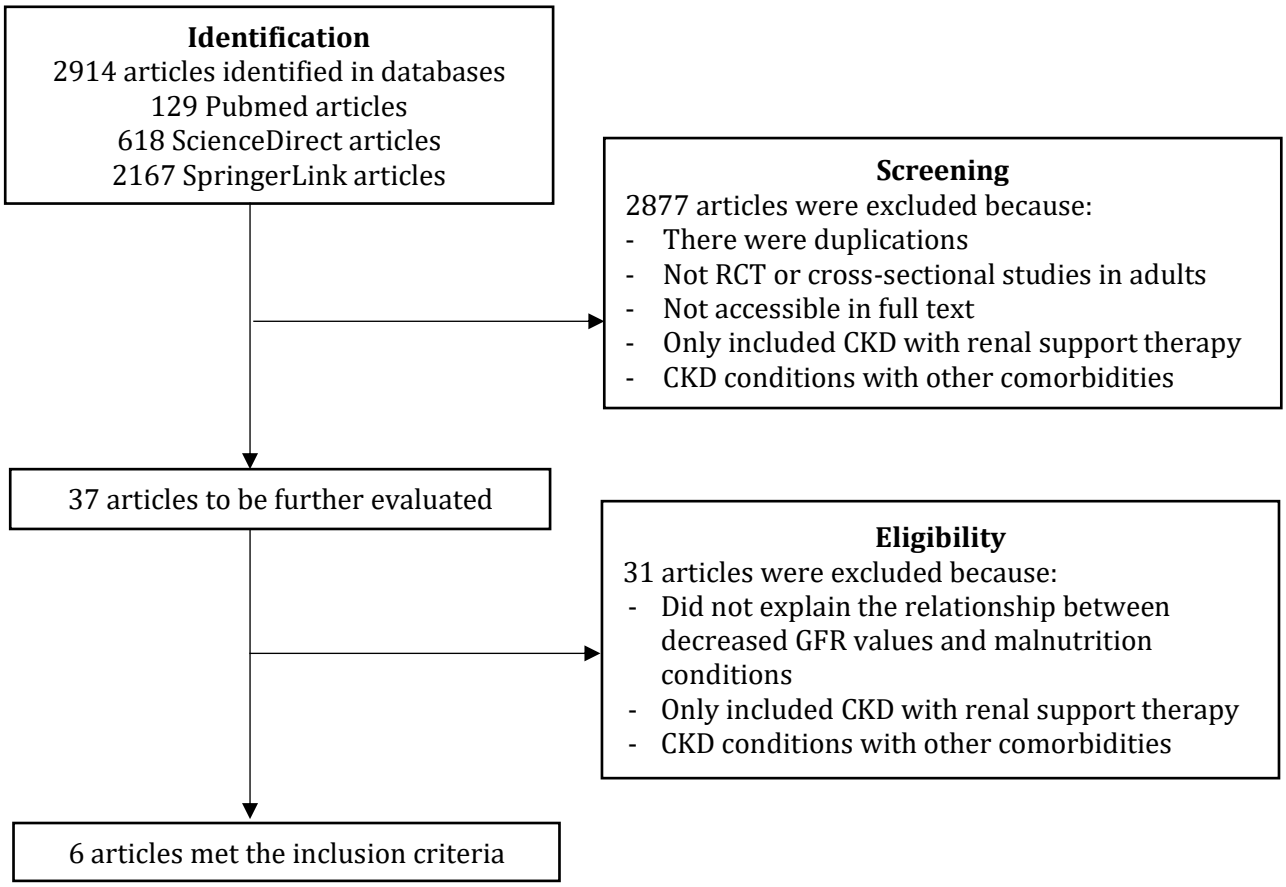

Figure 1. PRISMA method flowchart to determine which articles to use

Result and Discussion

Based on a search using three keywords in three databases, 2914 articles were found in PubMed (129), ScienceDirect (618), and SpringerLink (2167). Articles identified from the three databases were screened. Relevant articles were screened by assessing indicators in the form of title, year of publication, research design, research variables, interventions, respondents, and research objectives. After screening based on these parameters, 6 relevant articles were finally obtained.

The research objective of the six relevant articles was to determine the relationship between changes in GFR and malnutrition status in adult patients with pre-dialysis CKD. Clinical outcomes in the form of malnutrition status were observed from various anthropometric and clinical physical aspects, including BMI, upper arm circumference, triceps skinfold thickness, decreased muscle mass and fat mass, and handgrip strength.

The research design of the six relevant articles analyzed was a randomized controlled clinical trial (RCT) and cross-sectional study. In the two articles with an RCT design, there was a control group and an intervention group in a certain time period, which were then analyzed for clinical outcomes related to anthropometric and clinical physical aspects. In the four articles with a cross-sectional study design, there was a group without dialysis and a group of renal assisted therapy (hemodialysis and kidney transplantation).

The respondents used in this study were CKD patients with pre-dialysis conditions without other comorbidities. In the control group in the RCT design, patients with CKD were given alkali supplementation in the form of sodium bicarbonate. After assessing the quality of the six relevant studies using the JBI Critical Appraisal Tools, the details of the results of each study article are summarized briefly in Table 1.

The results of the analysis of six relevant articles that have been summarized above show that decreased GFR values in adult pre-dialysis CKD patients are related to malnutrition status through a mechanism of reduced kidney function

influenced by various factors, including increased protein catabolism, decreased serum creatinine/cystatin C ratio, increased plasma adiponectin and ghrelin levels, and increased number and diversity of types of prescribed drugs. These various factors can cause malnutrition, as evidenced by decreased BMI, upper arm circumference, triceps skinfold thickness, muscle mass, fat mass, and handgrip strength. The GFR is one of the main indicators for assessing kidney function. The greatest decrease in GFR occurred in patients with predialysis CKD. The lower the GFR indicates that the kidney damage that occurs is greater so that kidney function decreases, one of which is in maintaining stable protein metabolism (Sheikh et al., 2022).

Table 1. Summary of study articles relevant to inclusion criteria

Researchers and Years	Research Title and Subject	Method	Results and Conclusions
Zhou et al. (2018)	Sarcopenia and its Relationship with Muscle Mass, Glomerular Filtration Rate, and Physical Function in Patients with Chronic Kidney Disease Stage 3-5 Subject: 148 adult CKD patients with GFR <30 ml/min/ 1,72 m2	Research Design Randomized controlled clinical trial Intervention Not undergoing any renal replacement therapy and not affected by other comorbidities	GFR measurement in the range of 8-55 mL/min/1,73 m2 was associated with decreased muscle mass (P < 0,05), fat mass (P < 0,05), appendicular skeletal muscle index (P < 0,05). Functional reach was associated with arm muscle mass (P < 0,05) and Berg balance test score was associated with trunk muscle mass (P < 0,05). Handgrip strength was associated with arm muscle mass (P < 0,001). Isometric quadriceps strength was associated with arm muscle mass (P < 0,001). Men (44%) experienced more decreased muscle mass than women (22%). Women (36%) experienced more decreased muscle mass strength than men (26%). Men (16%) were much more susceptible to sarcopenia than women (8%). Discussion Among CKD stage 3-5 patients, decreased muscle mass, especially appendicular skeletal muscle, was significantly associated with decreased GFR. Two important parameters related to physical function, balance, and strength, were significantly associated with muscle mass. Men were significantly more susceptible to sarcopenia than women during the decline in kidney function.
Dubey et al. (2020)	Correction of Metabolic Acidosis Improves Muscle Mass and Renal Function in Chronic Kidney Disease Stages 3 and 4: A Randomized Controlled Trial Subject 188 CKD stage 3 and 4 patients with venous bicarbonate	Research Design Randomized controlled clinical trial Intervention It was conducted on pre-dialysis CKD patients by giving oral sodium bicarbonate supplementation where patients with structural and functional abnormalities in the	The intervention group showed higher lean body mass values {36,8 kg [95% CI 36.5–37.1] compared to the control group 36 [3,57–36,4]; P = 0,002}. The intervention group also showed higher upper arm circumference measurements [22,9 cm (95% CI 22,8–23) compared to the control group 22,6 cm (22,5–22,7); P = 0,001]. The intervention group showed higher GFR [32,74 mL/min/ 1,73m2 (95% CI 31,5–33,9) compared to the control group 28,2 (27–29,4); P = 0,001]. GFR decreased rapidly in 39 patients

Researchers and Years	Research Title and Subject	Method	Results and Conclusions
	levels <22 mEq/L and stable LFG where the change in values during 4 weeks of observation was <5%	gastrointestinal tract, decompensated chronic liver disease, heart failure, morbid obesity, malignancy, chronic infection, undergoing bicarbonate therapy for >2 weeks, or receiving immunosuppressants were not included in this study.	(41,5%) in the control group and 19 patients (20,2%) in the intervention group (P ≤ 0,001). Conclusion The results of the study showed a positive effect of alkali supplementation in maintaining body muscle mass and GFR in CKD stage 3 and 4 patients so that it can reduce the risk of CKD complications in the form of metabolic acidosis which triggers increased protein catabolism in the body which can lead to malnutrition.
Singhal et al. (2019)	Serum Creatinine and Cystatin C-Based Index Can Be a Screening Biomarker for Sarcopenia in Elderly Population Subject PGK patients over 65 years of age	Research Design Cross-sectional study Intervention Patients suffering from Acute Kidney Injury or critical illness or undergoing regular dialysis or unable to undergo adequate assessment were not included in this study.	The prevalence of sarcopenia in CKD patients was 53%. The average serum creatinine/cystatin C ratio was 74,79±24,91 and was not significantly directly related to sarcopenia. The average biochemical total body mass index (biochemical TBMI) was 36,40±7,88 (males—38,77±7,72, females—31,22±5,13). The lower the biochemical TBMI was significantly associated with an increased risk of sarcopenia (P <0,01). Conclusion The lower the serum creatinine/cystatin C ratio is associated with lower LFG. The lower the serum creatinine/cystatin C ratio, the lower the biochemical TBMI which causes a higher risk of sarcopenia.
El-Khashab & Behiry (2019)	Adiponectin and Ghrelin: The Role of Nutritional Regulation in Chronic Kidney Disease Patients Subject 180 PGK patients with an average age of 34.6±9.53 years	Research Design Cross-sectional study Intervention CKD patients were divided into three groups, namely without dialysis, hemodialysis, and kidney transplantation. Patients under 18 years of age, with a history of DM, autoimmune, infection, decompensated liver disease, other acute diseases in the last 3 months, a history of dyslipidemia in the family, and consumption of antibiotics, multivitamins, or any supplementation other than folic acid and vitamin B were not	118 patients were male (60%). Plasma adiponectin levels were significantly higher in the hemodialysis group (17±3,5) compared to the kidney transplant group (10,8±5,2) and the non-dialysis group (4,7±2,3). Ghrelin levels were lower in the kidney transplant group (2,1±0,2) compared to the hemodialysis group (2,8±0,25) and the non-dialysis group (2,8±0,3, P<0,001). Plasma adiponectin and ghrelin levels were inversely associated with BMI. Conclusion Plasma adiponectin levels were strongly and inversely related to BMI in the non-dialysis group and the hemodialysis group. Ghrelin was inversely correlated with BMI and GFR and positively and significantly correlated with serum creatinine in the non-dialysis group and the hemodialysis group. Thus, the higher the adiponectin and ghrelin levels, the

Researchers and Years	Research Title and Subject	Method	Results and Conclusions
		included in this study.	lower the BMI. The higher the ghrelin levels, the higher the serum creatinine and the lower the GFR..
Soysal et al. (2023)	Prevalence and Incidence of Geriatric Syndrome Based on Glomerular Filtration Rate in Elderly Patients Subject 1692 CKD patients aged ≤60 years Medication Prescription, Common Side-effects, and Nutritional Status are Associated in Patients With Chronic Kidney Disease	Research Design Cross-sectional study Intervention Patients with acute kidney disease or other severe diseases that may impair general health status such as acute cerebrovascular attack, sepsis, acute coronary syndrome, acute respiratory failure, osteoarthritis, or neuromuscular diseases that may impede walking ability or immobility, or delirium, visual and hearing impairment, and undergoing regular hemodialysis therapy were not included in this study.	It was found that there was a 2,5-fold increased risk of fraility, 2,4-fold increased risk of sarcopenia and 2,7-fold increased risk of malnutrition in individuals with GFR between 30–59 ml/min/1,73 m2 compared to individuals with GFR ≥60 ml/min/1,73 m2. No significant differences were found in other geriatric syndrome parameters. Conclusion The lower the LFG in geriatric individuals with CKD without dialysis will cause a higher risk of frailty and the possibility of sarcopenia and malnutrition.
Dahl et al. (2022)	Medication Prescription, Common Side Effects, and Nutritional Status Associated with Patients with Chronic Kidney Disease Subject PGK stage 3-5 patients aged >18 years who understand Norwegian or English	Research Design Cross-sectional study Intervention In CKD patients without dialysis, the minimum is at stage 3-5. In CKD patients with hemodialysis therapy must be in stable condition. In CKD patients with kidney transplantation must be in successful transplant status with stable graft function. CKD patients with a life expectancy of less than 6 months were not included in this study.	Conducted in 217 CKD patients consisting of 112 CKD stage 3-5 patients without dialysis, 33 CKD patients with hemodialysis, and 72 CKD patients with kidney transplantation. On average, patients are currently prescribed 9 drugs. The number of drugs prescribed is inversely related to the size of the upper arm circumference, triceps skinfold thickness, handgrip strength, albumin levels, and hemoglobin when compared with age, gender, and kidney function. Prescribed drugs with side effects of nausea and xerostomia are associated with decreased handgrip strength. Conclusion The lower the LFG in CKD without dialysis, the more diverse the number and types of drugs prescribed. Increasing the number and diversity of types of drugs prescribed is associated with decreased nutritional status. The greater the number and types of drugs prescribed, the lower the BMI, upper arm circumference size, triceps skinfold thickness, and albumin levels.

In predialysis CKD conditions, a decrease in GFR values indicated worsening kidney function. Worsening kidney function disrupts the kidney's ability to perform protein metabolism. The presence of increased protein catabolism in infectious conditions in the form of pre-dialysis CKD will cause an increasing amount of protein to be metabolized, so that kidney function that has begun to decline will be increasingly burdened in working to metabolize large amounts of protein (Hayati et al., 2021).

One of the results of the protein metabolism process was the serum urea and creatinine levels. Serum urea and creatinine which are toxic should be able to be excreted from the body by the kidneys when functioning normally (Nareswari et al., 2023). The condition of decreased kidney function in predialysis CKD causes limited amounts of urea and serum creatinine that can be excreted from the body so that the amount increases in the blood. The increase in urea and serum creatinine levels in the blood ultimately has an impact on the decreasing GFR value, which indicates that kidney function has worsened (Loho et al., 2016).

In conditions of decreased LFG, there is an increase in protein catabolism, which, if it continues, can cause patients with CKD to experience malnutrition. The process of protein catabolism causes the amount of protein reserves in the body to decrease, so that CKD patients will continue to experience a decrease in nutritional status until they fall into a state of malnutrition. Malnutrition is one of the most common types of problems and one of the risk factors that worsens the prognosis of the disease and increases the risk of death in CKD patients (Xi et al., 2022). If malnutrition continues, it will cause CKD patients to be at risk of experiencing sarcopenia, which results in a decrease in quality of life, depression and other adverse clinical impacts (Meza-Valderrama et al., 2021).

Increased protein catabolism, one of the initial causes of malnutrition, is characterized by an increase in the process of breaking down protein reserves stored in the body. The breakdown of protein reserves occurs because increased protein catabolism due to kidney disorders is not accompanied by sufficient daily protein intake. The breakdown of protein reserves that are generally clearly visible is in the skeletal and arm muscles. Increased protein catabolism in arm muscles causes a decrease in muscle mass and arm fat mass. Decreased arm muscle mass will cause nutritional status to decline, the size of the upper arm circumference to shrink and the strength of the handgrip to decrease, which if it continues to occur can cause malnutrition (Adrianto et al., 2021). The decline in nutritional status due to protein catabolism explained above is in line with research conducted by Sherly et al. (2021) which states that the decline in nutritional status to the point where CKD patients experience malnutrition is caused by an increase in protein catabolism that is not in line with the daily protein intake of CKD patients. The increase in protein destruction due to CKD conditions that are not balanced with the process of protein formation through nutritional intake causes the body to activate its defense mechanism to meet daily nutritional needs by breaking down the body's protein reserves. This breakdown of the body's protein reserves is what, if it continues to occur, will increase the risk of malnutrition in CKD patients and can also worsen kidney function. In research conducted by Dubey et al. (2020), CKD patients who did not receive alkali supplementation had lower body muscle mass and upper arm circumference measurements due to the rapid decrease in GFR. The rapid decrease in GFR occurs due to increased metabolic acidosis, which triggers increased protein catabolism in the body and can lead to malnutrition.

This is in line with research conducted by Zhou et al. (2018), GFR in pre-dialysis CKD patients in the range of 8-55 mL/min/1,73 m^2 is associated with the incidence of decreased muscle mass, fat mass, and appendicular skeletal muscle index. The decrease in arm muscle mass can affect functional abilities, one of which is handgrip strength. Men (44%) were more susceptible to decreased muscle mass than were women (22%). Meanwhile, women (36%) experienced a greater decrease in muscle mass than men (26%). However, in general, men (16%) were much more susceptible to sarcopenia than were women (8%).

The increased incidence of sarcopenia in pre-dialysis CKD patients is also supported by research conducted by Soysal et al. (2023), who stated that CKD patients with LFG between 30–59 ml/min/1,73 m^2 experienced a 2,5-fold increased risk of frailty, a 2,4-fold increased risk of sarcopenia, and 2,7-fold higher malnutrition in individuals with compared to individuals with LFG ≥60 ml/min/1,73 m^2.

Apart from being supported by these two studies, the relationship between decreased GFR

and the incidence of sarcopenia is also supported by research Singhal et al. (2019) which states that the prevalence of sarcopenia in CKD patients is 53%. In addition to decreased muscle mass and upper arm circumference, sarcopenia in CKD patients can also be seen through the average biochemical total body mass index (biochemical TBMI). Biochemical TBMI values are influenced by the serum creatinine/cystatin C ratio. A lower serum creatinine/cystatin C ratio is associated with lower GFR. The lower the serum creatinine/cystatin C ratio, the lower the biochemical TBMI, which causes a higher risk of sarcopenia in patients with CKD.

In addition to the serum creatinine/cystatin C ratio, the decrease in body mass index (BMI) of patients with CKD can also be influenced by plasma adiponectin and ghrelin levels. Research results El-Khashab & Behiry (2019) stated that plasma adiponectin and ghrelin levels in pre-dialysis CKD patients were lower than in CKD patients with renal support therapy (hemodialysis and kidney transplantation). Plasma adiponectin and ghrelin levels were inversely related to BMI. Ghrelin levels were inversely related to GFR, but directly related to serum creatinine. The higher the plasma adiponectin and ghrelin levels, the lower is the BMI. The higher the ghrelin level, the higher the serum creatinine level, which will cause a lower GFR.

Malnutrition in CKD patients is generally associated with increased protein catabolism and serum creatinine levels. However, malnutrition can also be caused by prescribed drug therapy in patients with CKD. Prescribed drug therapy, especially drugs that have side effects of nausea and xerostomia, can cause decreased appetite (Dahl et al., 2022). Malnutrition in CKD patients is generally associated with increased protein catabolism and serum creatinine levels. However, malnutrition can also be caused by prescribed drug therapy in patients with CKD. Prescribed drug therapy, especially drugs that have side effects of nausea and xerostomia, can cause decreased appetite (Iorember, 2018).

Based on research conducted by Dahl et al. (2022), Lower GFR decline especially in pre-dialysis CKD patients causes more diverse number and types of drugs prescribed. Increasing the number and diversity of prescribed drugs can be associated with decreased nutritional status. A greater number and types of drugs prescribed can cause lower BMI, upper arm circumference, triceps skinfold thickness, albumin levels, and handgrip strength.

Conclusion

Based on the literature study that has been conducted through 6 relevant study articles, it can be concluded that malnutrition is one of the most common nutritional problems in adult pre-dialysis CKD patients. Decreased GFR is strongly associated with the occurrence of malnutrition in pre-dialysis CKD patients through three main factors: increased protein catabolism, decreased serum creatinine/cystatin C ratio, and increased number and diversity of prescribed drugs. The incidence of malnutrition due to changes in GFR in patients with pre-dialysis CKD can be seen through several indicators, including decreased muscle and fat mass, BMI, upper arm circumference size, triceps skinfold thickness, and handgrip strength.

The increased risk of malnutrition caused by decreased GFR can be prevented or minimized by paying attention to increased protein catabolism, decreased serum creatinine/cystatin C ratio, and increased number and diversity of types of drugs prescribed to pre-dialysis CKD patients; this is especially expected to be useful in nutritional management by considering a low-protein diet that can help maintain adequate protein intake but does not worsen the kidney function that has decreased to metabolize more protein from daily intake. Studies related to the increased risk of malnutrition caused by decreased GFR are expected to be used for the early detection of malnutrition risk and to help determine the severity of malnutrition in pre-dialysis CKD patients.

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