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NUTRITIONAL ASSESEMENT OF CHRONIC KIDNEY DISEASE PATIENTS UNDERGOING HEMODYLYSIS: A REVIEW

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Abstract

Background: Hemodialysis is becoming more common for chronic kidney disease (CKD), a worldwide health issue. This review study examines the complex relationship among nutritional statu.s, illness progression, and treatment results in CKD patients on hemodialysis. **Aims and objective:** The report discusses CKD patients' dietary issues, including proteinenergy loss, altered metabolism, and micronutrient deficits. Malnutrition in CKD is multidimensional, including inflammation, comorbidities, and dietary limitations, making nutritional evaluation complicated. **Methods:** The nutritional evaluation of CKD patients on haemodialysis includes anthropometric assessments, biochemical indicators, dietary questionnaires, and imaging. Each method's merits and weaknesses are highlighted to help clinicians and researchers choose accurate and reliable nutritional assessment techniques. **Results**: Nutritional status affects CKD patients' mortality, morbidity, and quality of life, according to the review. Dietary advice, oral nutritional supplements, and tailored diets are prioritized. Telehealth and tailored diet for CKD patients on haemodialysis are being examined. **Discussion:** The findings seek to influence future research and clinical practice, improving consequences and quality of life for CKD patients on haemodialysis. **Conclusion**: In conclusion, this review synthesizes current information on the nutritional evaluation of CKD patients on haemodialysis, highlighting the difficulties and potential of managing this complex patient population's nutrition.

Key words: Chronic kidney disease, Haemodialysis, Malnutrition, Nutritional assessment, Protein consumption

1. INTRODUCTION

Chronic kidney disease (CKD) may be attributed to any of the three disease processes, including intrinsic renal pathology affecting the vascular, glomerular, or tubule-interstitium, prerenal conditions characterized by lower renal perfusion pressure, or postrenal factors causing obstruction. Chronic kidney disease (CKD) is defined as an etiology-independent decline in estimated glomerular filtration rate (eGFR) to 60 ml/min/1.73 mt2 or lower for a minimum of three months. There is a clear upward trend in the frequency and incidence of renal failure, which is associated with substantial monetary costs and negative results. Important considerations include the evaluation and monitoring of long-term patients participating in intervention programmes, including haemodialysis. In recent years, chronic kidney disease (CKD) has been observed on a global scale. This disease is characterised by a slow but steady progression and is mostly caused by lifestyle factors such diabetes, hypertension, smoking, and alcohol consumption. There is a global reach to the CKD pandemic. With a prevalence rate of over 14%, almost 37 million Americans are projected to suffer from chronic kidney disease. Over the last century, people have lived longer on average. Recent data from the International Society of Nephrology's Kidney Disease Data Centre Study revealed a prevalence of 17%, with reported prevalence ranging from less than 1% to 13% across various locations. Chronic kidney disease (CKD) has a wide range of possible causes in India. Chronic kidney disease (CKD) of unknown aetiology (CKDu) is prevalent in certain regions of Andhra Pradesh, Odisha, and Goa. CKDu is characterised by a gradual onset and gradual progression of chronic interstitial nephropathy. [1-2].

Nearly half of those with severe renal impairment and nearly all of those with mild to moderate renal function decline do not receive treatment [3-4]. Regardless of the presence or absence of diabetes or hypertension, the prevalence of chronic kidney disease (CKD) stages 3, 4, and 5 was found to rise with age [5]. Comorbidities, such as cardiovascular disease, infections, hepatitis, bone diseases, and malnutrition, may increase the risk of hospitalisation and death in this population due to their lack of regular physical exercise [6-9]. Chronic kidney disease (CKD) patients have a higher risk of death, morbidity, and poor quality of life (QOL) [9]. The increasing prevalence of obesity, hypertension, and diabetes—diseases that affect chronic kidney disease and end-stage renal disease (CKD/ESRD)—has raised the importance of effectively treating patients' nutrition, according to 2018. Healthcare providers still lack adequate training and access to formal nutrition programmes, even though there are recommendations and a clear need for it [10]. Additionally, there is evidence to show that primary care dietitians are vital in the management of chronic kidney disease (CKD). Dietitians who don't often teach patients about kidney illness may require further education to help patients cope with the specific challenges of chronic kidney disease (CKD) and end-stage renal disease (ESRD) [10]. The results of these assessments give light on the patient's specific nutritional needs, which in turn allows for the development of more targeted nutritional treatments. Implementing this proactive method in a specific community or organisation ensures personalised healthcare, reduces malnutrition-related problems, and improves overall well-being [11].

One of the most important ways to improve patient survival rates in the latter stages of chronic kidney disease (CKD) is haemodialysis (HD), the most used renal replacement treatment worldwide [12]. If a kidney

transplant is not an option for a patient, dialysis can be used as a supportive treatment in the interim or as a therapeutic intervention before the transplant operation [13]. Among patients undergoing maintenance haemodialysis (MHD), proteinenergy malnutrition is very common, according to Jafari et al. (year). The use of non-sterile dialysate and reverse filtration. Unfortunately, serum C-reactive protein (CRP) levels cannot be completely restored to normal levels even after haemodialysis (HD) utilising ultra-pure dialysate and biocompatible membranes. What this means is that factors unrelated to dialysis are crucial in triggering the inflammatory response [14–17]. Healthcare providers' reports of common conditions like diabetes, hypertension, and glomerulonephritis (GN) were the focus of the 2016 study by Anjum et al. [18].

Previous studies in various healthcare settings have employed a range of tools to comprehensively assess patients' nutritional status [18]. A person's eating habits can be better understood with the use of dietary evaluations such food frequency surveys and the 24-hour dietary recall [19, 20]. You may learn a lot about someone's nutritional health and body composition from anthropometric measurements like their waist circumference, skinfold thickness, and body mass index (BMI). The purpose of the study by Molsted et al. was to investigate HRQOL in dialysis patients and those with chronic kidney disease (CKD). Results showed that compared to people receiving hemodialysis (HD), patients with Parkinson's disease (PD) rated Dialysis Staff Encouragement and Patient Satisfaction higher ($p \leq 0.05$). On the other hand, research has demonstrated that smoking is associated with lower HRQOL scores on multiple occasions [21].

One way to quantify protein status is by biochemical examinations, which include measuring blood albumin and prealbumin levels [18]. Integrating many methods in previous studies allows for a more complete understanding of nutritional status, which in turn allows healthcare providers to personalise treatments more effectively, considering the specific needs of each patient. [22].

2. METHODS AND TOOLS FOR NUTRITIONAL ASSESSMENT

In order to detect any food deficiencies or excesses, it is essential to evaluate an individual's nutritional status through nutritional assessment. It is essential to conduct nutritional screenings on patients with a body mass index (BMI) below 18.5 kg/m2 according to the European Society for Clinical Nutrition and Metabolism (ESPEN). When it comes to nutritional screening, the Dialysis Malnutrition Score (DMS) and body mass index (BMI) are seen as basic instruments [23]. In order to determine if patients receiving HD are at danger of malnutrition, these instruments are contrasted with the gold standard, the Patient-Generated Subjective Global Assessment (PG-SGA). The number 23.

A nutritionist screened participants for dietary deficiencies by collecting data related to DMS and BMI cut-off values. When compared to the PG-SGA, the DMS questionnaire asked more specific questions about the patient's dialysis history and included a physical exam section that looked for signs of subcutaneous fat loss and muscular atrophy. Each DMS component was scored using a 5-point scale, where 1 indicates normal and 5 indicates very severe [24]. All DMS components add up to a possible total score between 7 and 35. A diagnostic scale developed by Beurer GmbH of Ulm, Germany, known as the Beurer BG 64, was utilised to ascertain the dry weight, which is a component of body mass index (BMI). This weight reading was recorded

following the end of the dialysis treatment. As per the classification offered by the World Health Organisation (WHO), the body mass index (BMI) threshold was established as BMI < 18.5 kg/m2. Looking back, we were able to pull serum albumin and serum cholesterol levels from the medical records. When blood albumin levels are below 38 g/L and serum cholesterol levels are below 2.59 mmol/L, protein-energy malnutrition can be diagnosed according to the criteria set by the International Society of Renal Nutrition and Metabolism (ISRNM). A measuring tape was used to take the mid-upper arm circumference (MUAC), and a triceps skin fold (TSF) probe was placed on the back of the arm to evaluate its thickness. The following equation was used to estimate the mid-arm muscle circumference (MAMC). [24].

MAMC (cm) =MAUC (cm) -[TSF (mm) x).

2.1 Common methods and tools for nutritional assessment:

Various methods and tools are used in nutritional assessment, each providing different insights into an individual's nutritional health. Here are some common methods and tools for nutritional assessment:

A. Anthropometric Measurements:

- Height and Weight: These fundamental measures may be used in the computation of Body Mass Index (BMI), which serves as a gauge for the level of adiposity in the body [25].
- Waist and Hip Circumference: This metric is valuable in evaluating central obesity and the potential for developing chronic illnesses [25]. B. Biochemical Assessment:
- Blood Tests: Assess the concentrations of several nutrients, including vitamins, minerals, and proteins. Typical laboratory assessments include measurements such as hemoglobin concentration, serum albumin levels, and vitamin D status, among others [26].
- Urine Tests: Evaluate the processes of nutrient excretion and absorption [26]. C. Clinical Assessment:
- Medical History and Physical Examination: One should conduct an examination to identify indications and indications of imbalances in nutritional intake, including both insufficiencies and surpluses. These may manifest is many ways, including dermatological problems, the state of hair and nails, as well as neurological symptoms [27]. D. Dietary Assessment:
- 24-Hour Dietary Recall: Participants are able to accurately remember and report all food and beverage items that they have ingested throughout the previous 24-hour period [28].
- Food Frequency Questionnaires (FFQ): Evaluate the prevalence of food intake during a certain timeframe.
- Food Records or Diaries: Participants meticulously document every food and beverage intake throughout a designated timeframe [28].

2.2 Role of dietary records, dietary recalls, and dietary interviews

Dietary records, dietary recalls, and dietary interviews are crucial instruments in the realm of nutrition for collecting data pertaining to an individual's food consumption and dietary patterns. Each methodology has distinct merits and constraints, and their judicious integration allows for a holistic assessment of an

individual's dietary patterns [29]. The following is a comprehensive summary of the functions and responsibilities associated with these tools:

2.2.1 Dietary Records:

Role: Dietary records include the practice of persons meticulously documenting and maintaining an exact record of every food and beverage intake over a designated timeframe, often ranging from 3 to 7 days. This methodology offers a complete and intricate depiction of individuals' everyday food patterns [29].

Advantages: Enables a comprehensive evaluation of dietary choices, serving sizes, and eating habits. This paper presents a comprehensive examination of nutrient consumption patterns. The use of memory is minimized, hence decreasing the probability of underreporting [29]. Limitations: Individuals have the propensity to modify their dietary patterns when they are aware of being under scrutiny. The successful completion of the task necessitates a proficient level of reading and a strong drive for achievement. The participation in this activity may impose a significant load on individuals and consume a considerable amount of time [29].

2.2.2 Dietary Recalls:

Role: Dietary recalls include people recollecting and documenting their food consumption within a designated timeframe, often spanning the preceding 24 hours. This approach demonstrates efficacy in expeditiously evaluating food consumption [30].

Advantages: The task can be executed expeditiously. This tool is valuable for the estimation of typical food habits. The use of dietary records necessitates a greater amount of work from participants in comparison to other methods [30].

Limitations: Depends on the reliability of memory, which may be susceptible to recall bias. The potential limitation of this approach is its inability to account for day-to-day fluctuations in dietary consumption. The accuracy of the information obtained is contingent upon the interviewer's proficiency in eliciting and investigating relevant details [30].

2.2.3 Dietary Interviews:

Role: Food interviews are a method of data collection whereby an interviewer engages in direct contact with a subject to get comprehensive information pertaining to their food habits. The approach may be categorized into three types: structured, semi-structured, and unstructured [31]

Advantages: Enables the resolution of replies that lack clarity. This offers a chance to examine the cultural and societal factors that impact individuals' decisions about their eating preferences. This intervention has the potential to be modified and used across many groups and contexts [31].

Limitations: Participants may be subject to social desirability bias, a phenomenon in which individuals may alter their responses to align with what they perceive as the interviewer's expectations. The accuracy of

dietary habit memory and communication by participants is crucial for this study. The process may be somewhat laborious, particularly when carried out in a face-to-face setting [31].

3. Dietary guidelines for haemodialysis patients

Chronic renal Disease (CKD) stages 4 and 5 are indicative of significant renal impairment, necessitating the use of dietary interventions to promote kidney function and enhance overall well-being. Collaboration between persons diagnosed with chronic kidney disease (CKD) and their healthcare team, which may include a certified dietitian or nutritionist, is crucial in order to develop a tailored strategy [32]. The following are a set of general dietary guidelines applicable to individuals in stages 4 and 5 of chronic kidney disease (CKD).

➢ **Protein Intake:** It is advisable to closely monitor one's protein consumption, since an excessive intake of protein has the potential to contribute to the buildup of waste products within the bloodstream. Nevertheless, it is crucial to ensure the maintenance of an appropriate quantity of protein of superior quality in order to mitigate the risk of malnutrition. The protein requirements of individuals exhibit variability, therefore necessitating the involvement of a healthcare expert to ascertain the optimal quantity for each individual [33].

➢ **Phosphorus Control:** It is advisable to restrict phosphorus consumption due to the potential challenges faced by damaged kidneys in effectively eliminating excessive phosphorus from the bloodstream. Phosphorus-rich food sources include dairy products, nuts, seeds, and certain cereals. It is important to exercise caution and thoroughly scrutinize food labels due to the presence of chemicals with elevated levels of phosphorus in processed and fast meals [34]. ➢ **Sodium (Salt) Restriction**: In order to regulate blood pressure and maintain proper fluid balance, it is advisable to decrease the consumption of salt. This entails the practice of refraining from consuming processed and packaged food items, opting for the use of herbs and spices as flavor enhancers in lieu of salt, and imposing restrictions on the intake of condiments with high sodium content [35].

➢ **Potassium Management**: The restriction of potassium consumption may be necessary based on an individual's blood potassium levels. Foods that possess a notable concentration of potassium include bananas, oranges, potatoes, tomatoes, and some varieties of leafy green vegetables. The potassium content of vegetables may be reduced by the process of boiling or leaching [36].

➢ **Fluid Intake:** It is advisable to closely monitor one's fluid intake in order to prevent the occurrence of fluid excess and subsequent edema. The permissible quantity of fluids may exhibit variability contingent upon individual circumstances and the coexistence of medical diseases such as heart failure [37].

➢ **Calcium Levels:** It is important to monitor calcium consumption, since imbalances may arise as a result of fluctuations in phosphorus levels. The potential need of calcium supplements should be considered, with due diligence given to seeking guidance from a healthcare practitioner in order to ascertain the optimal amount [38].

➢ **Medication Management:** It is important to adhere to the instructions provided by your healthcare practitioner about the consumption of prescription drugs, which may include phosphate binders as well as medications aimed at regulating blood pressure and mitigating other associated symptoms [39].

3.1 Nutrient restrictions and allowances

In the context of managing chronic kidney disease (CKD) stages 4 and 5, it is important to give meticulous consideration to the limitations and allowances of nutrients in order to promote general well-being and minimize further harm to the kidneys. It is important to monitor protein consumption in order to strike a balance between the need for essential amino acids and the necessity to restrict the buildup of waste products [40] The management of phosphorus levels is of utmost importance, requiring a decrease in the consumption of foods that are rich in phosphorus such as dairy products, nuts, and certain cereal [41].The maintenance of equilibrium necessitates the consideration of calcium levels in conjunction with phosphorus. Achieving a balanced caloric intake is crucial in order to mitigate the risk of malnutrition. Additionally, the comprehensive strategy should include effective medication management, which involves the administration of phosphate binders and blood pressure drugs. The implementation of personalized suggestions, which are informed by periodic blood tests and consultations with healthcare specialists, plays a crucial role in facilitating an efficient and customized strategy for dietary management in individuals with CKD stages 4 and 5 [41].

3.2 Importance of individualized dietary plans

The significance of personalized dietary planning in the treatment of stages 4 and 5 of chronic kidney disease (CKD) should not be underestimated. The health state, dietary demands, and tolerances of individuals might exhibit substantial variations, hence requiring a customized strategy to maximize desired results [42]. The concept of individualization enables the tailoring of protein intake to accommodate the specific needs of individuals, taking into account the intricate interplay between fulfilling critical amino acid needs and minimizing strain on compromised renal function. This system allows accurate regulation of phosphorus, salt, and potassium concentrations, taking into account individualized blood test results, so assuring efficient administration while maintaining nutritional sufficiency [43]. The optimization of fluid intake guidelines may effectively mitigate the occurrence of problems, such as fluid excess and edema [44]. Personalized dietary programs have been shown to not only augment the efficacy of treatment interventions but also foster patient well-being and compliance by catering to individual requirements and preferences. Consequently, this approach eventually contributes to the enhancement of quality of life among individuals with advanced renal disease [45].

In the past, people with chronic kidney disease (CKD) or end-stage renal disease (ESRD) were estimated to have consumed approximately the same amount of calories, protein, electrolytes, and vitamins based on food records, the semi-quantitative food frequency questionnaire, and 24-hour meal recall [46-47]. Protein consumption is directly related to the urea appearance rate, sometimes called the net urea production rate, because urea is the main byproduct of amino acid breakdown [48]. The production of urea nitrogen exceeds

the actual protein consumption, leading to a deviation from the average dietary intake, in cases where the patient is in a catabolic state with inflammation, infection, and concurrent comorbidities. [48].

3.3 Roles of registered dietitians

Registered dietitians play a crucial role in providing comprehensive treatment and managing persons diagnosed with stages 4 and 5 of chronic kidney disease (CKD) [49]. These healthcare experts possess specific knowledge in the field of nutrition and play a crucial role in the creation and execution of individualized dietary regimens that cater to the unique requirements of every patient [50]. Within the realm of chronic kidney disease (CKD), dietitians engage in close collaboration with healthcare teams to diligently oversee and modify dietary plans in accordance with the dynamic health circumstances and individual responses to therapy[51].Their area of specialization goes beyond dietary issues, embracing a wide range of lifestyle adjustments, behavior change assistance, and educational interventions aimed at empowering patients to make educated decisions about their nutritional needs [52]. Registered dietitians play a crucial role in improving the quality of life for persons in late stages of chronic kidney disease (CKD) by serving as primary advocates for nutritional well-being. Their contributions are vital in achieving optimum health outcomes and facilitating the comprehensive treatment of this intricate illness [53].

4. Nutritional assessment and clinical outcomes

The evaluation of nutritional status has significant importance within the realm of healthcare, since it has far-reaching consequences for clinical results. By means of assessing food intake, anthropometric measures, biochemical indicators, and clinical history, healthcare practitioners may get significant knowledge on an individual's nutritional state [54]. This data is crucial for the identification of malnutrition, nutritional deficiencies, or excessive nutrient intake, and plays a pivotal role in informing the design and implementation of focused therapies [55]. This assessment not only informs the development of treatment programs but also helps in the overall management of the respective diseases [56]. The correlation between nutritional health and therapeutic outcomes has been well documented, since adequate nutrition plays a significant role in bolstering immune function, expediting wound healing, and enhancing overall patient resilience. Hence, the implementation of a thorough nutritional evaluation plays a pivotal role in attaining favorable clinical results, underscoring the need of including nutritional interventions within the wider framework of healthcare provision [56].

4.1 The link between nutritional status and health outcomes

The correlation between dietary status and health consequences is inherent and significant. The nutritional status of an individual, which includes elements such as food intake, nutrient equilibrium, and general nutritional welfare, plays a crucial role in determining the body's capacity to operate at its highest level and defend against illnesses. Sufficient nourishment has a crucial role in bolstering immunological function, sustaining organ health, and fostering general physiological equilibrium [57].The correlation highlights the

significance of addressing nutritional requirements within the healthcare sector, as adequate nutrition serves as both a fundamental aspect of preventing diseases and a crucial factor in achieving favourable treatment results and overall physical and mental wellness [58]. The significance of nutritional status on health outcomes, ranging from facilitating growth and development to aiding in the recovery from sickness, underscores the fundamental importance of nutrition in a4.2 Impact of malnutrition on morbidity and mortality

The presence of malnutrition has been shown to have a substantial and adverse effect on both morbidity and death rates across various groups [61]. Malnutrition, whether in the form of undernutrition, over nutrition, or particular nutritional deficiencies, hampers the optimal functioning of the human body, resulting in a series of detrimental health consequences [62]. The concurrent decrease in muscle mass and strength is a contributing factor to the heightened vulnerability and diminished physical mobility. Over nutrition, which is defined as the consumption of excessive calories and imbalances in nutrient intake, is strongly associated with the increasing occurrence of obesity-related ailments, including cardiovascular disorders, diabetes, and certain forms of cancer [63]. The presence of malnutrition, in its many manifestations, increases the susceptibility to sickness, complicates the treatment of chronic diseases, and extends the duration of recuperation from acute health emergencies [64]. In addition, it is important to note that malnutrition has a significant effect on mortality rates, as it heightens the susceptibility to severe consequences that may be life-threatening. The recognition and mitigation of malnutrition as a crucial health concern are imperative in order to enhance patient outcomes, decrease healthcare expenditures, and promote overall wellness across various demographic groups [65].

4.3 Effects of nutritional interventions on patients well being

Nutritional treatments are of significant importance in improving the overall well-being of patients via the identification and rectification of nutritional deficiencies, fostering holistic health, and aiding in the management of diverse health disorders [66]. Sufficient nourishment is crucial for the physiological processes of the human body, and certain treatments may have significant impacts on the outcomes of patients [67]. Tailored dietary programs have been shown to have a positive impact on persons dealing with chronic diseases, such as chronic kidney disease (CKD) or cancer. These plans may help alleviate symptoms, increase tolerance to therapy, and boost overall quality of life [68-69].

5. Management of Nutritional deficiencies

The treatment of nutritional deficiencies is a comprehensive strategy that includes the detection, repair, and prevention of such deficits in order to enhance overall health. This multifaceted approach is essential in order to accurately identify and determine the precise nature of any existing deficiencies [70]. Once properly diagnosed, specific therapies are implemented with the objective of replenishing the deficient nutrients [72]. The resolution of this issue may need adjustments to one's diet, the addition of supplements, or a mix of both, depending upon the extent and characteristics of the insufficiency [73]. Iron deficiency anaemia may be

effectively managed by implementing dietary modifications that include foods high in iron content or by using iron supplements [74]. In addition to addressing errors, it is crucial to prioritize preventative strategies in order to maintain an adequate nutritional status. These strategies include the promotion of a well-rounded and varied diet, the fortification of foods, and the consideration of individual risk factors [76].

The management of Protein-Energy Wasting (PEW) in individuals with chronic renal disease involves implementing customized dietary strategies that focus on improving protein consumption while simultaneously decreasing phosphorus and potassium levels [76-78]. Additionally, the inclusion of strategies that specifically target inflammation and comorbidities further enhances the efficacy of PEW management. Furthermore, the implementation of interventions that encourage physical activity and the identification and treatment of underlying factors are essential components of a holistic approach to treating protein-energy wasting (PEW) in patients with chronic kidney disease (CKD) [79].

Serum Proteins

Just like with other proteins, the levels of pre-albumin (or transthyretin) and serum albumin are determined by the physiological processes of synthesis and catabolism that occur simultaneously. People with chronic kidney disease (CKD) frequently experience hypoalbuminemia; however, there is a lack of knowledge regarding the levels of serum albumin or pre-albumin in elderly patients on dialysis [80]. Several factors influence the control of serum albumin production and catabolism in people with chronic kidney disease (CKD) [81]. Protein degradation, decreased protein intake, impaired nutrient absorption, increased levels of pro-inflammatory cytokines in the bloodstream, changes in the volume of distribution (like haemodilution), bodily losses, comorbidities, malnutrition, sarcopenia, and the effects of ageing are all factors to consider (Figure 1). Metabolic acidosis, inflammation, and dialysisrelated losses are the three main causes of hypoalbuminemia in patients receiving dialysis. [82].

5.1 Strategies for managing PEW

The effective management of Protein-Energy Wasting (PEW) necessitates a comprehensive and multidisciplinary strategy that encompasses the evaluation and intervention of both nutritional and non-nutritional elements that contribute to the development and progression of this illness [83]. Below are few essential measures for effectively controlling Post-Exercise **Malaise (PEM):**

➢ **Optimizing Dialysis Treatment**: It is important to customize the dialysis prescription according to the individual patient's requirements, taking into account several parameters like the frequency and length of dialysis treatments. It is important to effectively regulate fluid equilibrium throughout the process of dialysis in order to mitigate the risks of dehydration or excessive fluid accumulation [83].

➢ **Physical Activity:** It is advisable to promote consistent engagement in physical activity and exercise as a means to maintain muscle mass and enhance general welfare. Engage in collaborative efforts with physical therapists to create workout regimens that are tailored to the individual's physical ability [84].

➢ Psychosocial Support: Offer psychosocial assistance to mitigate the influence of psychological conditions such as depression, anxiety, or social isolation on the individual's dietary consumption [85].

➢ **Education and Counselling**: It is important to provide patients and caregivers with comprehensive education about the significance of diet in effectively treating Protein-Energy Wasting (PEW). Offer guidance and counselling about dietary adjustments, the regulation of portion sizes, and the selection of appropriate food options [86].

➢ **Regular Monitoring and Follow-up**: It is important to establish a systematic protocol for the continuous assessment of nutritional status and subsequent modification of the treatment plan as deemed necessary. It is important to consistently evaluate the patient's reaction to therapies and implement any required adjustments accordingly [87].

➢ **Medication Management**: It is advisable to contemplate the use of appetite stimulants or other pharmaceutical interventions, if deemed suitable, under the supervision and direction of a healthcare practitioner [88].ttaining and maintaining optimal health throughout one's life [5960].

5.2 Approaches to address micronutrients deficiencies

The mitigation of micronutrient deficiencies necessitates the implementation of comprehensive measures in order to promote and maintain good health. An essential strategy is the promotion of a comprehensive and well-rounded dietary pattern that incorporates a wide array of foods that are abundant in essential nutrients. When dietary modifications prove to be inadequate, the use of tailored supplements, under the supervision of healthcare specialists, may be beneficial in addressing particular deficiencies [89]. The use of routine blood testing is necessary in order to evaluate the efficacy of therapies and facilitate any required modifications [90]. Moreover, the implementation of food fortification in vulnerable groups might serve as a comprehensive approach to address deficits in essential micronutrients at a population level [91]. In order to successfully treat micronutrient deficiencies and promote prolonged well-being, it is crucial to adopt a comprehensive strategy that encompasses several strategies such as dietary diversification, education, targeted supplementation, and public health activities [92].

5.3 Fluid and electrolyte management

The control of fluid and electrolytes plays a critical role in the maintenance of physiological equilibrium and the promotion of general well-being. Sufficient hydration is vital, with individual fluid requirements being subject to variation depending on variables such as age, environment, and health problems [93]. In instances of renal failure, vigilant monitoring of fluid consumption is necessary in order to avoid fluid excess and its accompanying consequences. Electrolytes, such as sodium, potassium, and chloride, are essential for maintaining cellular function and need meticulous management [94]. The implementation of dietary modifications, such as the restriction of salt consumption and the regulation of potassium-rich food intake, constitutes fundamental elements in the control of electrolyte levels. Healthcare practitioners may advise persons with certain health issues such as heart or renal disease to follow customized dietary programs in

order to maintain an ideal balance of fluids and electrolytes [95]. Systematic monitoring via blood tests plays a crucial role in guiding actions and sustaining homeostasis. In order to achieve optimal fluid and electrolyte management and mitigate negative health consequences, it is essential to adopt a tailored strategy that takes into account an individual's unique health status and specific demands. This approach is crucial for promoting overall wellness and minimizing poor health outcomes [96].

5.4 Role of oral nutritional supplements

Oral nutritional supplements are of essential importance in providing assistance to those who may have challenges in adequately fulfilling their nutritional needs just via conventional food consumption [97]. These dietary supplements, which come in different formats like beverages, bars, or powders, provide concentrated reservoirs of vital nutrients, including proteins, vitamins, and minerals [98]. These products provide significant value in circumstances when consumers encounter difficulties such as diminished appetite, impaired mastication or deglutition, or heightened nutritional requirements resulting from sickness, surgical procedures, or the aging process [99-100]. Nevertheless, it is essential that the utilization of these supplements be overseen by healthcare specialists in order to guarantee suitability, accurate dose, and integration into a full nutritional regimen. In general, oral nutritional supplements play a significant role as supplementary aids to food consumption, facilitating the filling of nutritional deficiencies and fostering optimum well-being across various demographic groups [101-102].

6. Challenges and barriers to nutritional assessment

The process of nutritional evaluation encounters several obstacles, including the underreporting or misreporting of food consumption, the inconsistency in eating patterns, and the imprecise calculation of portion sizes [103-104]. There are several problems and constraints that might hinder the process of nutritional assessment, hence complicating the precise measurement of an individual's nutritional status [105].

- **Variability in Dietary Patterns**: The dietary habits of individuals exhibit significant variation, and the extensive range of available food options presents difficulties in establishing standardized evaluation methods [106]. The variety seen in dietary patterns may be attributed to a combination of factors, including diverse cultural customs, geographical disparities in food availability, and individual preferences [107].
- **Inconsistent Tools and Methods**: The use of diverse instruments and methodologies for the evaluation of nutritional status may give rise to incongruities in the obtained results. The establishment of uniformity in healthcare settings is essential in order to guarantee the dependability and comparability of evaluations [108].
- **Medical Conditions and Medications**: Several medical illnesses and drugs have the potential to impact an individual's nutritional state. Various factors such as fluid retention, inflammation, or the influence of drugs that impact hunger might provide challenges when attempting to evaluate nutritional signs [109].

➢ **Cultural and Language Barriers**: Communication during nutritional evaluations might be influenced by cultural influences and language limitations. Instances of misunderstandings or misinterpretations have the potential to arise, hence impacting the overall accuracy of the gathered information [110].

➢ **Lack of Awareness and Education:** A lack of sufficient understanding on the significance of nutritional assessment and its implications for health might lead people to disregard or abstain from engaging in the assessment procedure entirely [111-112].

6.1 Barriers in adherence to dietary guidelines

The capacity of people to sustain good eating habits may be impeded by a range of obstacles, hence affecting their adherence to dietary standards. The limitations imposed by time and the demands of modern lives often result in individuals depending on quick meal choices that may be lacking in nutritional value [113]. Access to healthful meals might be restricted by economic issues, such as the financial burden associated with purchasing fresh produce and better alternatives [114]. To overcome these obstacles, it is essential to implement specific interventions that include educational initiatives, the availability of reasonably priced nutritious food options, and the dissemination of culturally appropriate dietary recommendations [115].

6.2 Socioeconomic factors affecting nutritional choices

Socioeconomic variables have a substantial influence on individuals' nutritional choices, hence leading to differences in dietary patterns and overall health outcomes [116-117]. The availability of supermarkets and grocery shops offering a diverse range of nutritious options may be constrained in socioeconomically disadvantaged communities, hence exacerbating the issue of food deserts [118]. The process of aging and the administration of dialysis therapy are two separate but interrelated processes that might potentially contribute to the onset of proteinenergy wasting (PEW) in people [119]. The process of aging is an inherent and unavoidable phenomenon marked by a progressive deterioration in physiological capabilities [120]. With advancing age, it is common for people to experience a decrease in muscle mass, a fall in appetite, and changes in metabolism. These factors might together lead to the onset of ProteinEnergy Wasting (PEW). Furthermore, the process of aging may sometimes coincide with the presence of chronic medical disorders, which can further intensify the difficulties related to maintaining enough nutrition [121].

In contrast, dialysis therapy serves as a vital intervention for persons diagnosed with end-stage renal disease (ESRD) [122]. Although dialysis is essential for the elimination of waste materials and surplus fluids from the body, it may also result in undesired repercussions. The regularity of dialysis sessions has the potential to lead to heightened excretion of protein and nutrients, hence playing a role in the progression of protein-energy wasting (PEW). In addition, individuals undergoing dialysis may encounter a variety of symptoms, including but not limited to nausea, diminished appetite, and alterations in taste perception, hence presenting difficulties in adhering to a nutritious dietary regimen [123].

The confluence of the aging process and the use of dialysis treatment gives rise to a multifaceted interaction of several elements that contribute to an increased susceptibility to protein-energy wasting (PEW) [124]. The implementation of individualized food programs, the monitoring of nutritional status, and the provision of nutritional supplements, when deemed required, are crucial measures for maximizing the health and overall well-being of elderly adults receiving dialysis therapy [125]. In patients with chronic kidney disease (CKD), frailty and its components are prevalent. Frailty includes things like unintentional weight loss, selfreported exhaustion, measured weakness, slow walking speed, low physical activity, and reduced muscle mass below the 90th percentile for the age- and sex-matched general population. Frailty is also linked to preeclampsia (PEW) and muscle wasting. [125].

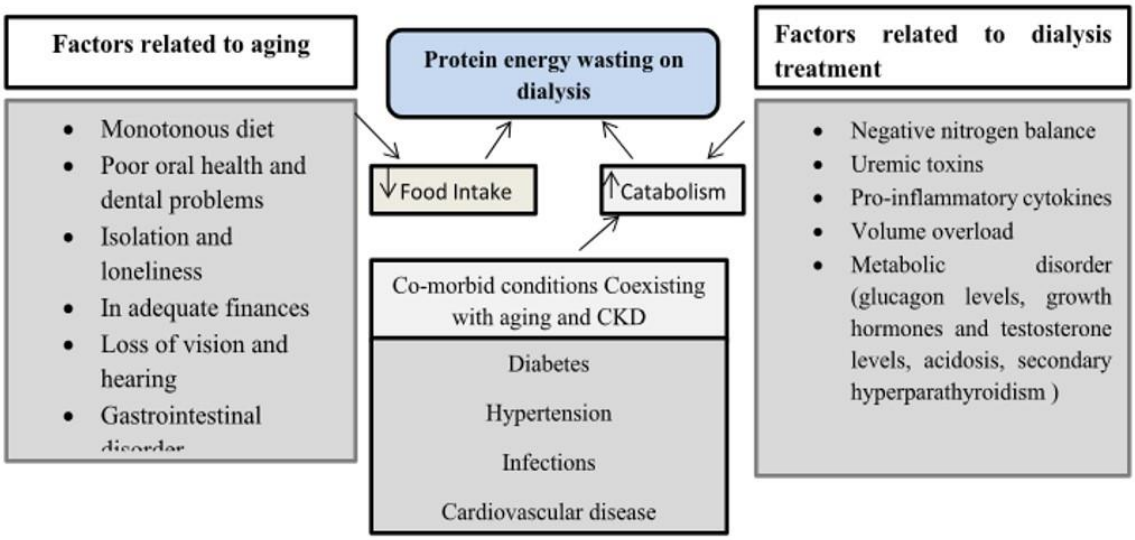

Figure: Common factors related to aging and to dialysis treatment, leading to protein energy wasting

7. Future direction in Nutritional Assessment

It is anticipated that the field of nutritional evaluation will see progress in the coming years, mostly propelled by technological improvements, individualized methodologies, and a more comprehensive comprehension of the intricate relationship between genetics, the microbiome, and nutrition. The following are significant trends:

➢ Precision Nutrition: The field of nutrigenomics has made significant progress, leading to the development of a more individualized method for evaluating nutritional needs[126]. This approach takes into account an individual's genetic composition and its impact on their unique reactions to various nutrients [127].

➢ Biomarker Development: Further investigation into biomarkers will result in the discovery of more refined indicators of nutritional status, facilitating expedited and more precise evaluations [128].

➢ **Data Analytics:** The use of big data analytics enables the integration of heterogeneous information, so promoting a comprehensive comprehension of the intricate interplay of nutrition, health, and illness [129-130].

➢ **Lifestyle Medicine:** The acknowledgment of the significance of lifestyle variables outside dietary choices, such as physical activity, sleep patterns, and stress management, will be essential in the evaluation and implementation of nutritional assessment and intervention approaches [131-132].

➢ **Global Health Equity:** The focus will be on ensuring that breakthroughs in nutritional assessment technology and treatments are accessible and usable in a wide range of socioeconomic and cultural situations, with the aim of addressing global health inequities [133134].

These observed patterns together indicate a shift towards a more sophisticated, personalized, and comprehensive method of evaluating nutritional status. This approach takes into account the complex interaction of many elements that influence dietary behaviors and their impact on health results [135]. The future landscape of nutritional evaluation and intervention tactics is expected to be influenced by technological advancements and a comprehensive comprehension of the intricate aspects of nutrition [136]. An area of research that is now receiving attention is the use of omics technologies, including metabolomics and proteomics, in order to discern certain biomarkers that provide more comprehensive understanding of the metabolic mechanisms affected by diet in persons diagnosed with chronic kidney disease (CKD) [137]. This progress sets the stage for the implementation of more efficient and individualized therapies in the forthcoming period. The field of healthcare monitoring has been significantly transformed by the progress made in telemedicine and digital health, leading to a revolution in the way healthcare is delivered [138]. Telemedicine systems play a crucial role in allowing healthcare providers to conduct real-time remote consultations, therefore facilitating the monitoring of patients' health status, particularly chronic illnesses, via virtual visits [139]. The use of artificial intelligence and machine learning algorithms in the analysis of extensive datasets produced by remote monitoring has significantly advanced the field [140-141].The ongoing development of these technologies presents a significant opportunity for enhancing the accessibility, efficiency, and overall quality of patient monitoring and treatment via the combination of telemedicine and digital health solutions [142].

The incorporation of personalized medicine, using genetic and molecular knowledge, offers customized therapeutic approaches that consider individual variances, hence enhancing the efficacy of therapy [143 - 144]]. The application of health technology, including mobile apps and wearable devices, promotes proactive health management and facilitates a collaborative partnership between patients and healthcare professionals, hence enhancing patient involvement [145-146]. The proliferation of telehealth services enables enhanced accessibility to medical expertise, especially in geographically isolated or underserved regions, resulting in prompt interventions and enhanced post-treatment support [147]. By integrating these methodologies and consistently advancing in these domains, healthcare systems have the potential to provide a patient-centric, streamlined, and fair milieu, eventually resulting in enhanced results and an elevated standard of care for heterogeneous populations [148-149].

CONCLUSION

The nutritional assessment of chronic kidney disease (CKD) patients undergoing hemodialysisis indispensable in addressing the intricate interplay between renal function, dietary intake, and overall health. These patients face a complex set of challenges, including protein-energy wasting, altered metabolism, and electrolyte imbalances, necessitating a comprehensive nutritional evaluation. A nuanced understanding of individual dietary needs and restrictions is vital for tailoring effective interventions that not only meet the nutritional demands of CKD but also mitigate the risks of malnutrition and associated complications. Regular and thorough nutritional assessments, coupled with personalized dietary plans, enable healthcare providers to optimize the well-being of CKD patients undergoing hemodialysis. We can improve these people's quality of life and long-term outcomes by highlighting the role of nutrition in the holistic management of chronic kidney disease (CKD). This will lead to a more thorough and patient-centered approach to their care.

REFERENCES

1. Centers for Disease Control, Chronic Kidney Disease in the United States. 2021. Available online: https://www.cdc.gov/kidneydisease/pdf/Chronic-Kidney-Disease-in-the-US-2021h.pdf (accessed on 23 February 2021).
2. World Health Organization (WHO). Global Health and Aging, 2011. Available at: http://www.who.int/ageing/publications/global_health.pdf
3. Adair, K.E.; Bowden, R.G. Ameliorating Chronic Kidney Disease Using a Whole Food Plant-Based Diet. Nutrients 2020, 12, 1007. [Google Scholar] [CrossRef] [PubMed][Green Version]
4. Coresh J, Astor BC, Greene T et al. Prevalence of chronic kidney disease and decreased kidney function in the adult US population: Third National Health and Nutrition Examination Survey. Am J Kidney Dis 2003; 41: 1–12
5. Thomas R, Kanso A, Sedor JR. Chronic Kidney Disease and Its Complications. Prim Care. 2008;35(2):329-44.
6. https://www.sciencedirect.com/science/article/pii/S0261561403001092
7. Chapter 1: Definition and classification of CKD. Kidney Int Suppl (2011). 2013 Jan;3(1):19-62. [PMC free article] [PubMed]
8. Eknoyan G, Lameire N, Barsoum R, Eckardt KU, Levin A, Levin N, Locatelli F, MacLeod A, Vanholder R, Walker R, Wang H. The burden of kidney disease: improving global outcomes. Kidney Int. 2004 Oct;66(4):1310-4. doi: 10.1111/j.1523-1755.2004.00894.x. PMID: 15458424.
9. Campolina AG, Bortoluzzo AB, Ferraz MB, Ciconelli RM. Validação da versão brasileira do questionário genérico de qualidade de vida short-form 6 dimensions (SF-6D Brasil). Cien Saude Colet. 2011;16(7):3103-10.
10. Anderson CA, Nguyen HA. Nutrition education in the care of patients with chronic kidney disease and end-stage renal disease. InSeminars in dialysis 2018 Mar (Vol. 31, No. 2, pp. 115121).

11. World Health Organization. Noncommunicable Disease, Mental Health Cluster. Innovative care for chronic conditions: building blocks for action: global report. World Health Organization; 2002 Jun 2.
12. Sociedade Brasileira de Nefrologia - SBN. Censo Geral 2011 [cited 2015 Mar 31].

Available from: Available from: https://tinyurl.com/lf4scbk

13. » https://tinyurl.com/lf4scbk
14. Pendse S, Singh A, Zawada E. Initiation of Dialysis. In: Handbook of Dialysis. 4th ed. New

York: 2008. p. 14–21

15. Jafari T. Nutritional assessment in patients on hemodialysis. Journal of Preventive Epidemiology. 2016 Jan 28;1(1):e08-.
16. Ahmad S, Misra M, Hoenich N, Daugirdas J. Hemodialysis Apparatus. In: Handbook of Dialysis. 4th ed. New York: 2008. p. 59-78.
17. Schindler R, Boenisch O, Fischer C, Frei U. Effect of the hemodialysis membrane on the inflammatory reaction in vivo. Clin Nephrol 2000; 53: 452–459
18. Aeddula NR, Bardhan M, Baradhi KM. StatPearls [Internet]. StatPearls Publishing;

Treasure Island (FL): Sep 12, 2022. Sickle Cell Nephropathy. [PubMed] [Reference list]

19. Anjum S, Muzaale AD, Massie AB, Bae S, Luo X, Grams ME, Lentine KL, Garg AX, Segev DL. Patterns of end-stage renal disease caused by diabetes, hypertension, and glomerulonephritis in live kidney donors. American Journal of Transplantation. 2016 Dec 1;16(12):3540-7.
20. Green SM, Watson R. Nutritional screening and assessment tools for older adults: literature review. Journal of advanced nursing. 2006 May;54(4):477-90.
21. Santos DA, Dawson JA, Matias CN, Rocha PM, Minderico CS, Allison DB, Sardinha LB, Silva AM. Reference values for body composition and anthropometric measurements in athletes. PloS one. 2014 May 15;9(5):e97846.
22. Molsted S, Prescott L, Heaf J, Eidemak I. Assessment and clinical aspects of health-related quality of life in dialysis patients and patients with chronic kidney disease. Nephron Clinical Practice. 2007 Apr 12;106(1):c24-33.
23. Chertow GM, Ackert K, Lew NL, Lazarus JM, Lowrie EG. Prealbumin is as important as albumin in the nutritional assessment of hemodialysis patients. Kidney international. 2000 Dec 1;58(6):2512-7.
24. Jones JM. The methodology of nutritional screening and assessment tools. Journal of Human Nutrition and Dietetics. 2002 Feb;15(1):59-71.
25. As'habi A, Tabibi H, Nozary-Heshmati B, Mahdavi-Mazdeh M, Hedayati M. Comparison of various scoring methods for the diagnosis of protein-energy wasting in hemodialysis patients. Int Urol Nephrol 2014;46(5):999e1004.
26. Bhattacharya A, Pal B, Mukherjee S, Roy SK. Assessment of nutritional status using anthropometric variables by multivariate analysis. BMC public health. 2019 Dec;19:1-9.
27. Madroño AG, Mancha A, Rodríguez FJ, de Ulíbarri JI, Culebras J. The use of biochemical and immunological parameters in nutritional screening and assessment. Nutricion hospitalaria.

2011;26(3):594-601.

28. Castillo-Martínez L, Castro-Eguiluz D, Copca-Mendoza ET, Pérez-Camargo DA, ReyesTorres CA, Ávila EA, López-Córdova G, Fuentes-Hernández MR, Cetina-Pérez L, del Pilar Milke-García M. Nutritional assessment tools for the identification of malnutrition and nutritional risk associated with cancer treatment. Revista de investigacion clinica. 2018 Aug 7;70(3):121-5.
29. Ngo J, Engelen A, Molag M, Roesle J, García-Segovia P, Serra-Majem L. A review of the use of information and communication technologies for dietary assessment. British Journal of Nutrition. 2009 Jul;101(S2):S102-12.
30. Shaffer NM, Baxter SD, Thompson WO, Baglio ML, Guinn CH, Frye FH. Quality control for interviews to obtain dietary recalls from children for research studies. Journal of the American Dietetic Association. 2004 Oct 1;104(10):1577-85.
31. Novotny JA, Rumpler WV, T JUDD JO, Riddick H, Rhodes D, McDowell M, Briefel R. Diet interviews of subject pairs: how different persons recall eating the same foods. Journal of the American Dietetic Association. 2001 Oct 1;101(10):1189-93.
32. Sharman SJ, Skouteris H, Powell MB, Watson B. Factors related to the accuracy of selfreported dietary intake of children aged 6 to 12 years elicited with interviews: a systematic review. Journal of the Academy of Nutrition and Dietetics. 2016 Jan 1;116(1):76-114. 33. Saglimbene VM, Su G, Wong G, Natale P, Ruospo M, Palmer SC, Craig JC, Carrero JJ, Strippoli GF. Dietary intake in adults on hemodialysis compared with guideline recommendations. Journal of Nephrology. 2021 Dec 1:1-9.
34. Kopple JD. The National Kidney Foundation K/DOQI clinical practice guidelines for dietary protein intake for chronic dialysis patients. American journal of kidney diseases. 2001 Oct 1;38(4):S68-73.
35. D'Alessandro C, Piccoli GB, Cupisti A. The "phosphorus pyramid": a visual tool for dietary phosphate management in dialysis and CKD patients. BMC nephrology. 2015 Dec;16(1):1-6.
36. Kalantar-Zadeh K, Tortorici AR, Chen JL, Kamgar M, Lau WL, Moradi H, Rhee CM, Streja E, Kovesdy CP. Dietary restrictions in dialysis patients: is there anything left to eat?.

InSeminars in dialysis 2015 Mar (Vol. 28, No. 2, pp. 159-168).

37. Luis D, Zlatkis K, Comenge B, García Z, Navarro JF, Lorenzo V, Carrero JJ. Dietary quality and adherence to dietary recommendations in patients undergoing hemodialysis. Journal of Renal Nutrition. 2016 May 1;26(3):190-5.
38. Molaison EF, Yadrick MK. Stages of change and fluid intake in dialysis patients. Patient education and counseling. 2003 Jan 1;49(1):5-12.
39. Bogacka A, Sobczak-Czynsz A, Kucharska E, Madaj M, Stucka K. Analysis of nutrition and nutritional status of haemodialysis patients. Roczniki Państwowego Zakładu Higieny. 2018;69(2).
40. Aggett PJ, Bresson J, Haschke F, Hernell O, Koletzko B, Lafeber HN, Michaelsen KF, Micheli J, Ormisson A, Rey J, de Sousa JS. Recommended dietary allowances (RDAs), recommended dietary intakes (RDIs), recommended nutrient intakes (RNIs), and population reference intakes (PRIs) are not "recommended intakes". Journal of pediatric gastroenterology and nutrition. 1997 Aug 1;25(2):236-41.

41. Rust P, Ekmekcioglu C. Impact of salt intake on the pathogenesis and treatment of hypertension. Hypertension: from basic research to clinical practice. 2017:61-84.
42. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero JJ, Chan W, Fouque D, Friedman AN, Ghaddar S, Goldstein-Fuchs DJ, Kaysen GA. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. American Journal of Kidney Diseases. 2020 Sep 1;76(3):S1-07.
43. Chung CF, Wang Q, Schroeder J, Cole A, Zia J, Fogarty J, Munson SA. Identifying and planning for individualized change: Patient-provider collaboration using lightweight food diaries in healthy eating and irritable bowel syndrome. Proceedings of the ACM on interactive, mobile, wearable and ubiquitous technologies. 2019 Mar 29;3(1):1-27.
44. Franz MJ, Boucher JL, Evert AB. Evidence-based diabetes nutrition therapy recommendations are effective: the key is individualization. Diabetes, metabolic syndrome and obesity: targets and therapy. 2014 Feb 24:65-72.
45. Amini Y, Saif N, Greer C, Hristov H, Isaacson R. The role of nutrition in individualized

Alzheimer's risk reduction. Current nutrition reports. 2020 Jun;9:55-63.

46. Di Carlo C, Iannotti G, Sparice S, Chiacchio MP, Greco E, Tommaselli GA, Nappi C. The role of a personalized dietary intervention in managing gestational weight gain: a prospective, controlled study in a low-risk antenatal population. Archives of gynecology and obstetrics.

2014 Apr;289:765-70.

47. Gehling E. Medical nutrition therapy: an individualized approach to treating diabetes.

Professional Case Management. 2001 Jan 1;6(1):2-9.

48. Maroni BJ, Steinman TI, Mitch WE. A method for estimating nitrogen intake of patients with chronic renal failure. Kidney Int 1985; 27: 58–65
49. Mitch WE, Ikizler TA. Handbook of Nutrition and the Kidney, 6th ed. Philadelphia, PA: Lippincott Williams & Wilkings, 2010
50. Olstad DL, Raine KD, McCargar LJ. The role of registered dietitians: in health promotion.

Canadian journal of dietetic practice and research. 2013 Jul;74(2):80-3.

51. Olstad DL, Raine KD, McCargar LJ. The role of registered dietitians: in health promotion.

Canadian journal of dietetic practice and research. 2013 Jul;74(2):80-3.

52. Dana Lee Olstad MSc RD. The Role of Registered Dietitians: In Health Promotion. Canadian Journal of Dietetic Practice and Research. 2013 Jul 1;74(2):80.
53. Kulick D, Hark L, Deen D. The bariatric surgery patient: a growing role for registered dietitians. Journal of the American Dietetic Association. 2010 Apr 1;110(4):593-9.
54. Ramirez W, Williams M. Do Physicians Perceive the Roles of Nutritionists and Registered Dietitian Nutritionists as Different?.
55. Wessner S, Burjonrappa S. Review of nutritional assessment and clinical outcomes in pediatric surgical patients: does preoperative nutritional assessment impact clinical outcomes?. Journal of pediatric surgery. 2014 May 1;49(5):823-30.

56. Crestani MS, Grassi T, Steemburgo T. Methods of nutritional assessment and functional capacity in the identification of unfavorable clinical outcomes in hospitalized patients with cancer: a systematic review. Nutrition Reviews. 2022 Apr 1;80(4):786-811.
57. Lin H, Zhang H, Lin Z, Li X, Kong X, Sun G. Review of nutritional screening and assessment tools and clinical outcomes in heart failure. Heart failure reviews. 2016 Sep;21:549-
65.
58. Kuzuya M. Nutritional status related to poor health outcomes in older people: Which is better, obese or lean?. Geriatrics & Gerontology International. 2021 Jan;21(1):5-13.
59. Covinsky KE, Martin GE, Beyth RJ, Justice AC, Sehgal AR, Landefeld CS. The relationship between clinical assessments of nutritional status and adverse outcomes in older hospitalized medical patients. Journal of the American Geriatrics Society. 1999 May;47(5):532-8.
60. Lou MF, Dai YT, Huang GS, Yu PJ. Nutritional status and health outcomes for older people with dementia living in institutions. Journal of advanced nursing. 2007 Dec;60(5):470-7.
61. Onis MD. Measuring nutritional status in relation to mortality. Bulletin of the World Health Organization. 2000;78:1271-4.
62. Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clinical nutrition. 2003 Jun 1;22(3):235-9.
63. Waitzberg DL, Goiburu ME, Goiburu MJ, Bianco H, Díaz JR, Alderete F, Palacios MC, Cabral V, Escobar D, López R. The impact of malnutrition on morbidity, mortality and length of hospital stay in trauma patients. Nutricion hospitalaria. 2006;21(5):604-10.
64. Marcen R, Teruel JL, De La Cal MA, Gamez C. The impact of malnutrition in morbidity and mortality in stable haemodialysis patients. Spanish Cooperative Study of Nutrition in Hemodialysis. Nephrology, dialysis, transplantation: official publication of the European Dialysis and Transplant Association-European Renal Association. 1997 Nov 1;12(11):2324-
31.
65. Sze S, Pellicori P, Zhang J, Weston J, Clark AL. The impact of malnutrition on short-term morbidity and mortality in ambulatory patients with heart failure. The American Journal of Clinical Nutrition. 2021 Mar;113(3):695-705.
66. Bonilla-Palomas JL, Gámez-López AL, Anguita-Sánchez MP, Castillo-Domínguez JC, García-Fuertes D, Crespin-Crespin M, López-Granados A, de Lezo JS. Impact of malnutrition on long-term mortality in hospitalized patients with heart failure. Revista Española de Cardiología (English Edition). 2011 Sep 1;64(9):752-8.
67. Capra S, Ferguson M, Ried K. Cancer: impact of nutrition intervention outcome—nutrition issues for patients. Nutrition. 2001 Sep 1;17(9):769-72.
68. Uster A, Ruefenacht U, Ruehlin M, Pless M, Siano M, Haefner M, Imoberdorf R, Ballmer PE. Influence of a nutritional intervention on dietary intake and quality of life in cancer patients: a randomized controlled trial. Nutrition. 2013 Nov 1;29(11-12):1342-9.

69. Yao CK, Gibson PR, Shepherd SJ. Design of clinical trials evaluating dietary interventions in patients with functional gastrointestinal disorders. Official journal of the American College of Gastroenterology| ACG. 2013 May 1;108(5):748-58.
70. Pigneur B, Ruemmele FM. Nutritional interventions for the treatment of IBD: current evidence and controversies. Therapeutic advances in gastroenterology. 2019 Nov;12:1756284819890534.
71. Ben-Porat T, Weiss-Sadan A, Rottenstreich A, Sherf-Dagan S, Schweiger C, Yosef-Levi IM, Weiner D, Azulay O, Sakran N, Harari R, Elazary R. Nutritional management for chronic kidney disease patients who undergo bariatric surgery: a narrative review. Advances in Nutrition. 2019 Jan 1;10(1):122-32.
72. Saxena A. Nutritional problems in adult patients with chronic kidney disease. Clinical Queries: Nephrology. 2012 Jul 1;1(3):222-35.
73. Ameh OI, Cilliers L, Okpechi IG. A practical approach to the nutritional management of chronic kidney disease patients in Cape Town, South Africa. BMC nephrology. 2016 Dec;17(1):1-8.
74. Ameh OI, Cilliers L, Okpechi IG. A practical approach to the nutritional management of chronic kidney disease patients in Cape Town, South Africa. BMC nephrology. 2016 Dec;17(1):1-8.
75. Ameh OI, Cilliers L, Okpechi IG. A practical approach to the nutritional management of chronic kidney disease patients in Cape Town, South Africa. BMC nephrology. 2016 Dec;17(1):1-8.
76. Steiber AL. Chronic kidney disease: considerations for nutrition interventions. Journal of Parenteral and Enteral Nutrition. 2014 May;38(4):418-26.
77. Ranjan P, Vikram NK, Kumari A, Chopra S, Choranur A, Pradeep Y, Puri M, Malhotra A, Ahuja M, Batra A, Balsarkar G. Evidence and consensus-based clinical practice guidelines for management of overweight and obesity in midlife women: An AIIMS-DST initiative. Journal of Family Medicine and Primary Care. 2022 Dec;11(12):7549.
78. Chan W. Chronic kidney disease and nutrition support. Nutrition in Clinical Practice. 2021 Apr;36(2):312-30.
79. Sabatino A, Regolisti G, Karupaiah T, Sahathevan S, Singh BS, Khor BH, Salhab N, Karavetian M, Cupisti A, Fiaccadori E. Protein-energy wasting and nutritional supplementation in patients with end-stage renal disease on hemodialysis. Clinical nutrition.
2017 Jun 1;36(3):663-71.
80. Okamura M, Inoue T, Ogawa M, Shirado K, Shirai N, Yagi T, Momosaki R, Kokura Y. Rehabilitation nutrition in patients with chronic kidney disease and cachexia. Nutrients. 2022 Nov 9;14(22):4722.
81. Kalantar-Zadeh K, Cano NJ, Budde K et al. Diets and enteral supplements for improving outcomes in chronic kidney disease. Nat Rev Nephrol 2011; 7: 369–384
82. Cabrerizo S, Cuadras D, Gomez-Busto F et al. Serum albumin and health in older people: review and meta analysis. Maturitas 2015; 81: 17–27
83. Friedman AN, Fadem SZ. Reassessment of albumin as a nutritional marker in kidney disease. J Am Soc Nephrol 2010; 21: 223–230
84. Lee CP, Chertow GM, Zenios SA. Optimal initiation and management of dialysis therapy.

Operations Research. 2008 Dec;56(6):1428-49.

85. Jensen GM, Gwyer J, Shepard KF, Hack LM. Expert practice in physical therapy. Physical therapy. 2000 Jan 1;80(1):28-43.
86. Sobel DS. Rethinking medicine: Improving health outcomes with cost-effective psychosocial interventions. Psychosomatic medicine. 1995 May 1;57(3):234-44.
87. Faith MS, Van Horn L, Appel LJ, Burke LE, Carson JA, Franch HA, Jakicic JM, Kral TV, Odoms-Young A, Wansink B, Wylie-Rosett J. Evaluating parents and adult caregivers as "agents of change" for treating obese children: evidence for parent behavior change strategies and research gaps: a scientific statement from the American Heart Association. Circulation. 2012 Mar 6;125(9):1186-207.
88. Kerem E, Conway S, Elborn S, Heijerman H, Consensus Committee. Standards of care for patients with cystic fibrosis: a European consensus. Journal of cystic fibrosis. 2005 Mar 1;4(1):7-26.
89. Mouhamed Y, Vishnyakov A, Qorri B, Sambi M, Frank SS, Nowierski C, Lamba A, Bhatti U, Szewczuk MR. Therapeutic potential of medicinal marijuana: an educational primer for health care professionals. Drug, healthcare and patient safety. 2018 Jun 11:45-66.
90. Graham RD, Welch RM, Bouis HE. Addressing micronutrient malnutrition through enhancing the nutritional quality of staple foods: principles, perspectives and knowledge gaps.
91. Dsouza MB. A STUDY ON THE HEALTH AND NUTRITION EDUCATION FOR

TEENAGERS. EPRA International Journal of Multidisciplinary Research (IJMR). 2023 Sep 13;9(9):68-71.

92. Rusińska A, Płudowski P, Walczak M, Borszewska-Kornacka MK, Bossowski A, Chlebna-

Sokół D, Czech-Kowalska J, Dobrzańska A, Franek E, Helwich E, Jackowska T. Vitamin D supplementation guidelines for general population and groups at risk of vitamin D deficiency in Poland—recommendations of the polish society of pediatric endocrinology and diabetes and the expert panel with participation of national specialist consultants and representatives of scientific societies—2018 update. Frontiers in Endocrinology. 2018 May 31;9:246.

93. Kim C, Mansoor GF, Paya PM, Ludin MH, Ahrar MJ, Mashal MO, Todd CS. Review of policies, data, and interventions to improve maternal nutrition in Afghanistan. Maternal & Child Nutrition. 2020 Oct;16(4):e13003.
94. Kim C, Mansoor GF, Paya PM, Ludin MH, Ahrar MJ, Mashal MO, Todd CS. Review of policies, data, and interventions to improve maternal nutrition in Afghanistan. Maternal & Child Nutrition. 2020 Oct;16(4):e13003.
95. Jéquier E, Constant F. Water as an essential nutrient: the physiological basis of hydration.

European journal of clinical nutrition. 2010 Feb;64(2):115-23.

96. Shirreffs SM, Armstrong LE, Cheuvront SN. Fluid and electrolyte needs for preparation and recovery from training and competition. Journal of sports sciences. 2004 Jan 1;22(1):57-

63.

97. Fusch C, Jochum F. Water, sodium, potassium and chloride. Nutritional Care of Preterm Infants. 2014;110:99-120.

98. Lobo DN. Fluid, electrolytes and nutrition: physiological and clinical aspects. Proceedings of the Nutrition Society. 2004 Aug;63(3):453-66.

99. Baldwin C, Smith R, Gibbs M, Weekes CE, Emery PW. Quality of the evidence supporting the role of oral nutritional supplements in the management of malnutrition: An overview of systematic reviews and meta-analyses. Advances in Nutrition. 2021 Mar;12(2):503-22. 100. Kokkinidou S, Peterson D, Bloch T, Bronston A. The important role of carbohydrates in the flavor, function, and formulation of oral nutritional supplements. Nutrients. 2018 Jun 8;10(6):742.

101. Sanz-Paris A, Camprubi-Robles M, Lopez-Pedrosa JM, Pereira SL, Rueda R, BallesterosPomar MD, Garcia Almeida JM, Cruz-Jentoft AJ. Role of oral nutritional supplements enriched with B-hydroxy-B-methylbutyrate in maintaining muscle function and improving clinical outcomes in various clinical settings. The journal of nutrition, health & aging. 2018 Jun;22:664-75.

102. Liu M, Yang J, Yu X, Huang X, Vaidya S, Huang F, Xiang Z. The role of perioperative oral nutritional supplementation in elderly patients after hip surgery. Clinical interventions in aging. 2015 May 11:849-58.

103. Hubbard GP, Elia M, Holdoway A, Stratton RJ. A systematic review of compliance to oral nutritional supplements. Clinical nutrition. 2012 Jun 1;31(3):293-312.

104. Livingstone MB, Robson PJ, Wallace JM. Issues in dietary intake assessment of children and adolescents. British journal of nutrition. 2004 Oct;92(S2):S213-22.

105. Frosch DL, Kaplan RM. Shared decision making in clinical medicine: past research and future directions. American journal of preventive medicine. 1999 Nov 1;17(4):285-94. 106. Tappenden KA, Quatrara B, Parkhurst ML, Malone AM, Fanjiang G, Ziegler TR. Critical role of nutrition in improving quality of care: an interdisciplinary call to action to address adult hospital malnutrition. Journal of the Academy of Nutrition and Dietetics. 2013 Sep 1;113(9):1219-37.

107. Archer E, Marlow ML, Lavie CJ. Controversy and debate: memory-based methods paper 1: the fatal flaws of food frequency questionnaires and other memory-based dietary assessment methods. Journal of Clinical epidemiology. 2018 Dec 1;104:113-24.

108. Gangestad SW, Haselton MG, Buss DM. Evolutionary foundations of cultural variation: Evoked culture and mate preferences. Psychological Inquiry. 2006 Apr 1;17(2):75-95. 109. World Health Organization. Oral health surveys: basic methods. World Health Organization; 2013.

110. Keller U. Nutritional laboratory markers in malnutrition. Journal of clinical medicine.
2019 May 31;8(6):775.

111. Smith HJ, Chen J, Liu X. Language and rigour in qualitative research: problems and principles in analyzing data collected in Mandarin. BMC medical research methodology. 2008 Dec;8(1):1-8.

112. Satija A, Yu E, Willett WC, Hu FB. Understanding nutritional epidemiology and its role in policy. Advances in nutrition. 2015 Jan;6(1):5-18.

113. Nova FF. Designing a Patient-Centered Clinical Workflow to Assess Cyberbully Experiences of Youths in the US Healthcare System (Doctoral dissertation, Marquette University).

114. Yeh MC, Ickes SB, Lowenstein LM, Shuval K, Ammerman AS, Farris R, Katz DL. Understanding barriers and facilitators of fruit and vegetable consumption among a diverse multi-ethnic population in the USA. Health promotion international. 2008 Mar 1;23(1):42-51. 115. Darmon N, Drewnowski A. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: a systematic review and analysis. Nutrition reviews. 2015 Oct 1;73(10):643-60.

116. Jacobs B, Ir P, Bigdeli M, Annear PL, Van Damme W. Addressing access barriers to health services: an analytical framework for selecting appropriate interventions in low-income Asian countries. Health policy and planning. 2012 Jul 1;27(4):288-300.

117. Popkin BM, Duffey K, Gordon-Larsen P. Environmental influences on food choice, physical activity and energy balance. Physiology & behavior. 2005 Dec 15;86(5):603-13. 118. Petersen PE, Kwan S. Equity, social determinants and public health programmes–the case of oral health. Community dentistry and oral epidemiology. 2011 Dec;39(6):481-7.

119. Sumida K, Kovesdy CP. Causes and treatment of protein-energy wasting in kidney disease. InNutritional Management of Renal Disease 2022 Jan 1 (pp. 191-206). Academic Press.

120. Fulop T, Larbi A, Witkowski JM, McElhaney J, Loeb M, Mitnitski A, Pawelec G. Aging, frailty and age-related diseases. Biogerontology. 2010 Oct;11:547-63.

121. Dionne JM, d'Agincourt-Canning L. Sustaining life or prolonging dying? Appropriate choice of conservative care for children in end-stage renal disease: an ethical framework.

Pediatric Nephrology. 2015 Oct;30:1761-9.

122. Espinosa-Cuevas A, González-Ortiz A, Lindholm B, Kalantar-Zadeh K, Carrero JJ. Protein-Energy Wasting During Peritoneal Dialysis. InNolph and Gokal's Textbook of Peritoneal Dialysis 2022 Apr 12 (pp. 1-26). Cham: Springer International Publishing. 123. Furthermore, dialysis patients often experience a range of symptoms such as nausea, loss of appetite, and taste changes, making it challenging to maintain a healthy diet.

124. Mori K, Kurajoh M, Inaba M, Emoto M. Multifaceted Nutritional Disorders in Elderly Patients Undergoing Dialysis. Kidney and Dialysis. 2022 Dec 22;3(1):1-23.

125. Johansson L, Fouque D, Bellizzi V, Chauveau P, Kolko A, Molina P, Sezer S, Ter Wee PM, Teta D, Carrero JJ, European Renal Nutrition (ERN) Working Group of the European Renal Association–European Dialysis Transplant Association (ERA-EDTA). As we grow old: nutritional considerations for older patients on dialysis. Nephrology Dialysis Transplantation. 2017 Jul 1;32(7):1127-36.

126. Carrero JJ, Stenvinkel P, Cuppari L, Ikizler TA, Kalantar-Zadeh K, Kaysen G, Mitch WE, Price SR, Wanner C, Wang AY, Ter Wee P. Etiology of the protein-energy wasting syndrome in chronic kidney disease: a consensus statement from the International Society of Renal Nutrition and Metabolism (ISRNM). Journal of renal nutrition. 2013 Mar 1;23(2):77-90.

127. Suryadevara CK. Revolutionizing dietary monitoring: a comprehensive analysis of the innovative mobile app for tracking dietary composition. International Journal of Innovations in Engineering Research and Technology. 2023 Aug 1;10(88).

128. Cassotta M, Forbes-Hernández TY, Calderón Iglesias R, Ruiz R, Elexpuru Zabaleta M, Giampieri F, Battino M. Links between nutrition, infectious diseases, and microbiota:
Emerging technologies and opportunities for human-focused research. Nutrients. 2020 Jun 19;12(6):1827.
129. Califf RM. Biomarker definitions and their applications. Experimental Biology and Medicine. 2018 Feb;243(3):213-21.
130. Alyass A, Turcotte M, Meyre D. From big data analysis to personalized medicine for all:
challenges and opportunities. BMC medical genomics. 2015 Dec;8(1):1-2.
131. Vagg T, Shanthikumar S, Morrissy D, Chapman WW, Plant BJ, Ranganathan S. Telehealth and virtual health monitoring in cystic fibrosis. Current opinion in pulmonary medicine. 2021 Nov 1;27(6):544-53.
132. Marcus JB. Culinary nutrition: the science and practice of healthy cooking. Academic Press; 2013 Apr 15.
133. Vodovotz Y, Barnard N, Hu FB, Jakicic J, Lianov L, Loveland D, Buysse D, Szigethy E, Finkel T, Sowa G, Verschure P. Prioritized research for the prevention, treatment, and reversal of chronic disease: recommendations from the lifestyle medicine research summit. Frontiers in Medicine. 2020 Dec 22;7:585744.
134. Schulz AJ, Zenk S, Odoms-Young A, Hollis-Neely T, Nwankwo R, Lockett M, Ridella W, Kannan S. Healthy eating and exercising to reduce diabetes: exploring the potential of social determinants of health frameworks within the context of community-based participatory diabetes prevention. American journal of public health. 2005 Apr;95(4):645-51.
135. Lakerveld J, Woods C, Hebestreit A, Brenner H, Flechtner-Mors M, Harrington JM, Kamphuis CB, Laxy M, Luszczynska A, Mazzocchi M, Murrin C. Advancing the evidence base for public policies impacting on dietary behaviour, physical activity and sedentary behaviour in Europe: the Policy Evaluation Network promoting a multidisciplinary approach. Food Policy. 2020 Oct 1;96:101873.
136. Hall KD, Hammond RA, Rahmandad H. Dynamic interplay among homeostatic, hedonic, and cognitive feedback circuits regulating body weight. American journal of public health. 2014 Jul;104(7):1169-75.
137. Heller MC, Keoleian GA, Willett WC. Toward a life cycle-based, diet-level framework for food environmental impact and nutritional quality assessment: a critical review. Environmental science & technology. 2013 Nov 19;47(22):12632-47.
138. van den Berg NJ, Hof AF, Akenji L, Edelenbosch OY, van Sluisveld MA, Timmer VJ, van Vuuren DP. Improved modelling of lifestyle changes in Integrated Assessment Models: Cross-disciplinary insights from methodologies and theories. Energy Strategy Reviews. 2019 Nov 1;26:100420.
139. Zimmerman EB, Woolf SH, Haley A. Understanding the relationship between education and health: a review of the evidence and an examination of community perspectives. Population health: behavioral and social science insights. Rockville (MD): Agency for Healthcare Research and Quality. 2015 Jul;22(1):347-84.

140. Pathmasiri W, Schroder M, McRitchie S, Sumner S. The Role of The Metabolism/Exposome in Chronic Kidney Disease: Discovery for Precision Nutrition. InTechnological Advances in Care of Patients with Kidney Diseases 2022 Oct 11 (pp. 25-43).

Cham: Springer International Publishing.

141. Prosperi M, Min JS, Bian J, Modave F. Big data hurdles in precision medicine and precision public health. BMC medical informatics and decision making. 2018 Dec;18:1-5. 142. Agrawal V, Agrawal S, Bomanwar A, Dubey T, Jaiswal A. Exploring the Risks, Benefits, Advances, and Challenges in Internet Integration in Medicine With the Advent of 5G Technology: A Comprehensive Review. Cureus. 2023 Nov 13;15(11).

143. Demiris G. The diffusion of virtual communities in health care: concepts and challenges. Patient education and counseling. 2006 Aug 1;62(2):178-88.

144. Al-Shorbaji N, Al-Shorbaji N. Improving healthcare access through digital health: The use of information and communication technologies. Healthcare Access. 2021 Aug 30;10. 145. Mbunge E, Muchemwa B, Batani J. Sensors and healthcare 5.0: transformative shift in virtual care through emerging digital health technologies. Global Health Journal. 2021 Dec 1;5(4):169-77.

146. Goetz LH, Schork NJ. Personalized medicine: motivation, challenges, and progress. Fertility and sterility. 2018 Jun 1;109(6):952-63.

147. Rutledge CM, Haney T, Bordelon M, Renaud M, Fowler C. Telehealth: preparing advanced practice nurses to address healthcare needs in rural and underserved populations. International journal of nursing education scholarship. 2014 Jan 1;11(1):1-9.

148. Williams DR, Costa MV, Odunlami AO, Mohammed SA. Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities. Journal of public health management and practice: JPHMP. 2008 Nov;14(Suppl):S8.

149. Silow-Carroll S, Alteras T, Stepnick L. Patient-centered Care for Underserved Populations: Ddefinition and best practices. Washington, DC: Economic and Social Research Institute; 2006 Jan.