Deanship of Graduate Studies

Al-Quds University

The effect of nutrition intervention on the nutrient intake and selected biochemical variables among Palestinian hemodialysis patients in Ramallah

MPH Thesis

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Jerusalem-Palestine

1444/2022

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A Thesis Submitted in Partial Fulfillment of Requirements for the Degree of Master of Public Health/Epidemiology School of Public Health- Al- Quds University

1444/2022

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Thesis Approval

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1. **Head of committee: Dr. Radwan Qasrawi** Signature: ....
2. **Internal examiner: Dr. Hazem Agha** Signature: ....
3. **External examiner: Dr. Manal Badrasawi** Signature: ....

Dedication

To my beloved mother and father for their endless support, faith, and encouragement,

To my sister and brother for their love and patience,

To the soul of my grandmother,

To my beloved aunt,

To my exceptional professors,

To all my friends,

To everyone who made this study possible.

Haneen Taweel

Declaration

I certify that this thesis submitted for the degree of master is the result of my own work, except where otherwise acknowledged. This thesis or any of its parts has not been submitted for higher degree to any other university or institution.

Signature:

Acknowledgments

I would like to thank my supervisor, Dr. Radwan Qasrawi who has always been a source of inspiration and encouragement. His faith and confidence in my abilities to complete this study is much appreciated and has been the reason for accomplishing such a unique study. All gratitude and appreciation for his endless patience, continuous guidance, and valuable assistance.

I am grateful to my second supervisor, Dr. Reema Tayyem. The completion of this study would have been impossible without her valuable scientific support and experience in clinical nutrition.

I am also grateful to all the professors at the Faculty of Public Health for their guidance and frequent support.

Special thanks to the Palestinian Ministry of Health for their collaboration.

I deeply appreciate all the patients who participated in this study. It would have been impossible to complete this study without their help. They have been a true inspiration.

Deep thanks to my family for their support, advice, and guidance.

With respect,

Haneen Taweel

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List of abbreviations

7-point SGA	Seven- Point Subjective Global Assessment
BMI	Body Mass Index
BUN	Blood Urea Nitrogen
CKD	Chronic Kidney Disease
eGFR	Estimated Glomerular Filtration Rate
ESRD	End Stage Renal Disease
FCT	Food Composition Table
HD	Haemodialysis
MIS	Malnutrition-inflammation scale
MNT	Medical Nutrition Therapy
MPM	USDA Multiple-Pass Method
PEM	Protein Energy Malnutrition
PEW	Protein-Energy Wasting
PMC	Palestine Medical Complex
PTH	Parathyroid Hormone
RAAS	Renin-Angiotensin System
RDN	Registered Dietitian Nutritionist
REE	Resting Energy Expenditure
SGA	Subjective Global Assessment
TIBC	Total Iron Binding Capacity

Abstract

Chronic Kidney Disease (CKD) is defined as the inability of the kidneys to perform its function in filtering the blood, and it develops gradually over an extended period. The continuous change in the health status of a CKD patient requires a coherent change in the nutritional needs through individualized diet plan. Haemodialysis (HD) is a type of dialysis that is done to clean the blood among patients with renal failure. Food consumption during HD and between HD sessions affects the treatment and how the patient feels. Proper diet will help in reducing the waste build-up in the blood. In Palestine, only few studies addressed the nutritional status of HD patients which indicated that most HD patients had mild to moderate malnutrition and that there is a need for a nutrition intervention program for Palestinian HD patients in clinical settings. This intervention study is the first study intended to examine whether implementing a dietary intervention in terms of providing diet plans for HD patients in Palestine Medical Complex (PMC) affect the micronutrient intake and levels of selected biochemical variables among these patients through the modulation of protein intake, adequacy of caloric intake, control of sodium, potassium, and phosphorus intake personalized to the nutrient requirements of each case. The study included a sample of 49 male and female End Stage Renal Disease (ESRD) patients aged 18 years and above who are admitted to nephrology department at PMC in Ramallah and are on regular HD schedule for a minimum of six months. Medical data, biomedical data, dietary information, anthropometric measurements, three 24-hour recalls, and the Subjective Global Assessment (SGA) were collected, and personalized diet plans were developed. The collected data was documented and analysed using SPSS version 23, and both descriptive and inferential statistics were conducted. The main limitation of this study is that it is single centred with a small sample size.

Results of the 24-h recall data comparison of phosphorus, potassium, and sodium intake before and after intervention showed that the mean phosphorus, potassium, and sodium dietary intake decreased post intervention with a mean decrease of 166.6mg (P=0.002), 474mg (P<0.001), and 271.1mg (P= 0.033), respectively. Results of the biochemical data showed an increase in mean serum phosphorus increased post intervention with a mean increase of 0.4mg (P= 0.033). Serum potassium and sodium levels, however, decreased after implementing the intervention with a mean decrease of 0.2mg (P= 0.165) and1.4mg (P=0.079), respectively.

These results show the significant effectiveness of this intervention study on the dietary intake of HD patients, where the intake has significantly decreased for all three nutrients post intervention. Moreover, serum potassium and sodium levels decreased post intervention, but were not significant indicating the need for more time of intervention implementation.

Chapter 1: Introduction

1.1 Introduction

Nutrition intervention is essential in the management of ESRD and in preventing health complications that are shown to be associated with the disease. Careful nutrition monitoring of HD patients through providing a diet plan based on the personalized needs of the patient's macro and micronutrient requirements is essential. Proper diet will help in reducing the waste build-up and extra fluid in the blood.

Serum phosphorus, potassium, and sodium levels are essential in the management of ESRD and the dietary intake of these patients in terms of phosphorus, potassium, and sodium is essential (Mitra et al., 2020). As the first of its kind in Palestine, a nutrition intervention was implemented in this study to improve the medical and nutritional status of HD patients at PMC as one of the main HD units in the West Bank. If the program showed to provide positive result, it will be developed to a national nutrition intervention system targeting Palestinian HD patients.

1.2 Problem statement

Nutrition intervention has a key role in both the management of CKD and in preventing health complications that are shown to be associated with the disease. Managing the nutritional status of a kidney disease patient requires detailed assessment of the nutritional requirements of the patient and a precise nutrition intervention plan. To prepare the intervention plan, the macro and micronutrients that are associated with the nutrition status of these patients should be considered. This implies the essential need for careful nutrition monitoring of the patients through providing a diet plan based on the personalized needs of the patient's macro and micronutrient requirements (Kramer et al., 2018). Food consumption during HD and between HD sessions affects the treatment and how the patient feels. Proper diet will help in reducing the waste build-up and extra fluid in the blood. Malnutrition is common among HD patients and a nutrition intervention should be implemented to manage this issue (Ghorbani et al., 2020).

Although many ESRD patients on HD in Palestine suffer from malnutrition (Omari et al., 2019) (Rezeq et al., 2018), according to our knowledge, most of them do not receive Medical Nutrition Therapy (MNT). According to the researcher of this study, this might be due to several reasons, including, but not limited to, the limited current role of dietitians in clinical settings, low number of dietitians per beds in Palestinian hospitals, low or non-exploited knowledge regarding the role of MNT in disease management for patients with CKD, and the low knowledge about the benefit of MNT among the patients themselves.

The above-mentioned gap in implementing MNT among Palestinian HD patients, in addition to the benefit of dietary intervention on the health of these patients, provides a strong baseline for the need to implement this intervention study among Palestinian HD patients to assess the effect of implementing personalized dietary intervention on HD patient's intake and lab tests.

1.3 Study justification

Nutritional imbalances are very common among HD patients, which makes nutritional intervention essential (Yang & He, 2020) to prevent malnutrition indicated by protein energy wasting and nutrient deficiencies. Poor intestinal absorption, inflammation, nutritional restriction, and lower dietary intake all affect the nutritional status of CKD patients (Iorember, 2018). Nutrition intervention for ESRD patients on HD is also important since Protein Energy Malnutrition (PEM) among CKD patients on HD is an independent predictor of morbidity and mortality with a prevalence of 75 percent (Beer et al., 2018). Previous research showed a significant positive impact of nutrition intervention that provides adequate protein and energy for HD patients who have PEM (Abdalla et al., 2016).

In Palestine, few studies addressed the nutritional status of HD patients, and none conducted a nutrition intervention study on HD patients providing individualized diet plans. A study conducted by Sweileh et al. (2018) assessed malnutrition among HD patients using the Seven-Point Subjective Global Assessment (7-point SGA) and indicated that 52.8% of the study participants were well-nourished, 47.2% were mildly-to-moderately malnourished, and none of them was severely malnourished (Rezeq et al., 2018). A study by Omari et al. (2019) indicated that 65% of study participants had moderate malnutrition, 34% had mild malnutrition, and 1% had severe malnutrition (Omari et al., 2019).

Up to our knowledge, no nutrition intervention studies were conducted in Palestine among HD patients to assess the effect of the intervention on patients' health status in terms of providing individualized diet plans. This was the first intervention study addressing this issue nationally. This forms a strong base for the need to implement this study in Palestinian clinical settings to address the essential role of implementing nutritional therapy in the treatment plan for ESRD patients on HD and the need for educating these patients on the role of proper and individualized nutrition therapy to manage micronutrient levels and malnutrition among HD patients.

As the first of its kind in Palestine, a nutrition intervention was implemented in this study to improve the medical and nutritional status of HD patients at PMC as one of the main HD units in the West Bank. If the program showed to provide positive result, it will be developed to a national nutrition intervention system targeting Palestinian HD patients

1.4 Study Objectives

1.4.1 Main Study Objective

To develop and validate a nutrition intervention plan for managing the nutrient intake of HD patients through the modulation of protein, caloric, sodium, potassium, and phosphorus intake personalized to the nutrient requirements of each case and assess the effectiveness of the intervention based on the patients' dietary intake and serum levels of selected biomarkers.

1.4.2 Specific Objectives

1. To develop an individualized dietary plan for each HD patient according to the HD macro and micronutrient dietary recommendation using a Food Composition Table.

2. To assess the changes in the caloric, protein, potassium, phosphorus, and sodium intake of HD patients pre- and post intervention.

3. To assess the changes in the serum phosphorus, potassium, and sodium levels of HD patients pre- and post intervention.

4. To evaluate the degree of malnutritionn among HD patients' pre- intervention.

5. To assess the patients' self-health rating, their interest in the relationship between health and nutrition, willingness to make dietary changes, and reading food labels.

1.5 Study research Question

Will implementing a dietary intervention for HD patients at the PMC affect the biomedical parameters and nutrient intake among these patients?

1.6 Context

CKD is among the ten most prevalent chronic diseases in Palestine. In 2017, about 1216 patients in the West Bank were diagnosed with ESRD and required HD (Omari et al., 2019). The need for HD is increasing noticeably in Palestine as in 2014 only, 687 patients needed HD. The number of centres providing HD services are under-staffed and thus it's expected that HD patients in Palestine are possibly not getting enough nutrition assessment or education (Omari et al., 2019). According to the MOH, 277,102 HD sessions took place in 2018, where 2,071 patients received HD on a regular basis (Ministry of Health, 2018). Regionally, there are 11 kidney dialysis units in the MOH hospitals, 1 unit in An -Najah National University hospital, and 5 units in Gaza Strip, with a total of 365 machines (Ministry of Health, 2018).

The study was conducted at PMC because HD is commonly done at a clinical setting, mainly hospitals. This hospital is one of the hospitals operating under the MOH and one of the main hospitals in Ramallah and al-Bireh governorate that serves HD patients living in the governorate in addition to patients coming from other areas. It was decided to conduct the nutrition assessment and intervention on the same day that the patient visits the hospital for his/her HD session to ensure consistent follow up and participation. The study was conducted at PMC as it has a HD section and would be conducted in the future in more HD units in Palestine if shown to be effective. The chosen age group is 18 years and above as the study will only be done on adults undergoing HD.

1.7 Operational definitions

1.7.1 ESRD

The term refers to kidney failure and it is the 5th and last stage of CKD. Either kidney transplant or dialysis should be provided for patients with ESRD to survive as ESRD is irreversible and fatal if no treatment was provided (American Kidney Fund, n.d.-a). CKD is categorized as ESRD or stage 5 CKD when the GFR is <15 mL/min/1.73 m^2 (Yang & He, 2020).

1.7.2 Haemodialysis

A technique in which a dialysis machine and a dialyzer are used to clean the blood and a minor surgery is usually done to allow the blood to enter the dialyzer. It is used when the kidneys are not able to sufficiently remove wastes and fluid from the blood. Patients use dialysis when 10 to 15 percent of the kidney function is remaining (National Kidney Foundation, 2015).

1.7.3 Dietary intervention

Dietary interventions are any type of nutrition advice, education, or diet plan provided for the patient or client personalized according to their needs with an intention to treat and/or enhance their nutrition status (Academy of Nutrition and Dietitics, 2018).

1.7.4 Subjective Global Assessment

A tool used to identify malnutrition by taking details of recent food intake, changes in weight, gastrointestinal symptoms, and a clinical assessment. SGA has been validated in a variety of patient settings and is considered the gold standard for identifying malnutrition (Canadian Malnutrition Task Force, n.d.).

1.7.5 Food composition table

A FCT includes energy and detailed macro and micronutrients composition for selected types of foods and meals (Medical Research Council, n.d.).

Chapter 2: Literature review

2.1 Literature Review

2.1.1 Definition

Chronic Kidney Disease (CKD) is defined as the inability of the kidneys to perform its function in filtering the blood, and it develops gradually over an extended period (NIDDK, 2022). CKD has several levels depending on how severely the kidneys are damaged. To determine the severity of the damage, the estimated glomerular filtration rate (eGFR) is measured based on serum creatinine levels, and the stages of CKD are categorized depending on the eGFR results (Kramer et al., 2018). For instance, CKD is categorized as stages 1 and 2 when eGFR is ≥60 mL/min/1.73 m^2 along an increase in urine albumin excretion and is classified as stages 3 and 4 when eGFR is between 59 and 15 mL/min/1.73 m^2. Stage 5 takes place when eGFR is <15 mL/min/ 1.73 m^2 or when kidney replacement therapy is required (Kramer et al., 2018).

Several health complications are associated with CKD, which emphasizes the importance of early intervention in the treatment to prevent other health complications from taking place. These complications include bone disease, anaemia, cardiovascular disease, gout, (NIDDK, 2022), kidney replacement therapy, mortality, and low quality of life (Bello et al., 2017). Comprehensive knowledge of the complications associated with CKD can improve the diagnosis, prevention, and management of the disease (Bello et al., 2017).

According to the American kidney fund and Mayo clinic the risk factors for CKD are diabetes, high blood pressure, family history of kidney disease, age, and ethnicity (American Kidney Fund, n.d.-b) (Mayo Clinic, n.d.). Mayo clinic considers additional risks for CKD including obesity, smoking and cardiovascular diseases. In addition to the above-mentioned risk factors, dietary intake is considered a modifiable risk factor for CKD (Asghari et al., 2018).

2.1.2 Associated diseases

In a cohort study carried among HD patients from 2013 to 2018 among 117 patients, the main cause of CKD among these patients was lupus nephropathy, followed by diabetes, and hypertension, respectively (Ramos et al., 2021).

High and low blood pressure, anemia, pericarditis, and bone disorder, are common complications among HD patients (Mayo Clinc, n.d.). Research has shown that although a high percentage of HD patients have diabetes, hypoglycaemia is also prevalent among these patients, whom are usually provided with similar dietary limitations as nondiabetic HD patients. It is suggested to aim for a 7%-9% haemoglobin A1c, and to avoid a A1c less than 6% as it is linked to uraemia and a suboptimal nutritional status. Glycaemic restrictions should be limited among patients with less than 7% A1c, and carefully studied for patients with higher A1c levels ensuring at least 35kcal/kg/d (Kalantar-Zadeh et al., 2015).

These results are close to published literature in Palestine were 33.64% of HD patients had both diabetes and hypertension, 55.46% had hypertension and 39.55% had diabetes (Naalweh et al., 2017). Another study reported 61.3% of HD having hypertension, 48.1% having diabetes, and 43.4% having both diabetes and hypertension (Rezeq et al., 2018). DM, previous CVD, and higher HbA1C have been shown to be linked to significantly higher mortality rates among HD patients and higher risk for CVD events (Ma & Zhao, 2017).

2.1.3 Nutrition management

Nutrition intervention is essential for patients with CKD on many levels; to control health risks, prevent complications, avoid accumulation of toxins, and maintain a controlled nutritional status. The dietary intervention needs to be personalized according to the medical needs of the patient and his/her food preferences (Anderson et al., 2016) . Nutrition management for patients with early stages of CKD is one of the essential factors to delay the progression of CKD. Maintaining healthy weight will decrease risk factors for developing CKD such as type II diabetes and hypertension. Controlling macro and micronutrients intake will slow disease progression once it's present. General nutrition guidelines are not enough for patients with CKD, due to the disease complexity and the presence of several health risks if not done professionally depending on the individualized needs of patients. Medical nutrition therapy (MNT) that is done by a registered dietitian nutritionist (RDN) is the most efficient and valuable approach as it will not only provide general counselling, but an intensive ongoing MNT that includes nutrition assessment/reassessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation (Kramer et al., 2018). Moreover, MNT will enhance medical results and is thought to decrease medical expenses (Kramer et al., 2018). In the US most adults with CKD have not received individualized MNT (Kramer et al., 2018), the same is the case in Palestine.

An intervention study indicated a positive impact of personalized nutrition interventions on patient health status (Hendriks et al., 2019). A systematic review and meta-analysis were conducted to assess the effect of dietary educational interventions for the management of hyperphosphatemia among HD patients where the educational sessions took place from 1-6 months found that using of self evaluation, individualized counselling, high-intensity education, and long duration of interventions are effective in managing hyperphosphatemia (Karavetian et al., 2014).

2.1.4 Epidemiology of CKD and ESRD

In the United States, CKD affects approximately 15% of the population and it’s expected that the incidence will increase further as result of the high rates of obesity and the aging in the US. (Kramer et al., 2018).

In Palestine, 0.8% males and 0.6% females aged 18 and above reported having CKD and receiving treatment in 2010. Among the elderly population aged 60 years and above, 2.8% males and 2.5% females reported having chronic kidney disease in the same year (Central Bureau of Statistics, 2013). In 2017, about 1216 patients in the West Bank were diagnosed with End Stage Renal Disease and required HD. The need for HD is increasing noticeably in Palestine as in 2014 only, 687 patients needed HD. The number of centres providing HD services are generally under-staffed in all areas and thus it's expected that HD patients in Palestine are possibly not getting enough nutrition assessment or education (Omari et al., 2019). A cross sectional study was done in 2010 at all dialysis units in the West Bank, the prevalence of ESRD patients on dialysis was 240.3 PMP, with the highest prevalence in Jericho city. About 62.3% patients lived in villages, 28.8% in cities, and 8.9% in refugee camps. Moreover, 45% of these patients were between 45 and 64 years. Among these patients, 22.5% were diabetic, 11.1% were hypertensive, and 10.6% had both diabetes and hypertension (Khader et al., 2013).

In Palestine, few studies addressed the nutritional status of HD patients, and none conducted a nutrition intervention study on HD patients. A study conducted by Sweileh et al. (2018) assessed malnutrition among HDP using the Seven-Point Subjective Global Assessment (7-point SGA) and indicated that 52.8% of the study participants were well-nourished, 47.2% were mildly-to-moderately malnourished, and none of them was severely malnourished (Rezeq et al., 2018). A study by Omari et al. (2019) used Malnutrition-inflammation scale (MIS), Body Mass Index (BMI), muscle mass, subcutaneous fat mass, plasma albumin and total iron binding capacity (TIBC) to assess nutritional status among HDP. It was indicated that 65% of study participants had moderate malnutrition, 34% had mild malnutrition, and 1% had severe malnutrition (Omari et al., 2019). A study done at al Shifa hospital in Gaza indicates that most of HDP have malnutrition and that it's directly related to morbidity and mortality. 66.7% of participants had

Hypoalbuminemia, 65% had Low pre-dialysis serum creatinine level, 61.7% had Low serum cholesterol level, and 46.7% had BMI lower than 23.8 kg/m²) for HD patients (El Belbeisi, 2013). A study by Zidan et al. (2020) indicated inadequate nutrition knowledge score among patients on HD and insufficient nutritional education. The nutrition knowledge was affected by the levels of education and age (Souzan Zidan, Manal Badrasawi, Bayan Nimer, Kawther Abu Sabha, 2019).

Although many ESRD patients on HD in Palestine suffer from malnutrition (Omari et al., 2019) (Rezeq et al., 2018), the majority of these patients in Palestine do not receive MNT due to several reasons, including, but not limited to, the limited current role of dietitians in clinical settings, low number of dietitians per beds in Palestinian hospitals, low or non-exploited knowledge regarding the role of nutrients in disease management for patients with CKD (Souzan Zidan, Manal Badrasawi, Bayan Nimer, Kawther Abu Sabha, 2019), and the low knowledge about the benefit of MNT among the patients themselves.

No nutrition intervention studies were conducted among HD patients in Palestine, this will be the first intervention study addressing this issue nationally. Internationally, several studies indicated the effectiveness of nutrition intervention for patients with CKD who were undergoing dialysis. This forms a strong base for the need to conduct this study among Palestinian HD patients. To develop the nutrition intervention program, a food composition table (FCT) will be used to better prepare individualized diet plans for patients, as a FCT is inclusive of both macro and micronutrient contents of food items and meals.

2.1.5 Protein

Current methods and dietary recommendations for HD patients, including the protein, phosphorus, potassium, and sodium intake recommendations and practices were evaluated for their pros and cons for patients undergoing HD. Studies have shown that a high intake of protein, which was identified as 1.2 to 1.4 g/kg/d, provides better hospitalization and survival results. The collected data from this study has shown, however, that more than 50% of HD patients consume less than 1.0 g/kg/d of dietary protein, which puts the patients at risk of protein-energy wasting (Kalantar-Zadeh et al., 2015).

Other research papers indicated that high protein intake negatively affects the functions of the kidney among HD patients reporting data from randomized controlled trials in humans and from animal models. This negative effect on the health of the kidney is due to the increase in GFR caused by the increase in both the blood flow to the kidney and the intraglomerular pressure, especially when associated with an increase in albumin excretion in the urine (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Research has shown that decreasing the intake of dietary protein has shown to decrease proteinuria by 20 to 50 percent as well as decreasing albuminuria levels, which has a beneficial effect on the function of the kidneys in terms of constricting afferent arterioles. In addition, renin-angiotensin system (RAAS) inhibition treatment has shown to constrict efferent arterioles, which also benefit the kidneys function (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

One of the largest controlled trials that studied the effect of decreasing protein intake on the progression of CKD was the Modification of Diet in Renal Disease study, which has not initially indicated a certain result of the positive effect of reduced protein intake on the health of the kidneys due to the short period in which the study was conducted or high prevalence of polycystic kidney among the study participants. However, further analysis of the results of this study indicated that reducing daily protein intake by as little as 0.2 g per kg of body weight led to a decreased decline in GFR, thus decreasing death risk by almost 50 percent (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Controlling acidosis remains one the main challenges among CKD patients and is essential for better management of the disease. Research has shown that reducing protein intake reduced acidosis and increased bicarbonate levels in the blood. Acidosis is formed by the metabolism of dietary amino acids that have sulfur, thus limiting protein containing foods decreases acidosis leading to improvements in both the kidney health and CKD-mineral and bone disorder (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Lower intake of energy among patients who followed a low dietary protein intake might be the reason for the increased risk for protein energy wasting, decreased body weight, fat, in addition to adverse changes in other anthropometric measurements (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017). In another study, participants had the recommended daily mean energy intake (30 kcal/kg.IBW/d) and didn't have negative results on their anthropometric measurements. Moreover, results of a randomized controlled trial suggested that comprehensive monitoring of stage 3 to 5 CKD patients is a good strategy to avoid malnutrition among patients following a low dietary protein (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Although protein reduction is required for all CKD patients, the amount of the reduction differs according to the case; less than 1gr per kg of ideal body weight per day is recommended for stages 1 and 2 without proteinuria, patients with one kidney, and stage 3b old patients with very gradual disease advancement. A protein intake of 0.6 to 0.8 gr per kg of ideal body weight per day is recommended for patients with eGFR<45 mg/ml/1.73m2BSA or those with proteinuria.

It is essential to note that protein requirements among HD patients should be higher than among CKD patients who are not undergoing dialysis, due to the fact that HD accelerates protein catabolism, leading to protein energy wasting, which might in turn lead to higher rates of hospitalization and death. It is favourable for the diet plan to be individualized satisfying 1.2 to 1.4 gr of protein per kg of ideal body weight per day.

A randomized controlled trial has shown that providing CKD patients with very low dietary protein with keto-analogs and vitamins postponed starting dialysis and reduced the cost of the management of the disease (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017). Moreover, it has been shown that providing CKD patients with low protein diets, delayed starting dialysis, and provided them with better transition to HD and less sessions per week (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Decreasing waste accumulation from dietary protein by-products has been shown to treat uraemia (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Adherence to a low protein intake among patients is challenging. Several factors that play a role in the adherence to a low protein diet including the knowledge, attitude, and support, good patient-physician communication, self-monitoring of protein intake, and periodic feedback by the dietitian, Education with simplified diet approach, individualized nutrition session considering food preferences, recipe suggestions (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017). A meta-analysis of 13 randomized controlled trials indicated that dietary protein restriction is possible, and patients almost met the recommended reduced protein intake (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017). What is considered as good adherence is the intake within the 20% (either higher or lower) of the recommendation in 80% of the time, while following the recommended energy intake (30-35 kcal per kg of ideal body weight per day) (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Some studies associated the type of dietary protein with the effect on the kidneys' function, where red meat was associated with higher risk of ESRD, due to the increased acid load from the sulfur containing amino-acids and the end products from animal proteins. On the other hand, a different study indicated that high protein intake was associated with cardiovascular diseases, but not with the deterioration of the kidneys' function (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

2.1.6 Phosphorus

According to literature, normal serum phosphorus is 3 - 4.5 mg/dl, however, several cross-sectional studies indicated that even individuals without kidney diseases had higher (between 1.6 - 6.2 mg/dl) serum phosphorus levels than the recommended level, which might be due to several factors including the individual's diet or other factors regulating the serum phosphorus levels (Suki & Moore, 2016).

Hyperphosphatemia among HD patients is expected and has been shown to be linked to several adverse health consequences including hyperparathyroidism and metastatic calcification which may be factors in morbidity and mortality among HD patients even when adjusting for age, sex, race, DM, smoking, acquired immunodeficiency syndrome, and/or neoplasm (Block et al., 1998).

A study conducted among more than 500 HD patients indicated that a high variability in serum phosphorus levels led to a significantly higher all cause mortality rates and to higher death rates from cardiovascular diseases. Results also showed that as age and phosphorus variation levels increase, and haemoglobin and albumin levels decrease, all cause mortality and mortality from cardiovascular diseases increases. This indicates that the more stable the serum phosphorus levels are, the lower the risk for all cause and cardiovascular mortality risks (Zhu et al., 2018).

For hemodialysis patients who have been receiving dialysis for at least 1 year, it was concluded that a large percentage have a serum phosphorus level above 6.5 mg/dL and that this places them at increased risk of death. This increased risk is independent of PTH. The mechanism(s) responsible for death is unknown but may be related to an abnormally high Ca x PO4 product.

Although mechanisms are not clearly established, this study supports the need for vigorous control of hyperphosphatemia to improve patient survival.

In a study analysing 34 HD patients, an increase in the intake of phosphorus was found to be associated with an acute increase in serum phosphorus levels, which indicates the importance of controlling the daily intake of phosphorus, and not only controlling the accumulated dietary intake of phosphorus over a period of time. The increase in the intake of dietary phosphorus among participants in this study has also led to an increase in iPTH levels and iFGF23 (Tsai et al., 2021).

To control serum phosphorus levels, HD patients are advised to restrict their dietary phosphorus intake, and cautiously use phosphorus binders. A cross sectional study was conducted to assess the intake of dietary phosphorus among HD patients and their adherence to prescribed phosphorus binders. The average phosphorus intake was 15.1 mg/kg/d among the participants in this study, and low adherence to phosphate-binders was significant among patients with low dietary phosphorus intake (less than 1000 mg/d). It is important to note, however, that in addition to dietary phosphorus intake, several other factors regulate serum phosphorus levels including PTH, vitamin D, fibroblast growth factor 23, through kidneys, bones, and the digestive system (Tao et al., 2019).

Moreover, serum phosphorus level is affected by bone health; the likelihood of the existence of bone diseases among CKD patients is high which increases the risk for high serum phosphate levels, especially among patients consuming high dietary phosphorus and low dietary calcium, which increase mortality rates among CKD patients. Several strategies are used to maintain normal serum phosphorus levels including diet, dialysis, and phosphate binders, maintaining bone health would also help (Suki & Moore, 2016).

On the same note, a research paper indicated that there is a high rate of nonadherence to phosphorus binders. Many HD patients forget to take phosphorus binders, while other patients have reported that they do not adhere to phosphorus binders intentionally. While patients forgetting to take phosphorus binders had lower normal serum phosphorus levels, those who intentionally did not adhere to phosphorus binders did not have different (neither lower or higher) serum phosphorus levels compared to those who adhered. Moreover, patients with higher knowledge of phosphorus content in their diets did not have a significant association with either lower or higher serum phosphorus levels. Moreover, most foods do not have phosphorus content on the food labels, which makes it harder for patients to check phosphorus levels in the packaged foods that they consume (Joson et al., 2016).

Dietary adherence to phosphorus guidelines has been shown to be lower compared to other micronutrients related to CKD. It is indicated that increasing HD patients' knowledge about phosphorus control through educational sessions is of limited effect, while patient support groups and patient focused psychoeducational approaches might be of a greater help (Joson et al., 2016).

To assess the effect of using phosphate counting tables on reducing dietary intake of phosphorus among HD patients, a study by Bertonsello-Catto et al (2019) was conducted to assess serum phosphorus levels after two months of receiving education sessions on the process of using phosphate counting table (Bertonsello-Catto et al., 2019)s. Although the improvement in serum phosphorus levels wasn't significant among patients who adhered to using the phosphate counting tables, patients who have not adhered to using the tables have shown to have an increased serum phosphorus level. This indicates that adherence to using phosphate counting tables can aid in improving serum phosphorus levels among the studied population (Bertonsello-Catto et al., 2019).

Although many high phosphorus foods are also sources of protein, and protein is important to prevent protein energy malnutrition among HD patients, it is often discussed that reducing dietary phosphorus will lead to lower dietary protein intake. While phosphorus and protein are often correlated in foods, it is important to consider that beyond the actual phosphorus content in food, several factors affect phosphorus intake including phosphate additives, preparation methods, and phosphorus bioavailability in food items. Moreover, research has shown that for a known dietary protein and energy intake, phosphorus can range up to 600mg/day. Knowing this, phosphorus levels can be reduced by reducing phosphate additives intake in processed foods, eating foods with lower phosphorus bioavailability, and using wet cooking methods (St-Jules, Woolf, et al., 2016).

A different study indicated that animal based dietary sources of protein are high in phosphorus and that limiting protein foods high in phosphorus has been shown to decrease serum phosphorus levels, which plays a role in the reduction of parathyroid hormone and fibroblast growth factor. Moreover, it has been shown that limiting protein intake reduces oxidative stress and improves insulin resistance, thus reducing the risk for atherosclerosis among these patients (Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, 2017).

Patients who were provided with a restrictive dietary phosphorus intake of less than 1000 mg/d had lower survival rates. The study argues that KDIGO recommendations to adjust the phosphorus intake of HD patients to maintain a normal serum phosphorus level might be challenging, as limiting dietary phosphorus might lead to lower protein intake and thus increasing the risk of mortality among HD patients. On the other hand, providing HD patients with high phosphorus to protein ratio increases mortality rates, which indicates the importance of providing patients with foods that have lower phosphorus to protein ratios, i.e. from natural and organic sources, and limit phosphorus intake from processed sources (Kalantar-Zadeh et al., 2015).

2.1.7 Potassium

Historically, the main reason for restricting potassium among ESRD patients was to restrict dietary protein and protein catabolites. Although restricting dietary potassium is still prescribed to HD patients, most of these patients consume less than the maximum limit of 3000 mg of potassium per day (St-Jules, Goldfarb, et al., 2016).

High potassium intake increases death risks among HD patients, even when adjusting for other factors that might also increase mortality rates (Kalantar-Zadeh et al., 2015). Research has shown that high dietary potassium intake among HD patients lead to high serum potassium levels. Moreover, higher dietary intake of potassium is associated with higher mortality, regardless of the serum potassium level. Higher dietary potassium intake has been linked to higher protein, phosphorus, and energy intake. When providing a dietary plan that restricts potassium, it is important to note that foods that are high in potassium are important for heart health. To incorporate heart healthy foods in the diets of HD patients, they should be advised to choose foods with potassium but are heart healthy over choosing food with potassium content but are not considered beneficial for cardiovascular health (Kalantar-Zadeh et al., 2015).

In a prospective cohort study collecting data using FFQ among HD patients attending outpatient clinics, it has been shown that mortality rate among patients with extreme potassium restriction was higher than among other the groups, even after covariate adjustments. The study suggests more research to be conducted on the optimal intake of dietary potassium among HD patients. Moreover, lower potassium intake was among patients consuming lower protein and energy and was lower among females than males (Narasaki et al., 2021).

A review study has highlighted the importance of considering individualized diet plans for patients on HD due to the adversity among these patients and their different food considerations. A dietitian should carefully assess and monitor each case on an individual level (St-Jules et al., 2018).

This study by St-Jules et al (2018) has emphasized the importance of accounting for the nutrient density of the foods in the prescribed diets. They suggest that it is important to consider the differences in energy levels and nutrients among foods from the same or from different food groups when planning a diet. Meaning that it is important to consider the nutrient density among foods rich in phosphorus and protein as its effect usually appears on the long run, while it's important to consider the amount of nutrient per serving in the case of potassium as its effect is acute. They implied that the consumption of a food item or meal that is lower in potassium (to decrease potassium intake in the diet of HD patients), but also lower in calories will lead to the consumption of another food (that is most likely to have potassium) to meet the patient’s caloric needs (St-Jules et al., 2018).

In the literature, the acute result of the potassium consumption on serum levels has been shown to be week. This implies the need to consider assessing the effect of potassium consumption on serum potassium levels based on its content per serving, in addition to considering the current assessment method, i.e., based on nutrient density (St-Jules et al., 2018).

The study also implied that although the nutrient intake of some macronutrients and micronutrients, mainly potassium, phosphorus, and protein is important in PEM and the serum levels of these micronutrients, other factors might be linked to the increase and/or decrease of the serum levels of these micronutrients. These factors include other constituents of the consumed food, the use of binders, and individual nutrient absorption differences among other different factors (St-Jules et al., 2018).

A cohort study conducted among HD patients has shown that only about 5% of the patients met their recommendations of potassium, and this intake was not different when compared between male and female patients, diabetic/non-diabetic patients, or well-nourished/malnourished patients. Moreover, analysing potassium intake from different food groups showed no difference when compared between patients with high or low serum potassium levels and there was generally low consumption of the food groups among the majority of patients (Ramos et al., 2021).

The same study by Ramos et al (2021) tested the serum potassium levels among HD patients, there was no difference between male and female patients as well as between diabetic and nondiabetic patients. However, serum potassium levels were lower among patients with malnutrition. Also, the increase in serum potassium was associated with an increase in serum creatinine and BUN and a decrease in the malnutrition inflammation score, but was not associated with serum bicarbonate, BMI, dialysis vintage, energy, protein, fibre, and potassium intake (Ramos et al., 2021).

About half of the participants in this study had high serum potassium levels, who also had high serum creatinine, BUN, less malnutrition, longer dialysis vintage, and higher body weights. High serum potassium, however, was not associated with higher intake of fruits, vegetables, and legumes. High serum potassium levels were higher among patients with higher serum creatinine levels and patients with diabetes due to lower kidney and intestinal potassium excretion and disordered cellular shift of potassium between cells (Ramos et al., 2021).

Although higher serum potassium was linked to higher serum creatinine level among HD patients in this study which is an indicator of better nutrition status and lower malnutrition, high serum creatinine was not associated with lower malnutrition (i.e., better nutritional status) among these patients (Ramos et al., 2021).

This study showed that the dietary intake of potassium increased with age, weight, and higher intake of fibre, fruits, vegetables, and dairy. On the other hand, it did not have a significant effect on dialysis vintage or on the serum bicarbonate levels. Moreover, higher intake of grains, roots and tubers, legumes, meat, and eggs has been shown to have an inverse effect on serum potassium levels (Ramos et al., 2021).

The dietary intake among study participants showed that potassium accounted for less than 2% of the higher serum levels of potassium, which indicated that other factors might have more impact on serum potassium levels among HD patients (Ramos et al., 2021).

Recommending relaxing potassium restriction has started to be advised lately. It has been shown that the intake of fruits and vegetables could possibly correct metabolic acidosis due their fibre (helping in constipation) and alkaline content (regulate cellular balance of potassium) (Ramos et al., 2021).

CKD patients who have diabetes have been shown to have higher serum potassium levels which may be attributed to several factors. First, patients with diabetes tend to have lower kidney and intestinal potassium excretion and disordered cellular shift of potassium between cells. Excretion of potassium through the intestines and kidneys has been shown to be regulated by aldosterone, which is usually low among diabetic HD patients, thus affecting potassium excretion. Second, low insulin levels affect the use of potassium in the body (Na - K- ATPase) leading to lower uptake of potassium into the cell, potassium thus stays in the extracellular space of the cell. Third, in case of hyperglycaemia, water moves out of the cell to the extracellular space, which leads to moving potassium outside the cell as well. Lastly, metabolic acidosis might also lead to higher serum potassium among CKD patients with diabetes, this was not the case however among HD patients in this cohort (Ramos et al., 2021).

Absorption and use of dietary potassium is different among different foods which should be considered when planning a diet for CKD patients. Some foods that are high in potassium with low potassium bioavailability should not be treated the same as foods with higher bioavailability when planning diets for these patients. Moreover, dietary potassium from animal based food sources are different in their impact on hyperkalaemia than from plant based foods (St-Jules, Goldfarb, et al., 2016).

It is important to note, however, that the results of the dietary intervention on patients' health is hard to predict. Substituting foods that are high in potassium might be difficult for patients, especially that they should also limit other nutrients such as phosphorus, proteins, and sodium, which might then lead to low adherence to the diet or adopting a very simple diet without enjoyment in food. HD patients reported that the renal diet was tasteless, too complicated, and hard to monitor (St-Jules, Goldfarb, et al., 2016).

Recommending patients to limit plant-based foods might result in inflammation, metabolic acidosis, oxidative stress, dyslipidaemia, constipation, among other conditions (St-Jules, Goldfarb, et al., 2016).

According to St-Jules et al. (2016) advantages of limiting potassium among HD patients is theoretical and was not supported by randomized controlled trials. However, they suggested restricting potassium among HD patients until further intervention studies are done (St-Jules, Goldfarb, et al., 2016).

In another prospective cohort study conducted among twenty countries following more than 55,000 patients, it has been clear that in several countries, serum potassium levels among HD patients were lower than they were twenty years earlier, while it remained constant in other countries. Moreover, when serum potassium levels of HD patients were tested at the beginning of the week it was usually higher than when collected during the week. The results of this study indicated that greater levels of serum potassium were associated with unfavourable health consequences when adjusted for several variables. Moreover, higher serum potassium level was associated with higher rates of composite arrhythmia in a monotonic association (Karaboyas et al., 2017).

A cohort study has identified a seasonal difference in potassium levels among patients with high and moderate serum potassium levels. Serum potassium levels were higher in summer among the high serum potassium group, while it was higher in winter among the moderate serum potassium group. It suggested that when the serum potassium was higher in the winter was due the fact that in winter patients tend to eat more as well as the fact that patients tend to have fewer sweat levels in the winter, thus lower loss of potassium in sweat, and this variation was previously noted in other studies. Fatal high serum potassium levels have been more prevalent in summer where patients consume more fruits and vegetables compared to winter. Moreover, patients in the high potassium group have been shown to be younger in age and have been undergoing HD for a longer time (Kim et al., 2021).

In the same study conducted by Kim et al (2021), patients in the higher potassium level group had more variability in serum potassium levels which was associated with higher death rates. Higher potassium levels might be both an indication of lower adherence to the prescribed restriction as well as to the better nutrition status (Kim et al., 2021).

It has been reported that the younger the patients, the more they are likely to be nonadherence to either the prescribed diet or the HD sessions (Kim et al., 2021).

Research has shown that the more time the patient underwent HD, the worse the kidney function is, thus the higher the risk for higher serum potassium levels (Kim et al., 2021).

Plant based diets for CKD patients: A review study showed that the provided restriction for CKD patients might result in decreasing the consumption of fruits and vegetables. Plants based foods have been shown to have several pros on the health of patients with CKD, mainly lower uremic toxin production, decrease metabolic acidosis, decrease atherogenic dyslipidaemia, cancer, and death, control serum phosphorus levels, and delay progression of stages 3 to 5 of CKD. Adopting a plant-based diet should be individualized, whether to control serum potassium levels or to reduce malnutrition. The study suggests more research to be conducted to assess any gaps in the field of plant-based diets and CKD as well as the extent of the effect of dietary potassium on HD patients. Moreover, if the patient has normal serum potassium level there is not enough data for the benefit of limiting plant-based foods, even in patients with progressive CKD stages (Carrero et al., 2020).

2.1.8 Sodium

Main problem of high BP among ESKD patients is due to the high sodium intake resulting in fluid overload. This indicates the importance of reducing dietary sodium intake to control hypertension among HD patients. Decreasing salt intake has shown to decrease both systolic and diastolic BP as well as decreasing the need for ultrafiltration, and mortality. Moreover, to ensure that the patient will benefit from prescribing a lower sodium intake diet, this prescription should be personalized according to the patient’s needs and health status (Borrelli et al., 2020). Ccomplete restriction of salt, however, has shown to have negative effects on the health of HD patients, particularly amongst those whom this restriction will affect the intake of energy and protein. This, however, doesn’t mean complete relaxation of salt intake (Kalantar-Zadeh et al., 2015).

Previous research has shown that the reduction in renal function plays a major role in increasing serum sodium levels and blood volume. It has been shown that controlling sodium and fluid intake will control hypertension among HD patients. Although this recommendation has been provided for HD patients for decades, there is still insufficient evidence to support this recommendation. Moreover, there is an imprecision in the used assessment tools and differences in consumption among HD patients and populations. According to the available literature, dietary recalls were the most used method to estimate sodium intake (Mc Causland et al., 2013). Several research have been done to indicate dietary sodium intake among HD patients. One research found that 8 Japanese HD patients consumed an average of 12.6 gr. salt per day based on their dietary records (Mc Causland et al., 2013). A study conducted in Spain estimated salt intake among HD patients using mass transfer equations and reported that an average of 10 gr. of salt was consumed by seventeen HD patients per day (Mc Causland et al., 2013). Close amount of salt intake (9.7 gr./day) was found among seventeen HD patients in the United States, and similar results were found when comparing data from the dietary recalls and the balance formula (Mc Causland et al., 2013). Moreover, a different study indicated an average consumption of 5.15 gr. of salt per day based on two diet diaries (Mc Causland et al., 2013). In a study conducted among French HD patients who control their volume and hypertension, their dietary salt intake was 3.8 gr/day as analysed from 3 food questionnaires (Mc Causland et al., 2013).

Another study was conducted among HD patients in New Zealand using a three-day weighed food record and has indicated the mean intake was 2502±957 mg/day, where most patients exceeded the recommended daily intake. Moreover, sodium has been shown to be positively correlated with energy intake (Xie et al., 2018).

In addition to results related to sodium intake, results of this study also indicated that 5% of patients met their recommendation of energy, 9% met their recommendation for protein (<=1.2g/kg), and that the majority of patients did not meet their recommendations of fibre (Xie et al., 2018).

To assess the awareness about sodium intake among HD patients, a descriptive correlational study was carried out among 114 patients and found that 47% were not aware about their recommended sodium intake, with higher knowledge among older patients and among patients who have been undergoing HD for more years. Moreover, more than a third of the patients did not believe or are unsure that salt was related to high BP or fluid gain. About 37% of the patients indicated that they were not educated about reducing their salt intake (Kauric-Klein, 2020).

2.1.9 Fluid

Fluid management for HD patients is an essential component in the management of the patients' health status (Canaud et al., 2019). Research has shown that higher weight gain between two HD sessions is associated with higher death rates (Kalantar-Zadeh et al., 2015). To properly manage the fluid homeostasis of a HD patients, both fluid and sodium imbalances should be considered; this requires dietary control of salt and fluid intake as well as controlling salt and fluid removal by dialysis (Canaud et al., 2019). Educating HD patients about fluid restriction has been shown significant improvements (Ramezani et al., 2018).

While fluid restriction has been shown to have a positive impact on the health of HD patients, it is suggested that this restriction should be accompanied with optimal nutrient and food intake (Kalantar-Zadeh et al., 2015).

Although restoring fluid and salt homeostasis has been shown to achieve better clinical outcomes, especially on the patient's cardiovascular health, excessive fluid removal has been shown to be linked to adverse cardiovascular events and higher possibility for organ damage (Canaud et al., 2019).

Recent research by Canaud et al (2019) indicated that the management of fluid status requires careful assessment and monitoring including clinical assessment, cardiac biomarkers, algorithm and sodium modeling, and non-invasive instrumental tools (Canaud et al., 2019). Moreover, recent technology on HD machines allows accurate and personalized fluid and sodium management through using feedback control tools and biosensors which is thought to achieve better homeostasis as well as better cardiovascular health for HD patients compared to only considering 'dry weight' method (Canaud et al., 2019).

2.1.10 Malnutrition

Protein-Energy Wasting (PEW) is known as the "depletion of protein/energy stores" and is frequent among later stages of CKD (Sabatino et al., 2017). PEW is associated with higher morbidity and/or mortality rates (Abdalla et al., 2016) (Sabatino et al., 2017) (de Mutsert et al., 2009), unfavorable outcomes (Sabatino et al., 2017), and higher healthcare cost (Sabatino et al., 2017).

Non-iatrogenic reasons for malnutrition are usually associated with dietary inadequacy, loss of appetite, dietary quality, and/or dietary inadequacy due to financial or psychosocial reasons (Sahathevan et al., 2020). Similar factors that play a role in the development of protein-energy wasting among HD patients were indicated in a study by Sabatino et al (2017), including decreased nutrient intake, reduced appetite, and muscle mass metabolism (Sabatino et al., 2017). In addition to PEM, published research indicated the existence of several other nutrition associated health problems related to nutrition among HD patients including anemia (Amjad et al., 2021) (Indrarini et al., 2019) (Abdelkarim et al., 2020), osteodystrophy (Seyedzadeh et al.,

2022) (Buargub et al., 2006) (Karavetian et al., 2015), fluid imbalances (Canaud et al., 2019) (Ohashi et al., 2018), and nutrient deficiencies (Shimizu et al., 2020) (Hsu et al., 2020).

In Palestine, a study by Badrasawi et al. (2021) was conducted to estimate malnutrition levels among HD patients at Hebron Governmental Hospital and to determine the associated factors with malnutrition. It was found that the prevalence of high-risk malnutrition is 45.4% and was significantly associated with profession, walking, HD complications, and HD side effects (Badrasawi et al., 2021). Results from a different study indicate that the risk of malnutrition among HD patients was 71.4% and was higher among female patients. The mean BMI±SD was 28.2 ± 6.3 kg/m^2.

Proper and continuous nutrition assessment is essential in protein-energy wasting treatment and prevention (Sabatino et al., 2017). Assessing the reason for malnutrition among HD patients is of a great importance to provide personalized nutrition intervention that is suitable for the patient's individualized needs (Sahathevan et al., 2020).

SGA is usually used to assess PEM among HD patients (de Mutsert et al., 2009) (Sabatino et al., 2017) (Beer et al., 2018). In a study by Hassanin et al (2021), comparing the prevalence of malnutrition among HD patients using different scores; BMI and Dialysis Malnutrition Score (DMS) were compared to the Subjective Global Assessment (SGA) in assessing malnutrition among these patients. DMS results matched the diagnostic results of malnutrition and showed acceptable sensitivity and specificity, BMI results of malnutrition, however, did not match the diagnostic results of malnutrition which indicated that BMI is not a valid tool for diagnosing malnutrition (Hassanin et al., 2021).

2.1.11 Kidney replacement therapy

The judgment on what type of kidney replacement therapy the patient should choose depends on the patient's physical, lifestyle and psychological conditions (Mitra et al., 2020). Determining when to start dialysis is made based on Kt/V, malnutrition, severe high serum potassium, acute pulmonary edema, acidosis, BUN, and serum creatinine level (Mitra et al., 2020). Kidney replacement therapy types are kidney transplant, peritoneal dialysis, or HD (Mitra et al., 2020).

Chapter 3: Conceptual framework

The conceptual framework presented in figure (1) below shows the link between the different variables included in this study. The patient's sociodemographic information, weight, height, and dietary habits are major variables that play a role in the dietary intake of HD patients and the serum levels of selected biomarkers that are linked to HD patients' health status which were assessed in this study. Lifestyle factors and dietary habits also play a role in the nutrition status of HD patients. BMI, interest in health and nutrition relationship, willingness to make dietary changes, and self-health rating all affect the final result of the intervention in terms of dietary intake and biomarkers.

1-Sociodemographic factors, weight, height, and dietary habits: It is assumed that there are several factors that influence the dietary intake of HD patients and their biomarker levels. Sociodemographic factors, including age, gender, education levels, and employment status, are considered one of the main factors affecting the intake of the HD patients and their lab tests. Patient's weights and heights, i.e., BMI, also impact the nutrition intake of HD patients and were considered in this intervention study. HD patients' dietary habits and nutrition intake also directly influences their nutrition intake and biomarker levels; both factors were taken into account in this study.

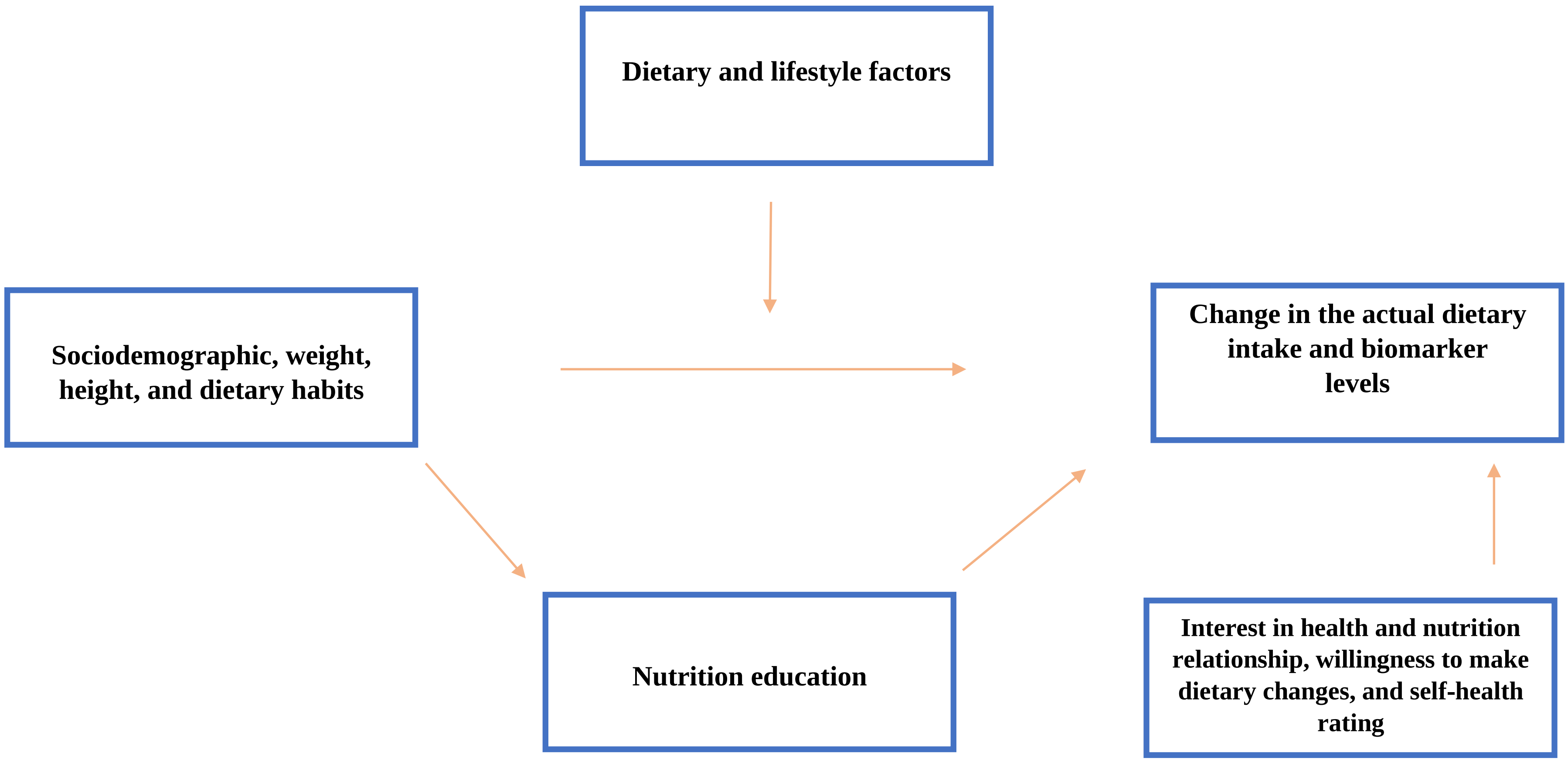
2-Dietary and lifestyle factors: In addition to the variables stated above, other variables are thought to have an effect on the dietary intake and biomarkers levels of HD patients. Dietary and lifestyle factors, such as reading the food labels were considered in this study.

3-Nutrition education: one to one nutrition education that targets the individualized needs of the patient was considered and implemented in this study. When providing the nutrition plans, each patient was educated about all aspects related to the plan and contents its contents to ensure providing the patients with better nutrition education related to their health status as well as better adherence to the meal plans.

4-Interest in health and nutrition relationship, willingness to make dietary changes, and self-health rating: there are other factors that affect the dietary intake and biomarker levels of HD patients and were assessed pre-intervention, but were not assessed pre-intervention, including patient's interest in health and nutrition relationship, willingness to make dietary changes, and self-health rating.

5- Change in the actual dietary intake and biomarker levels: The two main variables that affect the health status of HD patients are dietary intake and biomarker levels. Both variables were assessed pre-and post-intervention in this study.

Figure 1: the conceptual framework of this study



Chapter 4: Methodology

4.1 Study Design

The study design was divided into two phases to achieve the research objectives and hypothesis as follows:

Phase I: observational study design approach

A cross-sectional study design was used in the assessment of health and nutrition status of HD patients

Phase II: intervention study design approach

Following the cross-sectional study design, an interventional study design was used to apply the nutrition intervention program by recruiting participants from a clinical setting. The interventional part of the study developed a nutrition intervention by planning tailored menus for HD patients at PMC to manage their nutrient intakes and assess the improvement in the intake of selected nutrients and biomarkers.

4.2 Study Population

The study population is male and female HD patients aged 18 years and above who are admitted to nephrology department at PMC in Ramallah and have been on regular HD for at least the past 6 months.

4.3 Setting

The study was conducted at PMC in Ramallah, which is one of the main governmental hospitals in the West Bank that provides HD for ESRD patients. The campus was selected based on the MOH recommendations and is one of the main HD centres that includes the majority of CKD patients in the central West Bank.

4.4 Sample Frame

The sample frame is composed of 180 ESRD male and female patients admitted to nephrology department at PMC in Ramallah who have been on regular HD for at least 6 months. This is a single centred study that will only include patients from the PMC's HD unit.

4.5 Sample size calculations

The sample framework for this study is 180 ESRD patients on HD officially registered at the nephrology department at the PMC in Ramallah who met the inclusion-exclusion criteria. The sample size was based on 97% population proportion and 95% confidence level indicating the need to include 36 patients in this study. Thirteen more patients were added to compensate for any potential withdrawal and to increase homogeneity and decrease inter-individual variations. Overall, 49 patients were included in this intervention study.

4.6 Eligibility criteria

4.6.1 Inclusion criteria

All males and females having ESRD and are aged 18 years and above who were admitted to the nephrology department at PMC in Ramallah and have been on regular HD for at least 6 months at the time of the data collection. Patients with one or more of following associated diseases were included in this study: diabetes, hypertension, cardiovascular diseases, and urinary tract infection.

4.6.2 Exclusion criteria

CKD patients admitted to the nephrology department at PMC in the same time period but are not on regular HD. Patients who are aged less than 18 years were excluded. Any ESRD patient who is undergoing another type of dialysis was excluded as well. Patients who have liver cirrhosis, end stage liver disease, cancer, arthritis, or autoimmune diseases were excluded.

4.7 Pre-Intervention

To design the intervention plan, a comprehensive set of data was collected prior to building the plan to ensure providing the best possible plan for each patient, personalized according to their health indicators, health plans, and daily lifestyles. Personalizing diet plans is essential and ensures higher adherence rate. A questionnaire was first used to assess the socio demographic information, medical history, educational level, nutrition attitudes, and diagnosis date for each patient. Moreover, anthropometric measurements were collected at baseline to build the nutrition intervention plan according to these measurements. The same measurements were collected again after the intervention period of 3 months to assess the results of the intervention in terms of body weight. All the above-mentioned tools are described in detail in the sections below. Selected biomarkers, mentioned in detail in the subsequent section, were collected and used in preparing the diet plans considering individual differences and were later used to assess the change by comparing the results of these indicators before the intervention with the results of the same indicators after the intervention. To assess the dietary intake, 24-hour recalls were used; further details are described in the subsequent section. Since SGA is considered the golden standard for malnutrition assessment (*Subjective Global Assessment (SGA) - Diagnosing Malnutrition*, n.d.), the tool was used to assess malnutrition among HD patients by asking a set of standard questions at baseline.

4.7.1 Study tools

4.7.1.1 The nutrition intervention assessment criteria

1. **Health and Nutrition Assessment:** The previously validated HBSC questionnaire was used to collect data from patients including sociodemographic, medical, lifestyle, and attitudes towards nutrition. The questionnaire was previously translated from English to Arabic and back translated again and was tested for validity after the translation. Furthermore, the questionnaire was piloted before conducting the data collection to insure its validity and reliability among the targeted population.

The questionnaire included sociodemographic information, medical history, nutrition attitudes, nutrition labels, source of nutrition information, and diagnosis date. Previous research has shown that collecting dietary data apart from the 24-hour recalls is important for better assessment and therefore better plan the nutrition intervention (Ikizler et al., 2020). This might include data such as nutrition knowledge, attitudes, and beliefs, which were all collected in the questionnaire used in this study.

The data collection was conducted by a trained dietitian and was performed by one-to-one interview at the HD centre in PMC.

2. Dietary Intake Assessment: a 24-hour recall was used to assess the nutrient intake of each patient and to ensure that the provided diet suits the patient's lifestyle and preferences; this assures better adherence to the diet plan. Three 24-hour recalls were collected before the intervention and three 24-hour recalls were collected after the intervention to assess the effect of the conducted nutrition intervention on patients' health when compared with previous results. One of the recalls was conducted on a weekend and two recalls were carried out on working (week) days.

The 24-hour recalls were collected using the USDA Multiple-Pass Method (MPM). MPM uses a 5-step multiple-pass approach; in the first step is unstructured where the interviewer asks the patient to list the foods and beverages consumed in the last 24-hours without any interruption from the interviewer, in the following 3 steps a structured approach is used to help the patient in remembering more of his/her consumption, and the last step is also unstructured and allows the patient to finally probe his/her consumption (Steinfeldt et al., 2013). All details regarding the consumed foods were obtained for each consumed food item, meal, and drink. Cooking methods, food brands, recipes, and ingredients were obtained for the consumed foods and meals. The dietitian probed questions regarding the items that are usually consumed together when one item was mentioned. Time of meal consumption, the type of the meal, and the location of consumption was also collected. The food and recipes consumptions were quantified using the Palestinian Food Atlas that includes the food and recipes weights and servings. Patients' food intake was analysed using the MEDACINS software for nutrient analysis, which analyses the food intakes into 80+ nutrients.

3. Subjective Global Assessment (SGA): this is a globally used tool to assess malnutrition among CKD patients on HD and is considered the gold standard for malnutrition assessment. A study by (Enia et al., 1993) indicated that the SGA provides a suitable and clinically adequate assessment of the nutritional status of dialysis patients. One of the major benefits of using SGA is that it’s an inexpensive, yet reliable method for nutritional assessment of CKD patients on HD. SGA is recommended especially for regular assessment of the nutritional status of dialysis patients. Another study conducted in Jordan, signified that SGA is a suitable measure to evaluate malnutrition among HD patients in Jordan when compared to assessing malnutrition by anthropometric and biochemical measurements (Tayyem & Mrayyan, 2008). SGA was also used in a study in Palestine to assess the nutrition status of HD patients and was conducted twice, pre and post intervention, by a trained dietitian, to assess the level of improvement in malnutrition among the patients (Rezeq et al., 2018). SGA is a validated tool but has been tested for reliability in this study before it was conducted on the participating patients.

4. Lab tests and biomarkers: Lab tests and biomarkers were collected from the patients’ medical records for all study participants. Lab tests are conducted monthly at PMC for all patients on HD to assess their health status and to tailor their treatment and medicine according to the change in the results of the tested biomarkers. Likely, dietary planning for HD patients should consider the results of the lab tests and tailore the food plan micronutrient content according to the monthly results of the essential biomarkers. Baseline lab results were collected prior to the intervention and recollected in each subsequent month of the intervention. Baseline and subsequent lab results were recorded to assess intervention results.

As stated before, to assess the health status of HD patients several biomarkers are considered providing an insight of the monthly status of the patients. In this study, to assess the monthly dietary intake of patients, biomarkers were collected monthly and compared to previous lab test results. According to literature, there are several essential biomarkers that are important to consider in the assessment for HD patients' health; serum potassium, sodium, calcium, phosphorus, albumin, and total protein, HbA1C, serum creatinine, blood urea nitrogen (BUN), Haemoglobin, iron saturation, Ferritin, albumin, parathyroid hormone (PTH), and GFR (*Module 7 – Understanding Kidney Lab Tests*, 2012). In this study, the main biomarkers that were used are serum potassium, phosphorus, and sodium.

5. Anthropometric Data: In this study the body weight and height were collected pre-intervention to assess the nutrition status of the patients, calculate BMI, and to aid in estimating energy requirements. Anthropometric data were then collected again post intervention period of 3 months to compare post-intervention data with the initial readings. All measurements were taken by a trained dietitian.

To measure the weight, the "Seca 699" scale was used which was available at PMC's HD unit. To measure patients' heights, a tape measure was used and was placed on a straight wall and a ruler was used to mark the height from the top of the patient's head to the wall. Waist and hip circumferences were measured using a circular tape and the measured area for the waist circumference was just above the belly button while the hip circumference was measured from the widest area of the hip with the same tape. They measurements were collected while assuring that the patients are wearing the lightest available clothes and the measurement was taken with direct contact with the patient's clothes. The waist and hip circumference measurement were then used to calculate the waist to hip circumference ratio and the weight and height measurements were used to calculate the BMI.

The CDC's BMI classifications (*Defining Adult Overweight & Obesity | Overweight & Obesity | CDC*, n.d.) were used in classifying the weight status of the patients in which is classified as follows:

- BMI <18.5: underweight
- BMI 18.5 to <25: healthy weight
- BMI 25.0 to <30: overweight
- BMI 30.0 or more: obese

4.8 Intervention Implementation

To implement the intervention, several factors have been considered to provide a personalized nutrition intervention plan for each HD patient as described before. Dietary practices, medical history, and biomarkers mainly serum potassium, sodium, and phosphorus were considered to build the diet plans for each patient. The results of the above-mentioned biomarkers were also considered during the period of 3 months of continuous reassessment, where the results were used to build new diet plans that are consistent with the change in biomarkers.

The intervention consisted of several detailed meal plans provided for each patient. The initial diet plan and the subsequent diet plans followed the methodology described in this section and were validated by national and international clinical nutrition experts to ensure providing a suitable plan. The meal plans were uploaded on the MEDACINES software, which is a food composition database that includes the Palestinian meals and food items, to ensure meeting the correct cut-off points for potassium, sodium, phosphorus, carbohydrates, proteins, fat, and calories. Detailed description of the used cut-off points is described in the subsequent sections.

The nutrition intervention period was 3 months; each patient was followed for a total of 3 months during the intervention and was provided with a detailed diet plan that suits each patient's medical needs and designed in a way that matches their daily lifestyles. When the diet plans were provided, a detailed explanation of how to follow the diet plan was given for each patient individually by the dietitian, and all their questions and concerns were answered. Moreover, daily follow up for any needed questions and explanations was provided by the dietitian during the intervention period for each patient individually. Further details on the study tools and instruments are discussed in the subsequent section.

4.8.1.1 The nutrition intervention implementation criteria

The nutrition intervention program was designed to meet the criteria and nutrition recommendations of HD patients and provide a dietary intervention plan to control three major micro-nutrients that affect HD patients' health: sodium, potassium, and phosphorus. The program was designed and developed by a dietitian and was then validated by an international expert in the field of HD clinical nutrition. The diet was then reviewed by another dietitian to check the numbers and food items included in the plans. To assure that the diet plan met the individual recommendations (in terms of calculated amounts and numbers) of energy, micronutrients, and macronutrients, all meals and food items included in the plan were inserted to the MEDACINES software (described previously). These diet plans were designed in accordance with the international standards and guidelines for HD patients to assure meeting and/or limiting the specified requirements of macro and micronutrients (Yang & He, 2020)(Ikizler et al., 2020). The nutrition intervention criteria that were used are described in table (1) below, while the cut-off values of the lab results and biomarkers is described in table (2).

4.8.1.2 Determining caloric requirements and macronutrient needs

Several elements should be considered when preparing individualized diet plans. In this study BMI was calculated to classify the patients' weight status and was used along with energy requirements based on the KDOQI recommendation of 25 - 35 kcal/kg/day for HD patients (Ikizler et al., 2020) to build the diet plans. Continuous monitoring of patients to ensure that they are meeting their caloric requirements is essential (Ikizler et al., 2020) and was carried out on continuous basis in this intervention study.

4.8.1.3 Micronutrients and electrolyte intake

While previous evidence has shown that HD patients may be at risk of insufficient micronutrient intake, adequate intake of micronutrients are important for metabolic functions. Electrolyte intake among HD patients is of great concern for its role in the health maintenance of HD patients (Mitra et al., 2020). While some electrolytes, such as calcium and vitamin D are usually deficit among HD patients and thus supplemented in many cases, other electrolytes such as potassium and phosphorus should be limited or provided in certain amounts to prevent health complications (Mitra et al., 2020).

4.8.1.4 Dietary requirements recommendations for HD patients

The dietary recommendation for CKD patients on HD was searched through the literature, and the used recommendations for this study are described in the table below. Mainly, the recommendations by KDOQI Clinical Practice Guideline For Nutrition In CKD, and the Chronic Kidney Disease Diagnosis and Treatment book were used in the intervention plan (Ikizler et al., 2020)(Yang & He, 2020). Individualized plans were prepared for patients using the recommendations below.

Table 1: The dietary recommendations for CKD patients undergoing HD

Dietary recommendations for CKD patients undergoing HD	
Nutrient/Energy	**Recommendation**
Resting Energy Expenditure (REE)	If indirect calorimetry is not available, it is recommended to use disease-specific predictive energy equations to approximate REE which consider factors that affect the metabolic rate among HD patients (Ikizler et al., 2020).
Energy (kcal/kg body weight)	Energy recommendations for metabolically stable HD Patients is 25 - 35 kcal/kg/day. Age, gender, weight goals, body composition, CKD stage, physical activity, and diseases/inflammation are considered when determining energy recommendations for patients (Ikizler et al., 2020).
Protein (g/kg body weight)	-Protein recommendations for metabolically stable HD Patients ***who don't have diabetes*** is 1.0 - 1.2 g/kg/day. -Protein recommendations for HD Patients ***who have diabetes*** is 1.0 - 1.2 g/kg/day. If the patient is at risk of either hypoglycaemia or hyperglycaemia, higher protein may be provided (Ikizler et al., 2020).
Fat (% of total kcal/day)	It is recommended that the fat intake is 25-35% of the total daily energy requirements, of which 10% are from saturated fat (Yang & He, 2020).
Fluid (mL/day)	500 ml plus the previous day's urine output (NHS, 2018)
Sodium (g/day)	It is recommended to limit sodium to below 100 mmol/d (or <2.3 g/d). Limiting sodium is essential to prevent an increase in blood pressure, proteinuria, and control volume (Ikizler et al., 2020).

Potassium (g/day)	According to KDOQI, dietary potassium should be adjusted to maintain normal serum potassium levels. According to (Yang & He, 2020) limiting dietary potassium to 3 g/day is recommended for patients at risk of hyperkalaemia, while considering resolving factors other than the dietary intake that might be leading to high serum potassium levels. When limiting dietary potassium, fruits and vegetables intake (and fiber content) should be considered to avoid low consumption.
Calcium (mg/day)	For moderate to advanced CKD patients, elemental calcium range of 800 - 1000 mg is recommended from all dietary and medical sources (Yang & He, 2020).
Phosphorus (mg/day)	According to KDOQI recommendations, dietary phosphorus should be adjusted to maintain normal serum phosphorus levels, while considering the bioavailability of the dietary phosphorus source (Ikizler et al., 2020). According to (Yang & He, 2020), iindividualized approach should be considered for each person depending on the case. It is recommended to restrict dietary phosphorus to below 800 mg/day for patients having moderate-to-advanced CKD. If the patient is a stage 5 CKD patient on HD or is at risk of wasting, excessive restriction of protein to control high phosphorus levels should be avoided (Yang & He, 2020).

Table 2: the normal range of biomarkers for ESRD patients

To assess the status of HD patients' lab results, the ranges for biomarkers were determined to be normal or abnormal according to the ranges used at the PMC. The normal ranges are described in table (2) below.

Normal range of biomarkers for ESRD patients	
Lab result	**Normal range for HD patients**
Serum potassium (mg/dl)	3.5 to 5.3
Sodium (mg/dl)	135 to 145
Calcium (mg/dl)	8.8 to 10.2
Phosphorus (mg/dl)	1.5 to 6.8
Total protein (gm/dl)	6 - 8.5 (*Nephron Information Center*, n.d.)
Serum creatinine (mg/dl)	0.5 to 0.9
Blood urea nitrogen (mg/dl)	8 to 23
Haemoglobin (g/dl)	M: 13.5 to 17, F: 12 to 16
Ferritin (ng/ml)	Dialysis normal=200-500 (Nephron Information Center, n.d.)
Parathyroid hormone (pg/ml)	15 to 68
GFR (mL/min/1.73 m^2)	More than 90, with little or no protein or albumin in urine (*Understanding Your Lab Work - DaVita*, n.d.)

4.9 Post-intervention assessment

4.9.1.1 The nutrition assessment iintervention criteria

Post intervention measurements were conducted to assess the nutritional status of patients after receiving the intervention. Post intervention evaluation was done using the pre-intervention nutrition biomarkers and lab results and comparing them to the result post-intervention to assess how these biomedical markers have changed during the period of 3 months. In addition, anthropometric measurements were conducted to measure the change in the BMI for all patients and assess how weights have changed during the implementation period, especially for patients requiring an improvement in weights; whether to increase or decrease their weight. In addition, three 24-hour recalls were also conducted and compared with the pre-assessment measurements.

4.10 Scientific rigor

4.10.1 Validity

All the tools that will be used in this study are validated tools and wouldn't require any additional validation. The MPM 24-hour recall is developed by the USDA and is widely used. The SGA is also widely used to assess malnutrition and has been previously used nationally and is widely used internationally. The biomedical data is acquired from the hospital and doesn't require any validation. The anthropometric measurements do not require any validation. Finally, after the development of diet plans, they were validated by an international expert in the field of renal dietary planning. The diet was then reviewed by another dietitian to check the numbers and food items included in the plans. To assure that the diet plan met the individual recommendations (in terms of calculated amounts and numbers) of energy, micronutrients, and macronutrients, all meals and food items included in the plan were inserted to the MEDACINES software. Reliability: The reliability was tested for the SGA.

4.11 Ethics considerations and confidentiality

The research committee at the Faculty of Public Health at Al Quds University will evaluate the proposal for this study considering the ethical issues associated with conducting this research. Approval will be obtained from the committee before the implementation of this study. An approval from Al Quds University Institutional Review Board (IRB) will be acquired for performing this research. A consent form will be distributed to all study participants before they are being employed to participate in the study. The consent form will clearly describe the goal and objectives of the study and participants will be informed about the course of the study and what they should expect as a participant of such research. Only participants who sign the form will be employed in the study. The Palestinian Ministry of Health should also approve conducting this research at the Palestine Medical Complex.

4.12 Data management and statistical analysis

The collected data was documented and analysed using SPSS version 23. Descriptive analysis using the means and frequencies were conducted, and inferential analysis was performed. The continuous pre- and post-intervention model variables will be assessed using independent sample t-test. Most results are quantitative variables that will be statistically analysed as pre- and post-intervention. These variables include the serum potassium, sodium, and phosphorus, and dietary potassium, sodium, and phosphorus.

Chapter 5: Results

To describe the sample and to assess the results of the dietary intervention, several analysis methods were used. Descriptive analysis using means, standard deviations, and frequencies was conducted, and inferential analysis was also performed. Descriptive analysis was mostly conducted for the demographic data, nutrition knowledge and attitudes, diseases, and BMI for the study sample. The results analysed as pre- and post-intervention using paired sample T-test. The analysis includes the biomarkers and 24-h recall nutrient parameters of potassium, sodium, and phosphorus, as well as macronutrient dietary content of the patient's food analysed from the 24-hour recalls. In the last section, the most consumed items among patients pre-and post-intervention were reported, in addition the food items contributing to the highest intake of phosphorus, potassium and sodium among participants pre-and post-intervention.

5. 1 Sociodemographic Analysis

Results in table (3) shows the descriptive analysis of the study participants demographic information by gender. Table (3) indicates the demographic distribution of the HD patients in this intervention study, in which males represented 61.2% of the sample, while females represented 38.8%. About half of the patients are aged between 40-59 years and 25.5% are aged between 20-39 years while 22.4% were aged 60 years or higher, and most of the sample was married while only 24.5% were single. The majority (67.3%) of the patients lived in rural areas of Ramallah and El-Bireh governorate while 32.7% lived in urban areas of the same governorate. In addition, a 71.4% of participants were unemployed, while only 28.6% were employed at the time of the study. Furthermore, 71.4% had completed an education level up to high school, while

28.6% completed their studying beyond high school. Employment was significantly correlated with gender (*p*: 0.026).

Table 3: participants distribution by gender

	Female n(%)	**Male n(%)**	**Total n(%)**	***p*-value**
Locality				
Urban	7.00(36.84)	9.00 (30.00)	16.00 (32.65)	0.619
Rural	12.00 (63.16)	21.00 (70.00)	33.00 (67.35)	
Age (Years)				
20-39	7.00 (36.84)	6.00 (20.00)	13.00 (26.53)	0.060
40-59	11.00 (57.89)	14.00 (46.67)	25.00 (51.02)	
>60	1.00 (5.26)	10.00 (33.33)	11.00 (22.45)	
Education Level				
Up to high school	14.00 (73.68)	21.00 (70.00)	35.00 (71.40)	0.781
Higher than high school	5.00 (26.32)	9.00 (30.00)	14.00 (28.60)	
Marital status				
Single	7.00 (36.84)	5.00 (16.67)	12.00 (24.50)	0.110
Married	12.00 (63.16)	25(83.33)	37(75.50)	
Employment status				
Yes	2.00 (10.50)	12(40.00)	14 (28.60)	0.026
No	17.00 (89.50)	18(60.00)	35(71.40)	

Patients were asked regarding their interest in the relationship between nutrition and health. As shown in table (4), about 59.2% of patients indicated that they are interested in the relationship between nutrition and health, while 40.8% were not interested in the health-nutrition connection, where male reported higher interest rate than female. When patients were asked whether they are influenced by (follow) nutrition advice when they are provided, about 78% indicated that their eating habits were influenced by health advice compared with 22% who indicated that they were not influenced by such advice, whether in the form of general advice from a dietitian, posters, handouts, internet, etc. Moreover, only one patient followed a diet plan to lose weight. Additionally, almost 45% of patients perceived their health as “good”, and almost 33% perceive their health as “very good”.

Table 4: the distribution of study participants indicated by their interest in the relationship between nutrition and health, how much their eating habits are influenced by dietary recommendation, and their self-health ratings.

	Female n(%)	**Male n(%)**	**Total n(%)**	***p*-value**
Influence of Health Advice on Eating Habits				
No	4.00 (21.05)	7.00 (23.33)	11.00 (22.45)	0.852
Yes	15.00 (78.95)	23.00 (76.67)	38.00 (77.55)	
Interest in Nutrition and Health Relationship				
No	9.00 (47.37)	11.00 (36.67)	20.00 (40.82)	0.458
Yes	10.00 (52.63)	19.00 (63.33)	29.00 (59.18)	
Health Rating				
Excellent	2.00 (10.50)	5.00 (16.70)	7.00 (14.30)	0.292
Very good	8.00 (42.10)	8.00 (26.70)	16.00 (32.70)	
Good	9.00 (47.40)	13.00 (43.30)	22.00 (44.90)	
Poor	0.00 (0.00)	4.00 (13.30)	4.00 (8.20)	

To understand HD patients' attitudes towards nutrition, they were asked whether they check nutrition food labels and if so what exact macro and/or micronutrient they check. Table (5) shows that the majority of the patients do not check the major macro and micronutrient content of their purchased foods. Although the majority of HD patients do not check major nutrient content of the food items that they eat, higher percentages were found among those who check micronutrient related to HD than other macronutrients. For instance, only 22.4% of the patients checked energy, total fat, saturated fat, and cholesterol, and only about 10% checked carbohydrate levels. About 29% of the HD patients check sodium content, 33% check phosphorus levels, and 35% check potassium levels. Mostly, female reported higher attention to food labels than male.

Table 5: the food label nutrients checked by study participants shown by males and females

		Female n(%)	Male n(%)	Total n(%)	***p*-value**
Energy (kcal)	**Yes**	7.00(36.80)	4(13.30)	11.00 (22.40)	0.055
	No	12.00 (63.20)	26(86.70)	38.00 (77.60)	
Total fat	**Yes**	6.00 (31.60)	5(16.70)	11.00 (22.40)	0.223
	No	13.00 (68.40)	25(83.30)	38.00 (77.60)	
Saturated fat	**Yes**	6.00 (31.60)	5(16.70)	11.00 (22.40)	0.223
	No	13.00 (68.40)	25(83.30)	38.00 (77.60)	
Cholesterol	**Yes**	6.00 (31.60)	5.00 (16.70)	11.00 (22.40)	0.223
	No	13.00 (68.40)	25.00 (83.30)	38.00 (77.60)	
Carbohydrates	**Yes**	17.00 (89.50)	27.00 (90.00)	44.00 (89.80)	0.953
	No	2.00 (10.50)	3.00 (10.00)	5.00 (10.20)	
Salt/sodium	**Yes**	8.00 (42.10)	6.00 (20.00)	14.00 (28.60)	0.095
	No	11.00 (57.90)	24.00 (80.00)	35.00 (71.40)	
Phosphorus	**Yes**	7.00 (36.80)	9.00 (30.00)	16.00 (32.70)	0.619
	No	12.00 (63.20)	21.00 (70.00)	33.00 (67.30)	
Potassium	**Yes**	8.00 (42.10)	9.00 (30.00)	17.00 (34.70)	0.386
	No	11.00 (57.90)	21.00 (70.00)	32.00 (65.30)	

When patients were asked about their intake of nutritional supplements, the majority of the patients (85.7%) indicated that they take nutritional supplements, while 14.3% indicated that they do not take any nutrition supplements.

To assess participants weight status, the BMI was measured for patients pre and post dietary intervention. Results in table (6) indicated that more than half of the patients are either overweight or obese pre and post intervention (24.5% and 32.8%; 26.5% and 30.6%), respectively, and that there was a minor difference in the mean BMI pre and post intervention.

Table 6: BMI categories of HD patients pre- and post-intervention

Variable	Pre-intervention	Post-intervention
BMI	**Mean±SD**	
	27.36±5.59	27.32±5.6
BMI categories	**n(%)**	
Normal	21.00 (42.90)	21.00 (42.90)
Overweight	12.00 (24.50)	13.00 (26.50)
Obese	16.00 (32.70)	15.00 (30.60)
Total	49.00 (100.00)	49.00 (100.00)

To assess participants malnourishment status, the SGA was measured for patients pre and post dietary intervention. Results in table (7) indicated that the majority of the patients are well-nourished (75.50%), and the mean SGA score among the intervention patients is 5.98±0.83.

Table 7: SGA results among study participants pre intervention by gender

Variable	Male	Female	Total
SGA	**Mean±SD**		
	5.98±0.83		
SGA categories	**n(%)**		
Moderately malnourished	9.00(30.00)	3.00(15.80)	12.00(24.50)
Well-nourished	21.00(70.00)	16.00(84.20)	37.00(75.50)

It is important to note that the mean caloric intake pre-intervention was 1792.40±518.71 kcal/day and has decrease to 1602.97±417.14 kcal/day post-intervention. The mean carbohydrate intake decreased from 237.24±79.62 g/day pre-intervention to 218.43±53.42 g/day post-intervention. Protein intake has also decreased from 65.18±23.36 g/day pre-intervention to 58.94±20.34 g/day post-intervention. Lastly, fat intake decreased from 67.56±19.91g/day pre-intervention to 56.04±19.86g/day post-intervention

5. 2 Nutrition intervention assessment analysis

The section below describes the phosphorus, potassium, and sodium dietary content for the participants in this study based on 24-hour recall analysis. Dietary content was obtained from the patients pre- and post- intervention using three 24-hour recalls collected before applying the intervention and three more 24-hour recalls received from the patients after applying the dietary intervention. Table 5 below shows the dietary mean and standard deviation of phosphorus, potassium, and sodium content of the participants analyzed by gender, residency, age, education levels, interest in nutrition and health relationship, and influence of health advice on eating habits. Males had higher mean intake of the selected micronutrients pre intervention (Phosphorus: 871.7±426 mg/day, Potassium:1822.3±765.8 mg/day, and Sodium: 2680.3±774.5 mg/day) compared to females (Phosphorus: 680.1±222.3 mg/day, Potassium:1554.6±481.8 mg/day, and Sodium: 2512.3±633 mg/day) and higher intake of phosphorus (M: 684.1±236.6 mg/day vs. F: 546.6±152.1 mg/day) and potassium (M: 1291.8±391.7 vs. F:1169.8±375.6 mg/day) post intervention compared to females and almost the same mean dietary sodium intake post intervention for males (2343.8±666.9 mg/day) and females (2344.4±846.1 mg/day). Phosphorus intake among participants post-intervention was significantly correlated with males (p: 0.029)

Patients residing in urban areas had higher pre-intervention dietary intake of phosphorus (884.3±394 mg/day), potassium (1906.5±646.9 mg/day), and sodium (2768.5±598.2 mg/day) compared to pre-intervention dietary intake of phosphorus (755.3±356.8 mg/day), potassium (1627.3±682.5 mg/day), and sodium (2540.8±770.9 mg/day) for patients residing in rural areas.

The dietary intake of phosphorus (655.3±231.8 mg/day) and potassium (1166.6±345.2 mg/day) post-intervention was higher for patients residing in rural areas compared to phosphorus (580.3±178.8 mg/day) and potassium (1282.2±404.3 mg/day) intake of patients living in urban areas, while the post-intervention dietary intake of sodium was slightly higher in patients residing in urban areas (2394.3±823.1 mg/day) compared to those residing in rural areas (2319.7±697.4 mg/day).

Comparing patients age with their dietary intake indicated that the mean phosphorus and potassium intake for patients pre and post intervention was higher among older patients. For instance, phosphorus intake pre-intervention among patients aged 20-39 years was 614.6±172.8, 814.5±317.8 mg/day among patients between 40 and 59 years, and 974.7±548.7 mg/day among those aged above 60 years, while phosphorus intake post-intervention among patients aged 20-39 years was 554.6±202, 627.9±194.6 mg/day among patients between 40 and 59 years, and 727.5±261.2 mg/day among those aged above 60 years. Likely potassium intake pre-intervention among patients aged 20-39 years was 1396.1±484.8, 1730.1±563.8 mg/day among patients between 40 and 59 years, and 2073.1±939.9 mg/day among those aged above 60 years, while potassium intake post-intervention among patients aged 20-39 years was 1193.5±425.9, 1210.2±332.7 mg/day among patients between 40 and 59 years, and 1382.8±453.3 mg/day among those aged above 60 years. Dietary sodium intake was higher among older patients pre intervention but decreased with age post intervention as described in table 6. Potassium intake among participants pre-intervention was significantly correlated with patients aged above 60 years (p: 0.047).

Patients with higher education levels reported higher intake of phosphorus (929.1±498 mg/day) and potassium (1878.2±805.7 mg/day) pre-intervention compared to those with lower education levels (phosphorus: 744.7±297.9 mg/day, potassium: 1654.7±620.3 mg/day). Patients with lower education levels, however, had higher intake of both phosphorus (643.7±230.3 mg/day) and potassium (1250.8±411.7 mg/day) post-intervention. Moreover, dietary sodium intake was higher among patients with higher education levels pre- (2699.1±778.1 mg/day) and post-intervention (2469.4±970.8 mg/day) compared to the sodium intake of patients with lower education levels pre- (2581.6±705.7 mg/day) and post-intervention (2293.9±623.6 mg/day).

Results shown in the same table describe the interest of the patients in the relationship between nutrition and health and the effect of their interest with their dietary intake of phosphorus, potassium, and sodium. As clear from the table, patients with no interest in the relationship between nutrition and health had higher pre-intervention dietary intake of phosphorus (841.89±391.19 mg/day), potassium (1856.13±713.5 mg/day), and sodium (2793.02±869.58 mg/day) as well as higher post-intervention dietary intake of phosphorus (684.05±259.55 mg/day), potassium (1275.45±473 mg/day), and sodium (2379.88±779.05 mg/day).

Patients were also asked about the influence of dietary recommendations and education on their actual eating habits. It is clear from the results described in table 7 patients who are not influenced by dietary education had higher pre-intervention dietary intake of phosphorus (825.71±385.56 mg/day), potassium (1797.76±710.77 mg/day), and sodium (2660.03±689.1 mg/day) as well as higher post-intervention dietary intake of phosphorus (735.17±294.6 mg/day), potassium (1332.64±527.98 mg/day), and sodium (2447.08±952.03 mg/day).

Table 8: mean phosphorus, potassium, and sodium dietary intake of study participants both pre and post dietary intervention indicated by gender, residency, age, education levels, interest in nutrition and health relationship, and influence of health advice on eating habits.

Variables		Phosphorus (mg/day)		Potassium (mg/day)		Sodium (mg/day)	
		Pre (Mean±SD)	Post (Mean±SD)	Pre (Mean±SD)	Post (Mean±SD)	Pre (Mean±SD)	Post (Mean±SD)
Gender	Male	871.7±426	684.1±236.6*	1822.3±765.8	1291.8±391.7	2680.3±774.5	2343.8±666.9
	Female	680.1±222.3	546.6±152.1	1554.6±481.8	1169.8±375.6	2512.3±633.1	2344.4±846.1
Residency	Urban	884.3±394	580.3±178.8	1906.5±646.9	1166.6±345.2	2768.5±598.2	2394.3±823.1
	Rural	755.3±356.8	655.3±231.8	1627.3±682.5	1282.2±404.3	2540.8±770.9	2319.7±697.4
Age	20-39 years	614.6±172.8	554.6±202	1396.1±484.8	1193.5±425.9	2286±645.9	2360.2±1015.7
	40-59 years	814.5±317.8	627.9±194.6	1730.1±563.8	1210.2±332.7	2645.3±554.5	2349.8±680.8
	above 60 years	974.7±548.7	727.5±261.2	2073.1±939.9*	1382.8±453.3	2935.7±999.7	2311.9±475.9
Education	Up to high school	744.7±297.9	643.7±230.3	1654.7±620.3	1250.8±411.7	2581.6±705.7	2293.9±623.6
	higher than high school	929.1±498	598.7±183.2	1878.2±805.7	1228.7±327.4	2699.1±778.1	2469.4±970.8
Interest in Nutrition and Health Relationship	No	841.89±391.19	684.05±259.55	1856.13±713.5	1275.45±473	2793.02±869.58	2379.88±779.05
	Yes	766.75±358.9	594.09±177.67	1623.6±646.64	1223.15±320.6	2492.49±582.65	2319.3±712.39

Influence of Health Advice on Eating Habits	**No**	825.71±385.56	735.17±294.6	1797.76±710.77	1332.64±527.98	2660.03±689.1	2447.08±952.03
	Yes	789.24±370.65	600.6±182.86	1695.57±675.43	1218.98±339.46	2602.17±738.24	2314.2±669.22
	Total	797.4±370.3	630.8±217	1718.5±677.3	1244.5±386.3	2615.2±720.8	2344±732.9

Patients who reported having iron deficiency anaemia have lower pre-intervention intake of phosphorus (763.34±280.32 mg/day), potassium (1691.69±579.42 mg/day), and sodium (2635.59±673.47) compared to phosphorus (891.81±553.25 mg/day), potassium (1792.8±920.72 mg/day), and sodium (2558.59±866.52 mg/day) dietary intake among those who do not report having iron deficiency anaemia. On the post-intervention level, patients who indicated having iron deficiency anaemia also had lower intake of phosphorus (608.15±184.59 mg/day), potassium (1207.38±356.95 mg/day), and sodium (2282.74±724.47 mg/day) compared to the intake of phosphorus (693.56±288.28 mg/day), potassium (1347.29±457.8 mg/day), and sodium (2513.75±758.58 mg/day) post intervention among patients who did not indicate having iron deficiency anaemia.

Patients who indicated having high cholesterol levels have higher pre-intervention intake of phosphorus (911.82±368.52 mg/day), potassium (1853.2±692 mg/day), and sodium (2861.54±797.66 mg/day) compared to phosphorus (756.11±367.22 mg/day), potassium (1669.87±675.14 mg/day), and sodium (2526.19±681.02 mg/day) dietary intake among those who do not indicate having high cholesterol levels. On the post-intervention level, patients indicating having high cholesterol levels also had higher intake of phosphorus (734.75±209.51 mg/day), potassium (1384.71±353.72 mg/day), and sodium (2378.15±340.12 mg/day) compared to the intake of phosphorus (593.28±209.88 mg/day), potassium (1193.87±389.58

mg/day), and sodium 2331.7±834.54 mg/day) post intervention among patients who did not indicate having high cholesterol levels.

Similarly, patients who reported type II diabetes have higher pre-intervention intake of phosphorus (926.52±495.82 mg/day), potassium (1846.11±834.63 mg/day), and sodium (2822.9±869.35 mg/day) compared to phosphorus (708.39±219.33 mg/day), potassium (1630.52±542.32 mg/day), and sodium (2471.89±570.83 mg/day) dietary intake among those who do not report having type II diabetes. On the post-intervention level, patients reporting type II diabetes also had higher intake of phosphorus (712.87±216.05 mg/day), potassium (1373.27±384.33 mg/day), and sodium (2528.22±667.1 mg/day) compared to the intake of phosphorus (574.22±202.24 mg/day), potassium (1155.69±368.13 mg/day), and sodium (2217±760.24) post intervention among patients who did not report having type II diabetes. Phosphorus intake among participants pre-intervention was significantly correlated with patients reporting type II diabetes (*p*: 0.041).

Table 9: mean phosphorus, potassium, and sodium dietary intake of study participants both pre and post dietary intervention indicated by the iron deficiency anemia, high cholesterol levels, and type II diabetes.

Variables		Phosphorus (mg/day)		Potassium (mg/day)		Sodium (mg/day)	
		Pre (Mean±SD)	Post (Mean±SD)	Pre (Mean±SD)	Post (Mean±SD)	Pre (Mean±SD)	Post (Mean±SD)
Self-reported iron deficiency anemia	No	891.81±553.25	693.56±288.28	1792.8±920.72	1347.29±457.8	2558.59±866.52	2513.75±758.58
	Yes	763.34±280.32	608.15±184.59	1691.69±579.42	1207.38±356.95	2635.59±673.47	2282.74±724.47
Self-reported high cholesterol levels	No	756.11±367.22	593.28±209.88	1669.87±675.14	1193.87±389.58	2526.19±681.02	2331.7±834.54
	Yes	911.82±368.52	734.75±209.51*	1853.2±692	1384.71±353.72	2861.54±797.66	2378.15±340.12
Self-reported type II diabetes	No	708.39±219.33	574.22±202.24	1630.52±542.32	1155.69±368.13	2471.89±570.83	2217±760.24
	Yes	926.52±495.82*	712.87±216.05*	1846.11±834.63	1373.27±384.33	2822.9±869.35	2528.22±667.1

Patients who considered energy levels on the packaged foods that they consume had lower pre and post intervention phosphorus intake (713.2±268.02 and 626.69±148.32 mg/day) compared to the pre and post intervention phosphorus intake (821.81±394.63 and 632±234.77 mg/day) among patients who did not check energy levels. Same results were found for potassium intake among patients who checked energy levels versus those who did not; lower pre and post intervention potassium intake (1637.13±614.63 and 1233.08±245.41 mg/day) was found among patients who checked energy content of their consumed foods compared to the pre and post intervention potassium intake (1742.07±700.37 and 1247.8±420.98 mg/day) among patients who did not check energy levels. Sodium intake during pre-intervention was higher among patients who did not check energy levels compared to those who did (2339.45±503.33 and 2694.97±759.27 mg/day) but was slightly lower among patients not checking energy levels.

Patients who check sodium levels in their food had lower sodium intake pre-intervention compared with those who do not (2393.52±541.27 vs. 2703.81±770.22 mg/day) as well as post-intervention compared with those who do not (2311.66±554.02 vs. 2356.97±800.26 mg/day).

Patients who check phosphorus levels in their food had lower phosphorus intake pre-intervention compared with those who do not (739.21±261.07 vs. 825.65±413.75 mg/day), however, post-intervention phosphorus levels were higher among those who check phosphorus levels on food labels compared with those who do not (664.42±231.63 vs. 614.51±211.24 mg/day).

Patients who check potassium levels in their food had lower potassium intake pre-intervention compared with those who do not (1616.15±596.84 vs.1772.9±719.51 mg/day) as well as post-intervention compared with those who do not (1169.64±401.95 vs. 1284.27±378.04 mg/day).

Table 10: mean phosphorus, potassium, and sodium dietary intake of study participants both pre and post dietary intervention indicated by checking selected macro and micronutrients on food nutrition labels.

Checking nutrients on food labels		**Phosphorus (mg/day)**		**Potassium (mg/day)**		**Sodium (mg/day)**	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
Energy (kcal)	**Yes**	713.2±268.02	626.69±148.32	1637.13±614.63	1233.08±245.41	2339.45±503.33	2349.3±446.83
	No	821.81±394.63	632±234.77	1742.07±700.37	1247.8±420.98	2694.97±759.27	2342.5±801.82
Total fat	**Yes**	724.99±266.21	668.82±155.21	1738.56±665.59	1237.67±250.66	2441.65±452.67	2465.41±470.46
	No	818.39±395.85	619.81±232.39	1712.71±689.4	1246.48±420.18	2665.38±779.22	2308.89±794.62
Saturated fat	**Yes**	724.99±266.21	668.82±155.21	1738.56±665.59	1237.67±250.66	2441.65±452.67	2465.41±470.46
	No	818.39±395.85	619.81±232.39	1712.71±689.4	1246.48±420.18	2665.38±779.22	2308.89±794.62
Cholesterol	**Yes**	724.99±266.21	668.82±155.21	1738.56±665.59	1237.67±250.66	2441.65±452.67	2465.41±470.46
	No	818.39±395.85	619.81±232.39	1712.71±689.4	1246.48±420.18	2665.38±779.22	2308.89±794.62
Carbohydrates	**Yes**	664.27±306.78	664.09±181.98	1580.61±803.91	1199.38±322.93	2292.01±504.64	2212.05±490.69
	No	812.56±376.82	627.03±222.09	1734.18±670.47	1249.63±395.7	2651.88±736.77	2359.02±758.28
Salt/sodium	**Yes**	707.45±256.83	620.75±168.51	1659.87±618.63	1135.43±304.36	2393.52±541.27	2311.66±554.02
	No	833.41±404.56	634.83±235.67	1741.97±706.65	1288.13±410.3	2703.81±770.22	2356.97±800.26
Phosphorus	**Yes**	739.21±261.07	664.42±231.63	1653.87±595.11	1196.65±398.88	2433.7±465.26	2502.39±658.15
	No	825.65±413.75	614.51±211.24	1749.85±720.44	1267.7±384.07	2703.14±808.4	2267.24±764.27
Potassium	**Yes**	716.13±270.11	647.63±234.72	1616.15±596.84	1169.64±401.95	2367.72±526.25	2454.22±667.48
	No	840.61±411.2	621.88±210.28	1772.9±719.51	1284.27±378.04	2746.61±781.17	2285.49±769.17

Patients were categorized according to their BMI as normal weights, overweight, and obese and were then compared with their intake of phosphorus, potassium, and sodium. Prior to applying the nutrition intervention, the lowest phosphorus (722.25±377.02 mg/day), potassium (1561.25±727.26 mg/day), and sodium (2478.03±693.13 mg/day) levels were among patients who had normal weights prior applying the intervention. Post-intervention results indicated that the lowest phosphorus (590.82±153.05 mg/day) and potassium (1187.86±293.94 mg/day) intakes were among overweight patients, while the lowest sodium intake was among obese patients (2229.09±690.87 mg/day).

Table 11: mean phosphorus, potassium, and sodium dietary intake of study participants both pre and post dietary intervention indicated by weight change over the past year and BMI.

Variable		**Phosphorus (mg/day)**		**Potassium (mg/day)**		**Sodium (mg/day)**	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
BMI	**Normal**	722.25±377.02	605.95±239.43	1561.25±727.26	1204.52±423.92	2478.03±693.13	2389.69±682.42
	Overweight	772.85±263.49	590.82±153.05	1780.61±446.92	1187.86±293.94	2648.51±709.35	2402.88±889.83
	Obese	914.52±418.66	700.26±227.7	1878.36±742.56	1349.55±404.41	2770.13±774.85	2229.09±690.87

Pre-intervention, patients who rated their health status as “excellent” had higher intake of phosphorus (992.57±583.88 mg/day), potassium (2050.35±884.78 mg/day), while sodium (2880.22±872.25 mg/day) was higher among patients who rated their health as “poor”.

Similar results were found among these patients' post-intervention, patients who rated their health status as "excellent" had higher intake of phosphorus (645.05±155.54 mg/day), potassium (1313.3±198.51 mg/day), while sodium (2419.87±1004.24 mg/day) was higher among patients who rated their health as "good" as indicated in table 10 below.

Table 12: mean phosphorus, potassium, and sodium dietary intake of study participants both pre and post dietary intervention indicated by their rating of their health status.

Variables		Phosphorus (mg/day)		Potassium (mg/day)		Sodium (mg/day)	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
Health Rating	**Excellent**	992.57±583.88	645.05±155.54	2050.35±884.78	1313.3±198.51	2863.57±830.37	2328.11±364.9
	Very good	832.15±330.24	624.34±176.62	1796.76±674.27	1246.98±372.72	2748.48±737.79	2293.82±390.8
	Good	726.71±338.64	643.8±262.71	1562.45±624.51	1251.74±444.25	2390.97±626.94	2419.87±1004.24
	Poor	705.94±143.9	560.34±239.13	1683.13±548.99	1074.34±426.74	2880.22±872.25	2155.57±634.01

5. 3 Nutrition Intervention Biomarkers Analysis

To assess the effect of the dietary intervention on patients' health status, several biomarkers were measured and compared pre- and post-intervention. For instance, mean serum phosphorus level increased post-intervention (6.2±1.5) comparing to pre-intervention (5.7±1.8), mean serum potassium level decreased post-intervention (5.2±0.8) comparing to pre-intervention (5.4±0.8), and mean serum sodium level decreased post-intervention (137±3.6) comparing to pre-intervention level (138.4±4.7).

The section below describes serum phosphorus, potassium, and sodium results among participants in this study which was obtained from the patients both pre- and post- intervention using. Table 12 below indicates the mean and standard deviation of serum phosphorus, potassium, and sodium levels among participants in the study analyzed by gender, residency, age, and education levels.

Both males and females had almost the same mean serum phosphorus levels (5.7±1.8) and potassium (5.4±0.8 and 5.4±0.7) pre-intervention and slightly higher mean sodium serum levels among females (138.8±7) than among males (138.2±2.6). Males had higher mean serum phosphorus levels post intervention (6.2±1.3) compared to females (6±1.7) and higher mean serum sodium levels post intervention (137.1±2.8) compared to females (136.8±4.6). Females, however, had higher serum potassium levels (5.5±0.9) compared to males (5.1±0.7).

Comparing localities, it was found that pre-intervention, patients had living in rural areas had higher serum phosphorus levels (5.8±1.7) than those living in urban areas (5.6±2) and phosphorus levels increased post intervention among patients living both in urban (6.4±1.4) and rural (6±1.5) localities. Patients living in rural areas, however, had lower potassium levels (5.3±0.7) compared to patients living in urban areas (5.6±0.9), and patients living in both localities showed a reduction in their serum potassium levels (5.2±0.6 and 5.2±0.9) post intervention. Similarly, patients living in rural areas, had lower sodium levels (139.1±2.7) compared to patients living in urban areas (138.1±5.5), and patients living in both localities showed a reduction in their serum sodium levels (137.9±3.8 and 136.6±3.5) post intervention.

Comparing patients age with their mean serum phosphorus, potassium, and sodium levels indicated that serum levels pre-intervention was lower among older patients. For instance, phosphorus intake pre-intervention among patients aged 20-39 years was 5.8±2, 5.8±1.6 among patients between 40 and 59 years, and 5.5±2 among those aged above 60 years. Likely potassium intake pre-intervention among patients aged 20-39 years was 5.4±0.6, 5.6±0.8 among patients between 40 and 59 years, and 4.9±0.7 among those aged above 60 years. Lowest mean serum sodium levels were among patients aged above 60 years (137.9±3.2), followed by patients aged between 40 and 59 years (138.1±3), and the highest levels were among ages 20- to 39-year-old patients (139.5±7.9). Post-intervention phosphorus and sodium levels were among patients aged 40–59-year-old patients; 6.4±1.3 and 137.7±3.4, respectively. Highest post-intervention potassium level was among patients aged 20-39 years. Further details are indicated in table 11 below.

Patients with higher education levels have been shown to have higher serum phosphorus (5.9±1.8) and sodium levels (140.6±7.6) pre-intervention compared to those with lower education levels (phosphorus: 5.7±1.8, sodium: 137.5±2.6). Patients with lower education levels, however, had almost similar serum levels of potassium (5.4±0.7 and 5.4±0.9) pre-intervention. Higher intake of phosphorus (6.4±1.7) was among patients with higher educational levels, while higher serum potassium (5.4±0.7) was among those with lower educational levels. Post-intervention serum sodium levels were almost the same among both groups (137±3.7 and 137±3.3). Sodium serum levels among participants pre-intervention was significantly correlated with patients who completed their degree beyond high school (P= 0.038)

Results shown in the table (13) below describe the interest of the patients in the relationship between nutrition and health and the effect of their interest with their serum phosphorus, potassium, and sodium levels. As clear from the table, patients with no interest in the relationship between nutrition and health had lower pre-intervention dietary intake of phosphorus (5.7±1.7) and lower post-intervention serum phosphorus (5.8±1.4) compared to higher pre- and post-intervention phosphorus levels (5.8±1.8 and 6.4±1.5). Although mean potassium levels were higher among patients interested in the nutrition and health relationship pre-intervention (5.5±0.8), the same group had lower serum potassium levels post-intervention (5.1±0.7).

Serum sodium results, however, were higher among the group of patients who are interested in the nutrition and health relationship both pre- (139.3±5.5) and post- dietary intervention (137.1±3.4).

Patients were also asked about the influence of dietary recommendations and education on their actual eating habits. It is clear from the results described in table 13 that patients who are influenced by dietary education had higher pre-intervention serum levels of phosphorus (5.8±1.8), lower serum potassium levels (5.4±0.8), and almost similar serum sodium levels. Post-intervention analysis indicated that patients whom eating habits are influenced by recommendation had lower serum phosphorus (6.1±1.5), potassium (5.1±0.7), and sodium (136.7±3.7) levels.

Table 13: mean serum phosphorus, potassium, and sodium among study participants both pre and post dietary intervention indicated by gender, residency, age, education levels, interest in nutrition and health relationship, and influence of health advice on eating habits.

Variables		**Phosphorus (mg/dl)**		**Potassium (mg/dl)**		**Sodium (mg/dl)**	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
Gender	**Male**	5.7±1.8	6.2±1.3	5.4±0.8	5.1±0.7	138.2±2.6	137.1±2.8
	Female	5.7±1.8	6±1.7	5.4±0.7	5.5±0.9	138.8±7	136.8±4.6
Locality	**Urban**	5.7±1.8	6.2±1.5	5.4±0.8	5.2±0.8	138.4±4.7	137±3.6
	Rural	5.6±2	6.4±1.4	5.6±0.9	5.2±0.6	139.1±2.7	137.9±3.8
Age	**20-39 years**	5.8±1.7	6±1.5	5.3±0.7	5.2±0.9	138.1±5.5	136.6±3.5
	40-59 years	5.8±2	5.9±1.7	5.4±0.6	5.5±0.9	139.5±7.9	136.5±2.4
	above 60 years	5.8±1.6	6.4±1.3	5.6±0.8	5.1±0.7	138.1±3	137.7±3.4
Education	**Up to high school**	5.5±2	6±1.4	4.9±0.7	5.3±0.9	137.9±3.2	136±4.9
	higher than high school	5.7±1.8	6±1.4	5.4±0.7	5.4±0.7	137.5±2.6	137±3.7
Interest in Nutrition and Health Relationship	**No**	5.4±1.7	6.3±1.4	5.6±0.7	5.6±1	138.6±2	137.9±3
	Yes	5.8±1.8	6.1±1.5	5.4±0.8	5.1±0.7	138.4±5.3	136.7±3.7
Influence of health advice on eating habits	**No**	5.7±1.7	5.8±1.4	5.3±0.7	5.5±0.8	137.1±2.9	136.8±4
	Yes	5.8±1.8	6.4±1.5	5.5±0.8	5.1±0.7	139.3±5.5	137.1±3.4

Patients who considered energy levels on the packaged foods that they consume had higher pre intervention phosphorus (6.425±2.096 mg/dl), potassium (5.438±1.018 mg/dl), and sodium (139.364±9.32 mg/dl) than patients who checked energy levels. Patients who check energy levels on their packaged foods still had higher serum phosphorus levels (6.144±1.232 mg/dl) compared to patients not checking energy levels. On the other hand, patients who check energy had lower serum potassium (5.176±0.847 mg/dl) and sodium (136.818±3.281 mg/dl) levels post-intervention.

Patients who check sodium levels in their food had lower serum sodium pre-intervention compared with those who do not (136.571±3.48 vs. 139.171±5.02 mg/dl) but a bit higher serum sodium levels post-intervention compared with those who do not check sodium levels on the food label (137.214±3.043 vs. 136.914±3.815 mg/dl).

Patients who check phosphorus levels in their food had higher serum phosphorus pre-intervention compared with those who do not (6.11±1.925 vs. 5.546±1.677 mg/dl), however, post-intervention serum phosphorus levels were lower among those who check phosphorus levels on food labels compared with those who do not (6.088±1.898 vs. 6.19±1.214 mg/dl).

Patients who check potassium levels in their food had lower serum potassium intake pre-intervention compared with those who do not (5.392±0.824 vs. 5.411±0.739 mg/dl) as well as lower serum potassium levels post-intervention compared with those who do not check potassium on their packaged foods (5.118±0.61 vs. 5.286±0.884 mg/dl).

Table 14: mean serum phosphorus, potassium, and sodium of study participants both pre and post dietary intervention indicated by checking selected macro and micronutrients on food nutrition labels.

Variables		**Phosphorus (mg/dl)**		**Potassium (mg/dl)**		**Sodium (mg/dl)**	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
Energy (kcal)	**Yes**	6.45±2.10	6.20±2.13	5.44±1.02	5.18±0.85	139.36±9.32	136.82±3.28
	No	5.53±1.63	6.14±1.23	5.39±0.69	5.24±0.79	138.17±2.33	137.05±3.71
Total fat	**Yes**	6.35±1.99	6.05±1.88	5.32±0.91	5.10±0.67	136.55±3.91	136.91±3.24
	No	5.55±1.68	6.19±1.34	5.43±0.72	5.27±0.83	138.97±4.874	137.03±3.72
Saturated fat	**Yes**	6.35±1.99	6.05±1.875	5.32±0.914	5.10±0.67	136.55±3.91	136.91±3.24
	No	5.55±1.68	6.19±1.34	5.43±0.72	5.27±0.83	138.97±4.87	137.03±3.72
Cholesterol	**Yes**	6.35±1.99	6.05±1.875	5.32±0.91	5.10±0.67	136.55±3.91	136.91±3.24

	No	5.55±1.68	6.19±1.34	5.43±0.72	5.27±0.83	138.97±4.87	137.03±3.72
Carbohydrates	**No**	5.69±1.76	6.16±1.44	5.37±0.71	5.25±0.80	138.46±4.91	136.93±3.71
	Yes	6.10±1.94	6.14±1.71	5.68±1.22	5.04±0.82	138.20±3.35	137.60±2.30
Salt/sodium	**Yes**	6.39±1.81	6.07±1.86	5.32±0.81	5.08±0.67	136.57±3.48	137.21±3.04
	No	5.47±1.70	6.19±1.29	5.44±0.75	5.29±0.85	139.17±5.02	136.91±3.82
Phosphorus	**Yes**	6.11±1.93	6.09±1.90	5.40±0.85	5.12±0.63	136.88±3.34	136.63±3.20
	No	5.55±1.68	6.19±1.21	5.41±0.73	5.28±0.87	139.18±5.18	137.18±3.79
Potassium	**Yes**	6.21±1.91	6.06±1.84	5.39±0.82	5.12±0.61	136.94±3.25	136.88±3.28
	No	5.47±1.65	6.21±1.23	5.41±0.74	5.29±0.88	139.22±5.25	137.06±3.79

Patients were categorized according to their BMI as normal weights, overweight, and obese and were then compared with their intake of phosphorus, potassium, and sodium. Prior to applying the nutrition intervention, the lowest phosphorus (5.659±1.629 mg/dl) and potassium (5.289±0.604 mg/dl) were among patients who had normal weights prior applying the intervention, while the lowest sodium (137.583±3.232 mg/dl) levels were among patients who had overweight. Post-intervention results indicated that the lowest serum phosphorus (5.602±1.392 mg/dl) and potassium (5.182±0.636 mg/dl) levels were among overweight patients, while the lowest sodium levels were among overweight patients (136.231±4.146 mg/dl).

Table 15: mean serum phosphorus, potassium, and sodium of study participants both pre and post dietary intervention indicated by BMI.

Variables		Phosphorus (mg/dl)		Potassium (mg/dl)		Sodium (mg/dl)	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
BMI	**Normal**	5.66±1.63	5.60±1.39	5.29±0.60	5.18±0.64	137.71±2.61	136.91±2.57
	Overweight	5.85±2.18	6.63±1.37	5.45±0.71	5.23±0.78	137.58±3.23	136.23±4.15
	Obese	5.73±1.70	6.52±1.43	5.52±0.98	5.29±1.03	140.07±7.17	137.80±4.31

Pre-intervention, patients who rated their health status as “good” had higher serum levels of phosphorus (6.13±1.79 mg/dl) and sodium (139.5±6.04 mg/dl), while patients rating their health as “poor” had higher intake of potassium (5.65±0.44 mg/dl).

Similar results were found among these patients’ post-intervention, patients who rated their health status as “poor” had higher serum phosphorus levels (6.54±1.58 mg/dl), potassium (5.73±0.36 mg/dl), while serum sodium levels were higher among patients who rated their health as “good” (137.82±3.1 mg/dl).

Table 16: mean serum phosphorus, potassium, and sodium among study participants both pre and post dietary intervention indicated by their rating of their health status.

Variables		Phosphorus (mg/dl)		Potassium (mg/dl)		Sodium (mg/dl)	
		Pre (Mean±SD)	Post (Mean±SD)	Pre (Mean±SD)	Post (Mean±SD)	Pre (Mean±SD)	Post (Mean±SD)
Health Rating	Excellent	5.45±2	6.37±1.36	5.53±1.02	5.49±0.74	138.86±2.27	136.57±2.7
	Very good	5.42±1.49	5.56±0.84	5.42±0.87	5.16±0.64	137.19±3.83	136.38±4.32
	Good	6.13±1.79	6.46±1.74	5.31±0.65	5.11±0.94	139.5±6.04	137.82±3.1
	Poor	5.26±2.48	6.54±1.58	5.65±0.44	5.73±0.36	136.75±0.96	135.75±4.57

Table (17) below shows that serum phosphorus and potassium were higher pre-intervention among patients with iron deficiency anemia and stayed almost the same post intervention, while serum sodium levels were higher among patients without iron deficiency anemia pre and post intervention. Similar results were found for patients with high cholesterol levels. On the other hand, patients with type II diabetes had lower phosphorus, potassium, and sodium serum levels.

Table 17: mean serum phosphorus, potassium, and sodium of study participants both pre and post dietary intervention indicated by self-reported iron deficiency anemia, high cholesterol levels, and type II diabetes.

Variables		**Phosphorus (mg/dl)**		**Potassium (mg/dl)**		**Sodium (mg/dl)**	
		Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
Self-reported iron deficiency anemia	**No**	5.71±1.44	6.00±1.00	5.38±0.72	5.00±1.00	138.62±2.26	138.00±4.00
	Yes	5.74±1.88	6.00±2.00	5.41±0.79	5.00±1.00	138.36±5.4	137.00±4.00
Self-reported high cholesterol levels	**No**	5.74±1.89	6.00±2.00	5.38±0.73	5.00±1.00	138.81±5.25	137.00±3.00
	Yes	5.71±1.41	6.00±1.00	5.48±0.87	5.00±1.00	137.38±2.84	136.00±4.00
Self-reported type two diabetes	**No**	5.9±1.94	6.00±2.00	5.5±0.78	5.00±1.00	139.28±5.68	138.00±3.00
	Yes	5.48±1.48	6.00±1.00	5.27±0.73	5.00±1.00	137.2±2.59	136.00±4.00

5. 4 Paired sample T-test

Table (18) below shows the 24-h recall data comparison of phosphorus, potassium, and sodium intake before and after intervention. Results of the paired sample t-test showed that the mean phosphorus intake was decreased for the post intervention with a mean decrease of +166.6mg, t: 3.4 and the change in mean is not close and has shown to be statistically significant (*p*:0.002). Similarly, mean dietary potassium intake decreased after implementing the intervention with a mean decrease of 474mg, t=5.2, and this change is highly significant (*p*<0.001). Moreover, the mean change in sodium intake post-intervention was positive, i.e., sodium intake decreased with a mean decrease of 271.1mg, t=2.2, and this decrease is significant (*p*: 0.033).

Table 18 shows the results of the paired sample t-test for micronutrient dietary content in HD patients' diet

	Dietary content (g/day)	**Mean± SD**	**CI**	**t**	**df**	***p***
Pair 1	**Phosphorus pre – and post intervention**	166.60 ±347.50	66.80-266.40	3.40	48	.002
Pair 2	**Potassium pre – and post intervention**	474.0±641.50	289.80-658.30	5.20	48	.000
Pair 3	**Sodium pre – and post intervention**	271.10±866.00	22.40-519.90	2.20	48	.033

Table (19) below compares serum phosphorus, potassium, and sodium levels before and after the nutrition intervention. Results of the paired sample t-test showed that the mean serum phosphorus intake increased post intervention with a mean increase of -0.4mg, t=-2.2 and the change in mean is not close and has shown to be statistically significant (*p*: 0.033). Similarly, mean serum potassium intake decreased after implementing the intervention with a mean decrease of 0.2mg, t=1.4, however this change was not significant (*P*= 0.165). Moreover, the mean change in serum sodium levels post-intervention was positive, i.e., sodium intake decreased with a mean decrease of 1.4mg, t=1.8, however this decrease was not significant (*p*: 0.079).

Table 19 shows the results of the paired sample t-test for biomarkers in HD patients' diet

	Biomarker (mg/dl)	Mean± SD	CI	t	df	*p*
Pair 1	**Phosphorus pre – and post intervention**	-0.43±1.36	-0.80-0.00	-2.20	48	0.033
Pair 2	**Potassium pre – and post intervention**	0.18±0.88	-0.10-0.40	1.40	48	0.165
Pair 3	**Sodium pre – and post intervention**	1.43±5.56	-0.20-3.00	1.80	48	0.079

5. 5 Food intake analysis

Table 20 shows the ranking of the most consumed food items and meals pre-and post-intervention based on frequency

Food item	Pre-intervention	Post-intervention
Pita bread (white flour)	1	1
Black tea	2	2
Sugar	3	4
Olive oil	4	5
Cola	5	12
Coffee without sugar	6	3
Labneh	7	6
Dried thyme (za'atar)	8	8
Tomato, raw	9	0
Orange	10	19
Tangerine	11	15
Egg	12	9
White Rice	13	11
Cucumber	14	10
Apple	15	7
Hummus	16	17
Yogurt	17	16
Instant coffee with cream & sugar	18	0
Taboun Bread (Whole Wheat)	19	0
Potato chips	20	0
Chicken breast	0	20
Pickles	0	14
Grape juice	0	18
Sprite	0	13

To indicate the most consumed food items and meals among HD patients participating in this study, the 20 highest consumed food items pre- and post-intervention were ranked, and the results are presented in the table above. It is important to note that some items were among the 20 highest consumed foods pre-intervention but were no longer among the highest consumed items post-intervention. In this case, these items were ranked as zero (0); if the food item was among the highly consumed items post-intervention but was not among the highest consumed pre-intervention, the new items were added to this list but were ranked as zero (0) in the pre-intervention list.

Some of the items were highly consumed pre-intervention, including tomatoes, instant coffee with cream & sugar, whole wheat taboun bread, and potato chips but were not included in the post-intervention list. Chicken, pickles, grape juice, and Sprite, however, were among the 20 highly consumed food items post intervention but were not included in the pre-intervention list of items.

Certain items maintained the same rank pre- and post-intervention, and others had a close ranking pre- and post-intervention. For instance, pita bread, black tea, and dried thyme (za'atar) maintained the same rank while sugar, olive oil, labneh, hummus, and yogurt had close rankings pre- and post-intervention.

The chart below visually indicates how the ranking of the most consumed foods has changed pre- and post-intervention.

Figure 2: Ranking of most consumed foods pre- and post-intervention based on frequency

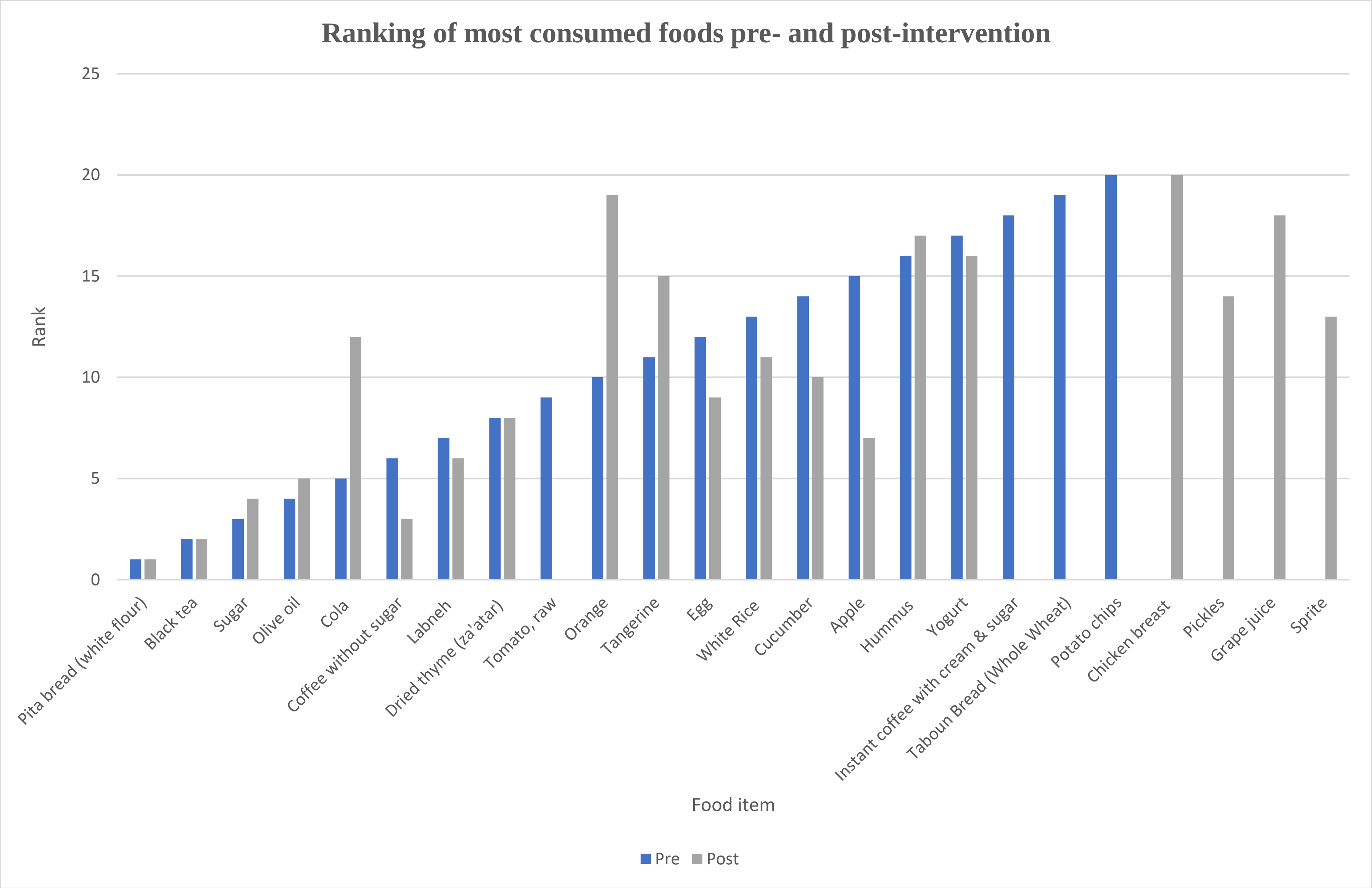


Table (21) below shows the ranking of the foods that contributed to the highest phosphorus consumption both pre- and post-intervention among the study participants. The foods with the highest phosphorus content in the diets of HD patients' pre-intervention were lamb meat, beef, hummus, white beans and tomato stew, and labneh. As patients' diets changed post-intervention, so did the foods that contribute to their dietary phosphorus intake. For instance, the food item that had the highest phosphorus content post-intervention was beef, followed by labneh, chicken, whole wheat taboun bread, and makloubeh. Some items in the pre-intervention list remained in the post-intervention list, such as beef and labneh, while other items such as whole wheat taboun bread were only included in the post intervention list.

Table 21 Foods that contributed to phosphorus intake of the patients pre-and post-intervention

Pre-intervention		Post-intervention	
Rank	**Food Name**	**Rank**	**Food Name**
1	Lamb meat	1	Beef
2	Beef	2	Labneh
3	Hummus	3	Chicken
4	White beans & tomato (yakhneh)	4	Taboun bread (whole wheat)
5	Labneh	5	Makloubeh
6	Mansaf	6	Eggplant & ground beef
7	Tomato & cucumber salad	7	Bread pita bakery (white flour)
8	Avocado with salt	8	Dried thyme (za'atar)
9	Cucumber	9	Fool mudammas
10	Stuffed grape leaves	10	Savory pastries with potato
11	Avocado & lemon salad	11	Sour cream (yogurt 14% fat)
12	Makloubeh	12	Baked Pastries (cheese goat)
13	Almond	13	Stuffed grape leaves
14	Tangerine	14	White rice

15	Chicken	15	Walnut
16	Potato	16	Eggplant pickled
17	Salad	17	Orange
18	Fool mudammas	18	Cola
19	Carrot	19	Vermicelli soup with chicken broth
20	Pickle	20	Apple

Table (22) below shows the ranking of the foods that contributed to the highest potassium consumption both pre- and post-intervention among the study participants. Foods with the highest potassium content in the diets of HD patients' pre-intervention were apple, watercress, baba ghanoush, fool mudammas, and potato chips. As patients' diets changed post-intervention, so did the foods that contribute to their dietary potassium intake. For instance, the food item that had the highest potassium content post-intervention was lamb meat, followed by kabab, baklawa, goat yogurt, eggs with olive oil. All items in the pre-intervention list changed post-intervention.

Table 22 Foods that contributed to potassium intake of the patients pre-and post-intervention

Pre-intervention		Post-intervention	
Rank	**Food Name**	**Rank**	**Food Name**
1	Apple	1	Lamb meat
2	Watercress	2	Kabab (ground lamb)
3	Baba ghanoush	3	Baklawa
4	Fool mudammas	4	Goat yogurt
5	Potato chips	5	Eggs with olive oil
6	Dried thyme (za'atar)	6	Dried thyme (za'atar)
7	Egg with olive oil	7	Cake with chocolate
8	Cucumber	8	Carrot
9	Green onions	9	Spinach baked pastry
10	Goat cheese	10	Green onions
11	Rice	11	Fool mudammas
12	Labneh	12	Tomato
13	Corn	13	Goat cheese
14	Cake with chocolate	14	Black tea
15	Pastrami	15	White rice
16	Chicken	16	Fresh lemon juice & sugar
17	Avocado with Salt	17	Labneh
18	Pita bread (white flour)	18	Hummus
19	Energy drink	19	Milk chocolate
20	Potato	20	Strawberry, raw

Table (23) below shows the ranking of the foods that contributed to the highest sodium consumption both pre- and post-intervention among the study participants. Foods with the highest sodium content in the diets of HD patients' pre-intervention were green peas & carrot yakhneh, dried thyme baked pastry, beef, homemade orange cake, and Ground Beef with Tahini Sauce. As patients' diets changed post-intervention, so did the foods that contribute to their dietary sodium intake. For instance, the food item that had the highest sodium content post-intervention was Makloubeh, followed by baked Cheese pastry, fried Potato, Falafel sandwich, and Freikeh soup. All items in the pre-intervention list changed post-intervention.

Table 23 Foods that contributed to sodium intake of the patients pre-and post-intervention

Pre-intervention		Post-intervention	
Rank	**Food Name**	**Rank**	**Food Name**
1	Green peas & carrot (yakhneh)	1	Makloubeh
2	Dried thyme baked pastry	2	Cheese baked pastry
3	Beef	3	Fried Potato
4	Homemade orange cake	4	Falafel sandwich
5	Ground Beef with Tahini Sauce	5	Freikeh soup
6	Freikeh soup	6	Hummus
7	Roasted peanut	7	Potato chips
8	Cappuccino	8	Salad
9	Dried thyme (za'atar)	9	Savory Pastries with Potato
10	Chicken	10	Ground beef
11	Pita bread (white flour)	11	Chicken
12	Summer squash	12	Pita bread (white flour)
13	Mujadara (lentil & rice)	13	Pizza
14	Stuffed eggplant	14	Beef
15	Baba ghanoush (eggplant salad)	15	White rice
16	Eggs	16	Yogurt
17	Mussakhan roll (shrak & chicken)	17	Spreadable cheese
18	Mayonnaise salad	18	Maftoul
19	Ground beef & potato	19	Bamba (corn & peanut snack)
20	Makloubeh	20	Instant Coffee with cream & sugar

Chapter 6: Discussion

This study aimed to develop a nutrition intervention plan for managing the nutrient intake of ESRD patients on HD through the modulation of protein intake, adequacy of caloric intake, control of sodium, potassium, and phosphorus intake personalized to the nutrient requirements of each case. In addition to reporting the demographic data among the study participants, nutrition knowledge and attitudes, diseases, and BMI, this study also reports data comparing pre- and post-intervention dietary intake of phosphorus, potassium, and sodium among study participants as well as the change in serum phosphorus, potassium, and sodium levels resulting from the dietary intervention. Moreover, the most consumed items among patients pre-and post-intervention and the food items contributing to the highest intake of phosphorus, potassium and sodium among participants pre-and post-intervention were also reported. The following chapter discusses main findings of this study and suggests future areas that should be studied in the field of nutrition and ESRD patients.

6. 1 Sociodemographic information

Sociodemographic analysis of study participants indicates that males represented the majority of the sample. Similarly, males represented more than 50% of the sample in two studies conducted in Nablus (Rezeq et al., 2018) (Khader et al., 2013) and in a study conducted in Hebron, (Badrasawi et al., 2021).

In this study, about half of the patients are aged between 40-59 years. Similarly, the mean age of HD patients in a study conducted in Hebron was 50.1 ± 16.6 years (Badrasawi et al., 2021) and most (86.8%) of the patients were above 45 years of age in a study conducted by Rezeq et al (2018) and 45% of HD were aged between 45 and 64 in a third study by Khader et al (2013) (Rezeq et al., 2018) (Khader et al., 2013). This indicates that older patients are usually more susceptible to having ESRD and undergo HD, and that older age is a risk factor for ESRD.

Most HD patients in this study lived in rural areas of Ramallah and El-Bireh governorate, which is expected as the HD unit at the PMC targets all the patients residing in rural areas of the governorate. These results were consistent with the result of a different research in Palestine which indicated that most HD patients lived in villages (Khader et al., 2013). On the other hand, a different study performed among Palestinian HD patients reported that about 46.4% of HD patients lived in cities, while the rest lived in villages or camps (Naalweh et al., 2017).

In addition, most of the participants in this study were unemployed. This was expected as in addition to the unemployment rate among the Palestinian population, many HD are unable to work due to their health status as well as the time that they spend at the dialysis unit making it harder to be consistent in a job position. This is consistent with the results of other studies conducted in Palestine which reported 89.4% and 76.8% unemployment among HD patients (Khatib et al., 2018) (Souzan Zidan, Manal Badrasawi, Bayan Nimer, Kawther Abu Sabha, 2019).

Furthermore, the vast majority of participants in this study completed an education level only maximum up to high school, compared to 47.4 % of patients completing primary education in a different study (Badrasawi et al., 2021), and 79.2% did not complete high school education (Rezeq et al., 2018).

To assess participants weight status, the BMI was measured for patients pre and post dietary intervention. Results indicated that more than half of the patients are either overweight or obese pre and post intervention (24.5% and 32.8%; 26.5% and 30.6%), respectively. These results comply with the recommendation of maintaining a higher BMI for HD patients as higher BMI and fat mass result in higher survival rates by means of reversing the catabolic conditions that the patients might experience (Okuno, 2021).

6. 2 Nutrition intervention and change in nutrients intake

Nutrition guidance for CKD patients is most useful when specified to the requirements and preferences of the patient and should be delivered at the right time and in the right format that suits the patient to attain the maximum benefit (Beto et al., 2016).

The diet for HD is very specific and target not only macronutrients, but most importantly provides specific recommendations for micro-nutrients, making it harder to implement among HD patients and might have undesirable effect on their quality of life. Moreover, the dietary guidelines for HD patients are complicated and require consistent follow-up and guidance and are usually unindividualized (Saglimbene et al., 2021).

Previous research has shown that the median sodium intake among HD patients is 1337 mg, mean phosphate intake was 1438 mg, and the mean potassium intake was 3655 mg (Saglimbene et al., 2021), and that there is higher phosphorus intake among dialysis patients on HD days compared to non-dialysis days (Tao et al., 2019)**.** Moreover, previous research implied that only about 25% of patients did not have a phosphorus intake higher than the recommended amount and only 28% did not exceed the recommendation for potassium, while 85% of the patients met the guidelines for sodium intake (Saglimbene et al., 2021). Similarly, excess intake of phosphorus (1104±316 mg/day), sodium (2308±910 mg/day), and potassium (2609±716 mg/day) was noticed among HD patients (Xie et al., 2018).

Median phosphorus (M: 1467, F: 1391 mg/day), potassium (M: 3715, F: 3569 mg/day), and sodium (M: 1378, F: 1292 mg/day) intake was higher among males than among females in previous research (Saglimbene et al., 2021). This is consistent with the results of this study were males had higher mean intake of the selected micronutrients pre-intervention compared to females and higher intake of phosphorus and potassium post-intervention compared to females and almost the same mean dietary sodium intake post intervention for males and females. Moreover, phosphorus intake among study participants was significantly correlated with males (*p*: 0.029) post-intervention. Males might have higher intake of phosphorus, potassium and sodium due to their overall higher energy needs, and thus higher food intake. Results from different research , however, indicated that females had more difficulties in following renal diets; this might be due to several reason, such as their higher responsibility in buying and preparing food which is influenced by their physical health (Beto et al., 2016).

Comparing patients age with their dietary intake in this study indicated that the mean phosphorus and potassium intake for patients pre and post intervention was higher among older patients. For instance, phosphorus intake post-intervention among patients aged 20-39 years was 554.6±202, 627.9±194.6 among patients between 40 and 59 years, and 727.5±261.2 among those aged above 60 years. Likely, potassium intake post-intervention among patients aged 20-39 years was 1193.5±425.9, 1210.2±332.7 among patients between 40 and 59 years, and 1382.8±453.3 among those aged above 60 years. Results from the literature did not match the results of this this intervention were previous research specified that older people have higher will to follow dietary guidance (Beto et al., 2016).

Patients with lower education levels had higher intake of both phosphorus and potassium post-intervention. This is consistent with reported data in the literature were higher reading levels have been shown to lead to higher dietary adherence (Beto et al., 2016). This indicates the need to find distinctive way to educate HD patients with lower educational levels with the required information that would help them to maintain normal levels of nutrient intake.

Patients were asked regarding their interest in the relationship between nutrition and health to compare this component of health literacy with their intake levels of phosphorus, potassium, and sodium. Results of this study indicated that patients with no interest in the relationship between nutrition and health had higher pre- and post-intervention dietary intake of phosphorus, potassium, and sodium. This is consistent with reported data in the literature were higher health literacy have been shown to lead to higher dietary adherence (Beto et al., 2016), especially among patients with low socioeconomic status indicating the need to provide the healthcare staff with trainings to enable them to work with such patients (Skoumalova et al., 2019). Published research papers indicated that 38 percent of HD patients are uncertain or disbelieved that dietary salt affected BP and 30% did not think it was related to fluid gain (Kauric-Klein, 2020).

It has been shown in published literature that educating HD patients (based on health belief model) has improved nutritional knowledge but did not improve dietary intake (Nooriani et al., 2019), the results of our study indicated similar findings. Patients participating in this study were asked about the influence of dietary recommendations and education on their actual eating habits, the results clearly indicated that patients who are not influenced by dietary education had higher pre- and post-intervention dietary intake of phosphorus, potassium, and sodium.

Patients who reported having iron deficiency anaemia have lower pre- and post intervention intake of phosphorus, potassium, and sodium compared to those who do not report having iron deficiency anaemia. This might be due to the fact that having anemia is linked to lower/insufficient dietary intake and lower overall dietary status. On the other hand, patients who reported high cholesterol levels and type II diabetes have higher pre- and post-intervention intake of phosphorus, potassium, and sodium compared to those who did not report having high cholesterol levels and type II diabetes, and phosphorus intake among participants pre-intervention was significantly correlated with patients reporting type II diabetes ($P = 0.041$). Higher intake of these micronutrients among HD patients with high cholesterol levels and type II diabetes could be due to higher food intake and/or unhealthy eating habits that have led to the occurrence of these health conditions.

Food labels do not usually identify the content of two of the most essential nutrients that should be monitored in the diets of HD patients, i.e., potassium and phosphorus. Indicating potassium and phosphorus content is not obligatory, making it harder for patients to compare commercial food products when buying/consuming them, and choose the items that match their goals. Moreover, food labels are usually hard to be read and understood (Beto et al., 2016). In addition, it is hard for patients to estimate the nutrient content of food/meals prepared at home (Beto et al., 2016).

Patients participating in this research who read energy levels on the packaged foods usually consume lower pre and post intervention phosphorus, potassium and sodium intake compared to the pre and post intervention phosphorus, potassium and sodium intake among patients who did not check energy levels. Similarly, patients who check sodium and potassium levels in their food had lower sodium and potassium intake pre- and post-intervention compared to those who do not and those who check phosphorus and potassium levels. These results make sense as patients who check this information on their purchased foods usually have the knowledge about the nutrients that affect their health and are actively searching for the content of these nutrients in their foods, thus leading to lower intake.

6. 3 Nutrition intervention and the change on biomarkers

To assess the effect of the dietary intervention on patients' health status, phosphorus, potassium, and sodium serum levels were measured and compared pre- and post-intervention. Although the mean serum phosphorus level increased post-intervention (5.7±1.8 vs. 6.2±1.5), the mean serum potassium and sodium levels decreased post-intervention compared to pre-intervention levels 5.4±0.8 vs. 5.2±0.8 and 138.4±4.7 to

137±3.6, respectively. Similar results were found among HD patients who were provided with personalized diets and nutrition education were serum phosphorus and potassium levels were significantly reduced, while the dietary intake of phosphorus and potassium increased post intervention (de Melo Ribeiro et al., 2020).

Serum phosphorus is affected by several factors other than the dietary intake, including PTH, fibroblast growth factor 23, digestive system, bone, and Vitamin D and maintaining normal serum levels is affected by these factors, which makes it more challenging to control even among people with normal kidney function (Suki & Moore, 2016).

In different research implementing an educational program for HD patients, it was also found that serum phosphorus, potassium, and sodium levels were significantly lower among the intervention group (Naseri-Salahshour et al., 2020). Self-reported adherence were also improved in the intervention group for both phosphorus and potassium dietary intake, and were statistically significant at the 3 and 9 month periods compared to pre-intervention (Griva et al., 2018). When a registered dietitian was responsible for controlling serum phosphorus levels among HD patients, there was a higher improvement than on serum phosphorus levels compared to when a nurse and a nephrologist were in charge (Blair et al., 2013). In a self-management controlled trial conducted among HD patients, a significant reduction in serum potassium was noted at 3 and 9 months of the intervention and serum phosphate was improved at the 3 month period but was not sustained till the 9 month period of the intervention (Griva et al., 2018).

Both males and females had almost the same mean serum phosphorus levels and potassium pre-intervention and slightly higher mean sodium serum levels among females than among males. Males had higher mean serum phosphorus levels post intervention compared to females and higher mean serum sodium levels post intervention compared to females.

Females, however, had higher serum potassium levels compared to males. Previous research has indicated that gender is not linked to higher mortality rates among HD patients (Ma & Zhao, 2017)

Comparing patients age with their mean serum phosphorus, potassium, and sodium levels indicated that serum levels pre-intervention was lower among older patients. Post-intervention phosphorus and sodium levels were among patients aged 40–59-year-old patients while the highest post-intervention potassium level was among patients aged 20-39 years. Having higher phosphorus levels among older aged HD patients was justified in the literature as individuals aged 50 years and above have higher rates of bone problems which is associated with higher serum phosphorus (Suki & Moore, 2016). Controlling bone diseases helps in managing the level of serum phosphorus which should be considered in the treatment plan (Suki & Moore, 2016). In the literature, it has been shown that higher age is directly associated with higher mortality rates among patients undergoing HD (Ma & Zhao, 2017), and elevated serum phosphorus is higher among older patients which was associated with harmful health episodes and mortality resulting from cardiovascular events (Suki & Moore, 2016).

6. 4 Effect of the intervention on the intake levels of selected micronutrients

The dietary intake of HD patients showed a significant decrease in the intake of phosphorus, potassium, and sodium after applying the intervention. This clearly shows the role of personalized diets and the consistent follow up from a dietitian on the decrease in the intake of the nutrients that have shown to possess a risk on the health of HD patients. The time of the intervention showed to be enough to make a significant change in the intake of phosphorus, potassium, and sodium.

6. 5 Effect of the intervention on serum levels of selected biomarkers

Comparing serum phosphorus, potassium, and sodium levels before and after this nutrition intervention study showed that the mean serum phosphorus increased post intervention with and the change has shown to be statistically significant ($P = 0.033$). The target was to decrease serum phosphorus levels, but the results showed otherwise. It was noted throughout the literature search that it is often harder to follow and adhere to phosphorus recommendations which might results in higher serum phosphorus levels. In addition, serum phosphorus levels are linked to bone health, digestive system health, PTH, and several other factors which might lead to the increase in serum phosphorus levels beyond patient's dietary intake. This was shown in this study, were dietary phosphorus intake decrease significantly, but was not accompanied with a decrease in serum phosphorus levels.

The serum potassium, however, decreased after implementing the intervention which was consistent with lower dietary intake of potassium among HD patients in this intervention, thus showing the effectiveness of this intervention study on potassium intake and potassium serum levels. The decrease in serum potassium levels was not significant which probably implies the need for more time to see significant decrease in the serum levels of this nutrient.

Moreover, the mean serum sodium levels post-intervention decreased which demonstrates the effectiveness of this intervention study on the dietary intake of sodium as it was accompanied by a decrease in sodium levels post intervention. Most likely, more time is required for statistically significant changes in serum sodium levels.

6. 6 Effect of the intervention on consumed food items and meals

The results of this study have not only shown a decrease in the intake of dietary phosphorus, sodium, and potassium, but has also shown an improvement in the dietary quality in the diets of these patients. Items with higher dietary quality were consumed post-intervention compared to baseline, which also indicates the improvement in the diets of these patients. It is important to note, however, that patients still consumed “unhealthy” food items and meals. These items were indicated in the results and should be worked on in future interventions.

Chapter 7: Conclusion and recommendations

Nutrition intervention has a key role in both the management of ESRD and in preventing health complications that are shown to be associated with the disease. Managing the nutritional status of a HD patient requires detailed assessment of the nutritional requirements of the patient and a precise nutrition intervention plan considering the macro and micronutrients that are associated with the nutrition status of HD patients.

This study indicated the possibility of developing an individualized dietary plan for each HD patient according to the HD macro and micronutrient dietary recommendation. These plans were developed on several phases and used data from a food composition software that includes meals and food items consumed by the Palestinian population. Using such data helped in better adherence to the diet plans.

The outcomes of this study indicated the effectiveness of the nutrition intervention on the dietary intake of phosphorus, potassium, and sodium among HD patients. This has shown that a 3-month intervention period is enough to show significant improvements in the dietary intake of three of the most essential micronutrients that affect the health of HD patients.

Providing personalized diet plans also resulted in changes in the serum levels of three essential biomarkers that affect the health of HD patients' serum phosphorus, potassium, and sodium. The study resulted in a decrease in serum potassium and sodium levels, but this improvement was not significant which probably implies the need for more time to see significant decrease in the serum levels of this nutrient.

As the first of its kind in Palestine, a nutrition intervention was implemented in this study to improve the medical and nutritional status of HD patients at PMC. Since the program showed to provide positive results, it is recommended to develop this intervention to a national nutrition intervention system targeting Palestinian HD patients.

References

Abdalla, S., Abdallah, K., & Yousif, Y. B. (2016). *5 th European Nutrition and Dietetics Conference*. *6*(3), 9600.

Abdelkarim, O. A., Abdelraheem, M. B., Abubakar, U., & Ekheir, H. K. (2020). *Prevalence and factors predicting anemia in sudanese hemodialysis patients*.

Academy of Nutrition and Dietitics. (2018). Snapshot NCP Step 3 : Nutrition Intervention. *Academy of Nutrition and Dietitics*, 3. https://www.ncpro.org/nutrition-intervention-snapshot

American Kidney Fund. (n.d.-a). *Kidney failure (ESRD) - Symptoms and causes*. Retrieved August 8, 2022, from https://www.kidneyfund.org/all-about-kidneys/kidney-failure-symptoms-and-causes

American Kidney Fund. (n.d.-b). *Risk factors*. https://www.kidneyfund.org/prevention/are-you-at-risk/

Amjad, A., Usmani, S., PASHA, H. H., Khan, W. A., Qamar, M. A., MUSTAFA, Z., Ather, U., Zulfiqar, S., & Habib, S. (2021). Prevalence of Iron Deficiency Anemia in Hemodialysis patients at NIKD. *Pakistan Journal of Medical and Health Sciences*, *15*(6), 1192–1194.

Anderson, C. A. M., Nguyen, H. A., & Rifkin, D. E. (2016). Nutrition Interventions in Chronic Kidney Disease. *Medical Clinics of North America*, *100*(6), 1265–1283. https://doi.org/10.1016/j.mcna.2016.06.008

Asghari, G., Momenan, M., Yuzbashian, E., Mirmiran, P., & Azizi, F. (2018). Dietary pattern and incidence of chronic kidney disease among adults: A population-based study 11 Medical and Health Sciences 1117 Public Health and Health Services.

Nutrition and Metabolism, *15*(1), 1–11. https://doi.org/10.1186/s12986-018-0322-7

Badrasawi, M., Zidan, S., Sharif, I., Qaisiyha, J., Ewaida, S., Jaradat, T., & Samamra, Y. (2021). Prevalence and correlates of malnutrition among hemodialysis patients at hebron governmental hospital, Palestine: cross-sectional study. *BMC Nephrology*, *22*(1), 1–12. https://doi.org/10.1186/s12882-021-02413-y

Beer, J., Mountford, E., & Boudville, N. (2018). Dietetic intervention in haemodialysis patients improves malnutrition. *Renal Society of Australasia Journal*, *14*(1), 14–20.

Bello, A. K., Alrukhaimi, M., Ashuntantang, G. E., Basnet, S., Rotter, R. C., Douthat, W. G., Kazancioglu, R., Köttgen, A., Nangaku, M., Powe, N. R., White, S. L., Wheeler, D. C., & Moe, O. (2017). Complications of chronic kidney disease: current state, knowledge gaps, and strategy for action. *Kidney International Supplements*, *7*(2), 122–129. https://doi.org/10.1016/j.kisu.2017.07.007

Bertonsello-Catto, V. R., Lucca, L. J., & da Costa, J. A. C. (2019). Phosphorus Counting Table for the control of serum phosphorus levels without phosphate binders in hemodialysis patients. *Clinical Nutrition ESPEN*, *32*, 153–157. https://doi.org/10.1016/j.clnesp.2019.03.008

Beto, J. A., Schury, K. A., & Bansal, V. K. (2016). Strategies to promote adherence to nutritional advice in patients with chronic kidney disease: A narrative review and commentary. *International Journal of Nephrology and Renovascular Disease*, *9*, 21–33. https://doi.org/10.2147/IJNRD.S76831

Blair, D., Byham-Gray, L., Sweet, S. J., Denmark, R., Parrott, J. S., Lewis, E., McCaffrey, S., & Thomson, S. (2013). Effect of a dietitian-managed bone algorithm on serum phosphorus level in maintenance hemodialysis patients. *Journal of Renal Nutrition*, *23*(2), 98–105.

Block, G. A., Hulbert-Shearon, T. E., Levin, N. W., & Port, F. K. (1998). Association of serum phosphorus and calcium x phosphate product with mortality risk in chronic hemodialysis patients: a national study. *American Journal of Kidney Diseases*, *31*(4), 607–617.

Borrelli, S., Provenzano, M., Gagliardi, I., Ashour, M., Liberti, M. E., De Nicola, L., Conte, G., Garofalo, C., & Andreucci, M. (2020). Sodium intake and chronic kidney disease. *International Journal of Molecular Sciences*, *21*(13), 1–13. https://doi.org/10.3390/ijms21134744

Buargub, M. A., Nabulsi, M. F., & Shafeh, T. A. (2006). Prevalence and pattern of renal osteodystrophy in chronic hemodialysis patients: a cross sectional study of 103 patients. *Saudi Journal of Kidney Diseases and Transplantation*, *17*(3), 401.

Canadian Malnutrition Task Force. (n.d.). *Hospital Care / INPAC*. Retrieved August 3, 2022, from https://nutritioncareincanada.ca/resources-and-tools/hospital-care-inpac/assessment-sga.

Canaud, B., Chazot, C., Koomans, J., & Collins, A. (2019). Fluid and hemodynamic management in hemodialysis patients: challenges and opportunities. *Jornal Brasileiro de Nefrologia : 'orgao Oficial de Sociedades Brasileira e Latino-Americana de Nefrologia*, *41*(4), 550–559. https://doi.org/10.1590/2175-8239-JBN-2019-0135

Carrero, J. J., González-Ortiz, A., Avesani, C. M., Bakker, S. J. L., Bellizzi, V., Chauveau, P., Clase, C. M., Cupisti, A., Espinosa-Cuevas, A., Molina, P., Moreau, K., Piccoli, G. B., Post, A., Sezer, S., & Fouque, D. (2020). Plant-based diets to manage the risks and complications of chronic kidney disease. *Nature Reviews Nephrology*, *16*(9), 525–542. https://doi.org/10.1038/s41581-020-0297-2

Central Bureau of Statistics. (2013). *Palestinian Family Survey 2010 Final Report*.

de Melo Ribeiro, P. V., Hermsdorff, H. H. M., Balbino, K. P., Epifânio, A. de P. S., de Paula Jorge, M., & Moreira, A. V. B. (2020). Effect of a nutritional intervention, based on transtheoretical model, on metabolic markers and food consumption of individuals undergoing hemodialysis. *Journal of Renal Nutrition*, *30*(5), 430–439.

de Mutsert, R., Grootendorst, D. C., Boeschoten, E. W., Brandts, H., van Manen, J. G., Krediet, R. T., Dekker, F. W., & Group, N. C. S. on the A. of D.-2 S. (2009). Subjective global assessment of nutritional status is strongly associated with mortality in chronic dialysis patients. *American Journal of Clinical Nutrition*, *89*(3), 787.

Defining Adult Overweight & Obesity | Overweight & Obesity | CDC. (n.d.). Retrieved June 11, 2022, from https://www.cdc.gov/obesity/basics/adult-defining.html

El Belbeisi, A. A. H. H. (2013). *Impact of Hemodialysis on Nutritional Status in Patients with End-Stage Renal Disease Aged 19-59 Years at Al-Shifa Hospital-Gaza, Palestine*. AL Azhar University.

Enia, G., Sicuso, C., Alati, G., Zoccali, C., Pustorino, D., & Biondo, A. (1993). Subjective global assessment of nutrition in dialysis patients. *Nephrology Dialysis Transplantation*, *8*(10), 1094–1098. https://doi.org/10.1093/oxfordjournals.ndt.a092299

Ghorbani, A., Hayati, F., Karandish, M., & Sabzali, S. (2020). The prevalence of malnutrition in hemodialysis patients. *Journal of Renal Injury Prevention*, *9*(2), e15–e15. https://doi.org/10.34172/jrip.2020.15

Griva, K., Nandakumar, M., Jo-an, H. N., Lam, K. F. Y., McBain, H., & Newman, S. P. (2018). Hemodialysis self-management intervention randomized trial (HED-SMART): a practical low-intensity intervention to improve adherence and clinical markers in patients receiving hemodialysis. *American Journal of Kidney Diseases*, *71*(3), 371–381.

Hassanin, I. A., Hassanein, H., Elmenshawy, P., El-Gameel, D., Elsheikh, A. A., El-Kobrosly, A., Samir, B., Emil, R., Alaa, M., & Selim, D. H. (2021). Malnutrition score and Body Mass Index as nutritional screening tools for hemodialysis patients. *Clinical Nutrition ESPEN*, *42*, 403–406. https://doi.org/10.1016/j.clnesp.2021.01.044

Hendriks, F. K., Smeets, J. S. J., van der Sande, F. M., Kooman, J. P., & van Loon, L. J. C. (2019). Dietary protein and physical activity interventions to support muscle maintenance in end-stage renal disease patients on hemodialysis. *Nutrients*, *11*(12), 1–13. https://doi.org/10.3390/nu11122972

Hsu, H.-J., Wu, I.-W., Hsu, K.-H., Sun, C.-Y., Chen, C.-Y., & Lee, C.-C. (2020). Vitamin D deficiency, cardiothoracic ratio, and long-term mortality in hemodialysis patients. *Scientific Reports*, *10*(1), 1–11.

Ikizler, T. A., Burrowes, J. D., Byham-Gray, L. D., Campbell, K. L., Carrero, J. J., Chan, W., Fouque, D., Friedman, A. N., Ghaddar, S., Goldstein-Fuchs, D. J., Kaysen, G. A., Kopple, J. D., Teta, D., Yee-Moon Wang, A., & Cuppari, L. (2020). KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update. *American Journal of Kidney Diseases*, *76*(3), S1–S107. https://doi.org/10.1053/j.ajkd.2020.05.006

Indrarini, A., Zahra, A. N., & Yona, S. (2019). The relationship between anemia, depression, duration of hemodialysis, and quality of sleep among end-stage renal disease patients. *Enfermería Clínica*, *29*, 24–29.

Iorember, F. M. (2018). Malnutrition in chronic kidney disease. *Frontiers in Pediatrics*, *6*(June). https://doi.org/10.3389/fped.2018.00161

Joson, C. G., Henry, S. L., Kim, S., Cheung, M. Y., Parab, P., Abcar, A. C., Jacobsen, S. J., Morisky, D. E., & Sim, J. J. (2016). Patient-Reported Factors Associated With Poor Phosphorus Control in a Maintenance Hemodialysis Population. *Journal of Renal Nutrition*, *26*(3), 141–148. https://doi.org/10.1053/j.jrn.2015.09.004

Kalantar-Zadeh, K., Tortorici, A. R., Chen, J. L. T., Kamgar, M., Lau, W. L., Moradi, H., Rhee, C. M., Streja, E., & Kovesdy, C. P. (2015). Dietary Restrictions in Dialysis Patients: Is There Anything Left to Eat? *Seminars in Dialysis*, *28*(2), 159–168. https://doi.org/10.1111/sdi.12348

Karaboyas, A., Zee, J., Brunelli, S. M., Usvyat, L. A., Weiner, D. E., Maddux, F. W., Nissenson, A. R., Jadoul, M., Locatelli, F., Winkelmayer, W. C., Port, F. K., Robinson, B. M., & Tentori, F. (2017). Dialysate Potassium, Serum Potassium, Mortality, and Arrhythmia Events in Hemodialysis: Results From the Dialysis Outcomes and Practice Patterns Study (DOPPS). *American Journal of Kidney Diseases*, *69*(2), 266–277. https://doi.org/10.1053/j.ajkd.2016.09.015

Karavetian, M., de Vries, N., Elzein, H., Rizk, R., & Bechwaty, F. (2015). Effect of behavioral stage-based nutrition education on management of osteodystrophy among hemodialysis patients, Lebanon. *Patient Education and Counseling*, *98*(9), 1116–1122.

Karavetian, M., de Vries, N., Rizk, R., & Elzein, H. (2014). Dietary educational interventions for management of hyperphosphatemia in hemodialysis patients: A systematic review and meta-analysis. *Nutrition Reviews*, *72*(7), 471–482. https://doi.org/10.1111/nure.12115

Kauric-Klein, Z. (2020). Sodium Knowledge, Beliefs, and Behaviors in Patients on Chronic Hemodialysis. *Blood Purification*, *49*(1–2), 25–32. https://doi.org/10.1159/000502678

Khader, M. I., Snouber, S., Alkhatib, A., Nazzal, Z., & Dudin, A. (2013). Prevalence of patients with end-stage renal disease on dialysis in the West Bank, Palestine. *Saudi Journal of Kidney Diseases and Transplantation : An Official Publication of the Saudi Center for Organ Transplantation, Saudi Arabia*, *24*(4), 832–837. https://doi.org/10.4103/1319-2442.113913

Khatib, S. T., Hemadneh, M. K., Hasan, S. A., Khazneh, E., & Zyoud, S. H. (2018). Quality of life in hemodialysis diabetic patients: A multicenter cross-sectional study from Palestine. *BMC Nephrology*, *19*(1), 1–9. https://doi.org/10.1186/s12882-018-0849-x

Kim, Y., Yun, S. H., Koo, H., Hwang, S., Kim, H. J., Lee, S., Baek, H., Kim, H. H., Lee, K. H., Kim, J. H., Park, J. I., & Yoo, K. D. (2021). Different seasonal variations of potassium in hemodialysis patients with high longitudinal potassium levels: A multicenter cohort study using dialysisnet. *Yonsei Medical Journal*, *62*(4), 315–324. https://doi.org/10.3349/ymj.2021.62.4.315

Ko, G. J., Obi, Y., Tortorici, A. R., & Kalantar-Zadeh, K. (2017). Dietary Protein Intake and Chronic Kidney Disease. *Physiology & Behavior*, *176*(12), 139–148. https://doi.org/10.1097/MCO.0000000000000342.Dietary

Kramer, H., Jimenez, E. Y., Brommage, D., Vassalotti, J., Montgomery, E., Steiber, A., & Schofield, M. (2018). Medical Nutrition Therapy for Patients with Non–Dialysis-Dependent Chronic Kidney Disease: Barriers and Solutions. *Journal of the Academy of Nutrition and Dietetics*, *118*(10), 1958–1965. https://doi.org/10.1016/j.jand.2018.05.023

Ma, L., & Zhao, S. (2017). Risk factors for mortality in patients undergoing hemodialysis: A systematic review and meta-analysis. *International Journal of Cardiology*, *238*, 151–158. https://doi.org/10.1016/j.ijcard.2017.02.095

Mayo Clinc. (n.d.). *Hemodialysis*. https://www.mayoclinic.org/tests-procedures/hemodialysis/about/pac-20384824

Mayo Clinic. (n.d.). *Chronic kidney disease*. https://www.mayoclinic.org/diseases-conditions/chronic-kidney-disease/symptoms-causes/syc-20354521

Mc Causland, F. R., Waikar, S. S., & Brunelli, S. M. (2013). The relevance of dietary sodium in hemodialysis. *Nephrology Dialysis Transplantation*, *28*(4), 797–802. https://doi.org/10.1093/ndt/gfs452

Medical Research Council. (n.d.). *Food composition data and databases*. Retrieved September 2, 2022, from https://dapa-toolkit.mrc.ac.uk/diet/introduction/food-composition

Ministry of Health. (2018). *Health Annual Report Palestine 2018*.

Mitra, P. K., Tasker, P. R. W., & Ell, M. S. (2020). *Chronic kidney disease*. Springer Nature Singapore Pte Ltd. https://doi.org/10.1024/1661-8157.97.17.947

Module 7 – Understanding Kidney Lab Tests. (2012). *501*(c).

Naalweh, K. S., Barakat, M. A., Sweileh, M. W., Al-Jabi, S. W., Sweileh, W. M., & Zyoud, S. H. (2017). Treatment adherence and perception in patients on maintenance hemodialysis: A cross - Sectional study from Palestine. *BMC Nephrology*, *18*(1), 1–9. https://doi.org/10.1186/s12882-017-0598-2

Narasaki, Y., Okuda, Y., Kalantar, S. S., You, A. S., Novoa, A., Nguyen, T., Streja, E., Nakata, T., Colman, S., & Kalantar-Zadeh, K. (2021). Dietary potassium intake and mortality in a prospective hemodialysis cohort. *Journal of Renal Nutrition*, *31*(4), 411–420.

Naseri-Salahshour, V., Sajadi, M., Nikbakht-Nasrabadi, A., Davodabady, F., & Fournier, A. (2020). The effect of nutritional education program on quality of life and serum electrolytes levels in hemodialysis patients: A single-blind randomized controlled trial. *Patient Education and Counseling*, *103*(9), 1774–1779.

National Kidney Foundation. (2015). *Hemodialysis*. https://www.kidney.org/atoz/content/hemodialysis#:~:text=Hemodialysis is a procedure where,surgery%2C usually to your arm

Nephron Information Center. (n.d.). Retrieved June 11, 2022, from http://nephron.org/nephsites/adp/labvalues.html

NHS. (2018). *Renal Disease : managing your fluid balance*.

NIDDK. (2022). *Chronic Kidney Disease (CKD)*. https://www.niddk.nih.gov/health-information/kidney-disease/chronic-kidney-disease-ckd

Nooriani, N., Mohammadi, V., Feizi, A., Shahnazi, H., Askari, G., & Ramezanzade, E. (2019). The effect of nutritional education based on health belief model on nutritional knowledge, Health Belief Model constructs, and dietary intake in hemodialysis patients. *Iranian Journal of Nursing and Midwifery Research*, *24*(5), 372–378. https://doi.org/10.4103/ijnmr.IJNMR_124_18

Ohashi, Y., Sakai, K., Hase, H., & Joki, N. (2018). Dry weight targeting: The art and science of conventional hemodialysis. *Seminars in Dialysis*, *31*(6), 551–556.

Okuno, S. (2021). Significance of adipose tissue maintenance in patients undergoing hemodialysis. *Nutrients*, *13*(6). https://doi.org/10.3390/nu13061895

Omari, A. M., Omari, L. S., Dagash, H. H., Sweileh, W. M., Natour, N., & Zyoud, S. H. (2019). Assessment of nutritional status in the maintenance of haemodialysis patients:

a cross-sectional study from Palestine. *BMC Nephrology*, *20*(1). https://doi.org/10.1186/s12882-019-1288-z

Ramezani, T., Sharifirad, G., Gharlipour, Z., & Mohebi, S. (2018). Effect of educational intervention based on self-efficacy theory on adherence to dietary and fluids-intake restriction in hemodialysis patients. *Health Education and Health Promotion*, *6*(1), 31–38.

Ramos, C. I., González-Ortiz, A., Espinosa-Cuevas, A., Avesani, C. M., Carrero, J. J., & Cuppari, L. (2021). Does dietary potassium intake associate with hyperkalemia in patients with chronic kidney disease? *Nephrology Dialysis Transplantation*, *36*(11), 2049–2057. https://doi.org/10.1093/ndt/gfaa232

Rezeq, H. A., Khdair, L. N., Hamdan, Z. I., & Sweileh, W. M. (2018). of Kidney Diseases and Transplantation Original Article Prevalence of Malnutrition in Hemodialysis Patients : A Single-Center Study in Palestine. *Saudi Journal of Kidney Diseases and Transplantation*, *29*(2), 332–340.

Sabatino, A., Regolisti, G., Karupaiah, T., Sahathevan, S., Sadu Singh, B. K., Khor, B. H., Salhab, N., Karavetian, M., Cupisti, A., & Fiaccadori, E. (2017). Protein-energy wasting and nutritional supplementation in patients with end-stage renal disease on hemodialysis. *Clinical Nutrition*, *36*(3), 663–671. https://doi.org/10.1016/j.clnu.2016.06.007

Saglimbene, V. M., Su, G., Wong, G., Natale, P., Ruospo, M., Palmer, S. C., Craig, J. C., Carrero, J. J., & Strippoli, G. F. M. (2021). Dietary intake in adults on hemodialysis compared with guideline recommendations. *Journal of Nephrology*, *34*(6), 1999–2007. https://doi.org/10.1007/s40620-020-00962-3

Sahathevan, S., Khor, B. H., Ng, H. M., Gafor, A. H. A., Daud, Z. A. M., Mafra, D., &

Karupaiah, T. (2020). Understanding development of malnutrition in hemodialysis patients: A narrative review. *Nutrients*, *12*(10), 1–30. https://doi.org/10.3390/nu12103147

Seyedzadeh, A., Tohidi, M. R., Golmohamadi, S., Omrani, H. R., Seyedzadeh, M. S., Amiri, S., & Hookari, S. (2022). Prevalence of renal osteodystrophy and its related factors among end-stage renal disease patients undergoing hemodialysis: Report from Imam Reza referral hospital of medical university of Kermanshah, Iran. *Oman Medical Journal*, *37*(1), e335.

Shimizu, S., Tei, R., Okamura, M., Takao, N., Nakamura, Y., Oguma, H., Maruyama, T., Takashima, H., & Abe, M. (2020). Prevalence of zinc deficiency in Japanese patients on peritoneal dialysis: comparative study in patients on hemodialysis. *Nutrients*, *12*(3), 764.

Skoumalova, I., Kolarcik, P., Geckova, A. M., Rosenberger, J., Majernikova, M., Klein, D., van Dijk, J. P., & Reijneveld, S. A. (2019). Is health literacy of dialyzed patients related to their adherence to dietary and fluid intake recommendations? *International Journal of Environmental Research and Public Health*, *16*(21), 1–10. https://doi.org/10.3390/ijerph16214295

Souzan Zidan, Manal Badrasawi, Bayan Nimer, Kawther Abu Sabha, R. T. & S. (2019). *Knowledge of haemodialysis patients about Nutrition: a cross-sectional study from Palestine*. *5*(1). https://journals.najah.edu/media/journals/full_texts/7_wBdv4Ba.pdf

St-Jules, D. E., Goldfarb, D. S., Pompeii, M. Lou, Liebman, S. E., & Sherman, R. A. (2018). Assessment and misassessment of potassium, phosphorus, and protein in the hemodialysis diet. *Seminars in Dialysis, 31*(5), 479–486. https://doi.org/10.1111/sdi.12713

St-Jules, D. E., Goldfarb, D. S., & Sevick, M. A. (2016). Nutrient Non-equivalence: Does Restricting High-Potassium Plant Foods Help to Prevent Hyperkalemia in Hemodialysis Patients? *Journal of Renal Nutrition*, *26*(5), 282–287. https://doi.org/10.1053/j.jrn.2016.02.005

St-Jules, D. E., Woolf, K., Pompeii, M. Lou, Kalantar-Zadeh, K., & Sevick, M. A. (2016). Reexamining the Phosphorus-Protein Dilemma: Does Phosphorus Restriction Compromise Protein Status? *Journal of Renal Nutrition*, *26*(3), 136–140. https://doi.org/10.1053/j.jrn.2015.12.004

Steinfeldt, L., Anand, J., & Murayi, T. (2013). Food Reporting Patterns in the USDA Automated Multiple-Pass Method. *Procedia Food Science*, *2*, 145–156. https://doi.org/10.1016/j.profoo.2013.04.022

Subjective global assessment (SGA) - Diagnosing Malnutrition. (n.d.). https://nutritioncareincanada.ca/resources-and-tools/hospital-care-inpac/assessment-sga

Suki, W. N., & Moore, L. W. (2016). *Phosphorus Regulation in Chronic Kidney Disease*.

Tao, X., Zhang, H., Yang, Y., Zhang, C., & Wang, M. (2019). Daily dietary phosphorus intake variability and hemodialysis patient adherence to phosphate binder therapy. *Hemodialysis International*, *23*(4), 458–465. https://doi.org/10.1111/hdi.12769

Tayyem, R. F., & Mrayyan, M. T. (2008). Assessing the Prevalence of Malnutrition in Chronic Kidney Disease Patients in Jordan. *Journal of Renal Nutrition*, *18*(2), 202–209. https://doi.org/10.1053/j.jrn.2007.10.001

Tsai, W. C., Wu, H. Y., Chiu, Y. L., Yang, J. Y., Pai, M. F., Wu, Y. R., Lin, W. Y., Hung, K. Y., Chien, K. L., Hsu, S. P., & Peng, Y. Sen. (2021). Acute effects of dietary phosphorus intake on markers of mineral metabolism in hemodialysis patients: post hoc analysis of a randomized crossover trial. *Renal Failure*, *43*(1), 141–148. https://doi.org/10.1080/0886022X.2020.1870138

Understanding Your Lab Work - DaVita. (n.d.). Retrieved June 11, 2022, from https://www.davita.com/education/kidney-disease/symptoms/understanding-your-lab-work

Xie, Z., McLean, R., & Marshall, M. (2018). Dietary sodium and other nutrient intakes among patients undergoing hemodialysis in New Zealand. *Nutrients*, *10*(4), 1–11. https://doi.org/10.3390/nu10040502

Yang, J., & He, W. (2020). *Chronic Kidney Disease* (J. Yang & W. He (Eds.)). Springer Nature Singapore Pte Ltd. 2020. https://doi.org/https://doi.org/10.1007/978-981-32-9131-7

Zhu, M., Dou, L., Zhu, M., Liu, S., Zhan, Y., Lu, J., Ni, Z., Qian, J., Cai, H., & Zhang, W. (2018). Variability of serum phosphorus and its association with mortality among hemodialysis patients. *Clinical Nephrology*, *90*(2), 79.

Abstract in Arabic:

يُعرَّف مرض الكلى المزمن (CKD) بعدم قدرة الكلى على أداء وظيفتها في ترشيح الفضلات والسوائل من الدم، ويتطور تدريجياً على مراحل. لتعويض وظيفة الكلى، يتم اللجوء الى غسيل أو زراعة الكلى. غسيل الكلى الدمويّ هو نوع من أنواع غسيل الكلى يتم إجراؤه لتنظيف الدم لمرضى الفشل الكلوي.

يتطلب التغيير المستمر في الحالة الصحية لمريض الكلى تغييرًا مستمراً في النظام الغذائي بما يتماشى مع الاحتياجات التغذوية للمريض ويتم ذلك من خلال تزويد المريض بنظام غذائي خاص بوضعه الصحي ويتم تعديله حسب التغيير الذي يطرأ على حالة المريض الصحية. يؤثر استهلاك الطعام أثناء جلسة غسيل الكلى وبين جلسات غسيل الكلى على العلاج والحالة النفسية للمريض كما يساعد النظام الغذائي السليم في تقليل تراكم الفضلات في الدم.

تناولت دراسات قليلة في فلسطين الحالة التغذوية لمرضى غسيل الكلى وبينت نتائج هذه الدراسات أن معظم مرضى غسيل الكلى يعانون من سوء تغذية خفيف إلى متوسط وأن هناك حاجة إلى توفير برامج تدخل غذائي لمرضى غسيل الكلى في المشافي الفلسطينية.

تعتبر هذه الدراسة الأولى من نوعها التي قامت باجراء تدخل تغذوي لمرضى غسيل الكلى في مجمع فلسطين الطبي وقامت بتقييم مدى التأثير الذي أحدثه هذا التدخل على حالة المريض الصحية بما في ذلك التغيير على مستويات البوتاسيوم والفسفور والصوديوم في الدم والتأثير على نسبة البوتاسيوم والفسفور والصوديوم التي قام المريض بتناولها ونسبة سوء التغذية بين هؤلاء المرضى.

اعتمدت البرامج التغذوية على تزويد المرضى بإحتياجاتهم من البروتين والسعرات الحرارية والصوديوم والبوتاسيوم والفوسفور حسب الاحتياجات التغذوية لكل حالة. اشتملت الدراسة على عينة مكونة من 49 مريضًا من الذكور والإناث من مرضى غسيل الكلى الذين تتراوح أعمارهم بين 18 عامًا وما فوق في مجمع فلسطين الطبي في رام الله والذين يخضعون لجدول غسيل كلى منتظم لمدة لا تقل عن ستة أشهر. تم جمع البيانات الطبية والبيانات الطبية الحيوية وقياسات الجسم وثلاث تقييمات (24 hour recalls) وتقييم (SGA) لتقييم الحالة التغذوية لمرضى غسيل الكلى وتم جمع واستخدام هذه المعلومات في مرحلتين: مرحلة التقييم الأولى قبل تزويد المرضى بالبرامج التغذوية وفي مرحلة التقييم النهائية لدراسة نجاعة البرامج المقدمة للمرضى. تم توثيق وتحليل البيانات التي تم جمعها باستخدام الإصدار 23 من برنامج الحزمة الإحصائية للعلوم الاجتماعية SPSS ، وتم إجراء إحصائات وصفية واستنتاجية.

أظهرت هذه الدراسة نتائجاً ايجابية فيما يتعلق بتناول الفوسفور والبوتاسيوم والصوديوم قبل وبعد التدخل التغذوي حيث انخفض تناول الفوسفور بمتوسط انخفاض قدره 166.6 ملجم وكان التغيير ذا دلالة إحصائية. كذلك انخفض تناول

البوتاسيوم بمتوسط انخفاض قدره 474 ملجم وكان التغيير ذا دلالة إحصائية. علاوة على ذلك ، انخفض تناول الصوديوم بشكل ملحوظ بمتوسط انخفاض قدره 271.1 ملجم وكان التغيير ذا دلالة إحصائية.

أظهرت نتائج مقارنة مستويات الفوسفور والبوتاسيوم والصوديوم في الدم قبل وبعد التدخل الغذائي أن متوسط الفوسفور في الدم زاد بعد التدخل بمتوسط زيادة 0.4 ملغ ، وقد أظهر التغيير أنه ذو دلالة إحصائية. اما بالنسبة لمستوى البوتاسيوم بالدم فقد انخفض بمتوسط انخفاض قدره 0.2 ملجم. علاوة على ذلك ، انخفض متوسط التغير في مستويات الصوديوم في الدم بعد التدخل بمتوسط انخفاض قدره 1.4 ملجم.

تظهر هذه النتائج فعالية الدراسة حيث انخفض تناول الفوسفور والبوتاسيوم والصوديوم بشكل كبير بعد التدخل. علاوة على ذلك ، انخفضت مستويات البوتاسيوم والصوديوم في الدم بعد التدخل. لم يكن الانخفاض في مستويات البوتاسيوم والصوديوم في الدم ذو دلالة إحصائية مما يشير إلى الحاجة إلى مزيد من الوقت لتحقيق انخفاض أكبر في مستويات هذه العناصر في الدم.

Annexes:

Questionnaire:

1. Food habits

1. Do you consider yourself to be a vegetarian or vegan?

Yes, a vegetarian or vegan

2. Neither of them - **move to question 3**

Do you avoid eating: Read all the options, and mark the answers

	Yes, avoid	No, don't avoid
1. Meat (beef, lamb, etc.)	1	2
2. Chicken, turkey	1	2
3. Fish	1	2
4. Dairy products	1	2
5. Eggs	1	2
6. Other foods, specify __________________________		

3. Are you allergic or sensitive to certain types of foods?

Yes

2. No **- move to question 5**

4. Which of the following foods are you allergic or sensitive to? Read all the options, and mark the answers

	Yes	No
1. Wheat	1	2
2. Peanuts, nuts, almonds	1	2
3. Broad beans	1	2
4. Cow's milk	1	2
5. Eggs	1	2
6. Others, specify ______________________		

A. Nutrition Supplements

5. During the past month, have you taken any nutrition supplements such as: multi vitamins, vitamins, minerals, dietary fiber, fish oil, iron or calcium?

Yes

2. No - **move to question 9**

6. Which nutrition supplements do you take? List each nutrition supplement mentioned by the interviewee, in a separate row in this column, and then ask questions 7-8 about each supplement.	**7.** Who recommended the __________ to you? (mention the name of the nutrition supplement)	**8.** How often do you take the __________________? (mention the name of the nutrition supplement)
(specify the supplement)	1. A doctor 2. A dietitian 3. An alternative medicine practitioner 4. Personal initiative 5. Another person, specify____________	1. 5-7 times a week 2. 3-4 times a week 3. 1-2 times a week 4. 1-3 times a month 5. Less than once a month 6. Other, specify_________
(specify the supplement)	1. A doctor 2. A dietitian 3. An alternative medicine practitioner 4. Personal initiative 5. Another person, specify____________	1. 5-7 times a week 2. 3-4 times a week 3. 1-2 times a week 4. 1-3 times a month 5. Less than once a month 6. Other, specify_________
(specify the supplement)	1. A doctor 2. A dietitian 3. An alternative medicine practitioner 4. Personal initiative 5. Another person, specify____________	1. 5-7 times a week 2. 3-4 times a week 3. 1-2 times a week 4. 1-3 times a month 5. Less than once a month 6. Other, specify_________
	1. A doctor	1. 5-7 times a week

(specify the supplement)	2. A dietitian 3. An alternative medicine practitioner 4. Personal initiative 5. Another person, specify____________	2. 3-4 times a week 3. 1-2 times a week 4. 1-3 times a month 5. Less than once a month 6. Other, specify_________
(specify the supplement)	1. A doctor 2. A dietitian 3. An alternative medicine practitioner 4. Personal initiative 5. Another person, specify____________	1. 5-7 times a week 2. 3-4 times a week 3. 1-2 times a week 4. 1-3 times a month 5. Less than once a month 6. Other, specify_________

To the interviewer: if the interviewee mentions more than 5 supplements, use another page.

Other remarks:

E. Diet

Interviewer - read: The next few questions relate to dieting patterns.

19. Are you currently on any kind of diet such as for weight loss, weight maintenance, for medical reasons, or for other reasons?

Yes

No - **move to question 27**

20. Are you on a weight loss or weight maintenance diet?

1. Yes
2. No - **move to question 23**

21. Why are you on this diet? Mark all the selected options

1.Doctor's recommendation

2.Dietitian's recommendation

3.Recommendation of an alternative practitioner

4.Personal decision for health reasons

5.Personal decision ,due to desire to lose weight

6.Joining another person who is dieting.

7.Other reasons, specify______________

22. What is the source of your dietary guidance ? Mark all the selected options

1. Doctor
2. Dietitian (individual or organized advice)
3. Organized program or support group (not led by a dietitian)
4. Books, professional literature
5. Personal knowledge
6. Other, specify: _________________

(Interviewer- if answered “yes” to question 20, then read “another” 23)

23. Are you on any other diet ,which is not for weight loss or weight maintenance?

Yes

No **move to question 27**

24. What kind of diet are you on? Mark all the selected options

1. Low fat or low cholesterol
2. Low salt or low sodium
3. Low sugar
4. Other, specify: ________________

25. Why are you on this diet? Mark all the selected options

Doctor’s recommendation

Dietitian’s recommendation

3. Recommendation of an alternative practitioner
4. Personal decision , for health reasons
5. Joining another person who is dieting.
6. Other reasons, specify_____________

26. What is the source of your dietary guidance? Mark all the selected options

1. Doctor
2. Dietitian (individual or organized advice)
3. Organized program or support group (not led by a dietitian)
4. Books, professional literature
5. Own knowledge
6. Other, specify: _____________________________

<u>2. Attitudes regarding nutrition</u>

Interviewer – read: The following questions relate to your attitudes regarding nutrition.

27. To what extent are you interested in the relationship between nutrition and health?

1. A very large extent

2. A large extent

3. A small extent

4. Not at all

28. To what extent are your eating habits influenced by information or publications about the relationship between nutrition and health?

1. A very large extent

2. A large extent

3. A small extent

4. Not at all

29. What are your sources of information regarding the relationship between nutrition and health? Mark all the selected options

1. Doctor
6. Publications of the Ministry of Health
2. Dietitian
7. Publications of hospitals, health insurance funds
3. Television
8 Personal studying, courses
4. Radio
9. Internet
5. Newspapers, magazines
10. Other, specify______________________.

30. When you buy food products, how important to you are the following	Very important	Important	Not too important	Not at all important
Price	1	2	3	4
Cleanliness of the product, shelf, store	1	2	3	4
“use-by-date’	1	2	3	4
Nutrition information label	1	2	3	4

31. When you read the food label, do you check the _________? **(**mention the information type)		**32.** How well is this information understood?	**33.** In your opinion is this information reliable?
Ingredients list	1. Always continue 2. Often to q. 32 3. Seldom 4. Never	Very well Well Not well Not understood at all 99. (Don’t know)	1. Very reliable 2. Reliable 3. Not reliable 4. Not reliable at all 99. (Don’t know)

List of food colors	1. Always continue 2. Often to q. 32 3. Seldom 4. Never	Very well Well Not well Not understood at all 99. (Don't know)	1. Very reliable 2. Reliable 3. Not reliable 4. Not reliable at all 99. (Don't know)
List of preservatives	1. Always continue 2. Often to q. 32 3. Seldom 4. Never	Very well Well Not well Not understood at all 99. (Don't know)	1. Very reliable 2. Reliable 3. Not reliable 4. Not reliable at all 99. (Don't know)
Nutrition claims such as: low fat, light, low sodium	1. Always continue 2. Often to q. 32 3. Seldom 4. Never	Very well Well Not well Not understood at all 99. (Don't know)	1. Very reliable 2. Reliable 3. Not reliable 4. Not reliable at all 99. (Don't know)
Health claims such as: good for reduction of blood pressure, for stress relief, for memory improvement.	1. Always continue 2. Often to q. 32. 3. Seldom 4. Never	Very well Well Not well Not understood at all 99. (Don't know)	1. Very reliable 2. Reliable 3. Not reliable 4. Not reliable at all 99. (Don't know)
Nutrition labelling, which specifies, the calories, protein, etc. per 100gram,	1. Always continue 2. Often to q. 32. 3. Seldom 4. Never	Very well Well Not well Not understood at all 99. (Don't know)	1. Very reliable 2. Reliable 3. Not reliable 4. Not reliable at all 99. (Don't know)

34 When you read the nutrition labels, do you check the information on:	Always	Often	Seldom	Don't pay attention at all
Calories (energy)	1	2	3	4
Total fat	1	2	3	4
Saturated fat	1	2	3	4
Cholesterol	1	2	3	4
Carbohydrates	1	2	3	4
Salt or sodium	1	2	3	4
Other specify__________	1	2	3	4

3. <u>Health status</u>

35. What is your state of health in general?

1. Very good
2. Good
3. Fair
4. Poor

36. Has a doctor ever diagnosed you as having:: (Interviewer: ask about "treatment" only if "yes")

	Yes	No	Are you on medication?
Anemia, due to lack of iron	1	2	1. Yes 2. No
Osteoporosis, reduced bone density	1	2	1. Yes 2. No
High cholesterol	1	2	1. Yes 2. No
Insulin-dependent diabetes, not including gestational	1	2	1. Yes 2. No
Non insulin-dependent diabetes, not including gestational	1	2	1. Yes 2. No
Stroke	1	2	1. Yes 2. No
Cancer	1	2	1. Yes 2. No

38. Are you receiving any medical treatment or medication on a regular basis?

1.Yes

2. No. move to question 40

39. What medication are you taking, and for what reason?

Medication	Reason
Health Status-Additional comments	

48. Has your weight changed in the past two years?

1. Increase of 5 kg or more

2. Decrease of 5 kg or more

No change **move to question 51**

Other, specify_________________________

49. Were the changes as a result of any type of diet?

1. Yes

2. No

99 (Don't know)

50. In the last two years, were there repeated increases and decreases in your weight, due to dieting?

Yes

2. No.

4. Physical activity

51. There are 24 hours in a day. On average, how many hours, on a weekday, do you_________? mention the activity	Sleep	____hours
	Sit	____hours
	Stand	____hours
	Walk (flat ground, medium pace)	____hours
	Do light physical activity	____hours
	Do heavy physical activity	____hours

52. Over the past year, have you regularly engaged in physical activity, lasting for 20 minutes or more, causing rapid breathing and perspiration?

Yes

No **– move to question 54**

53. How often do you engage in this activity?

4 times a week and more

3 times a week **Move to question 55**.

3. 1-2 times a week

4 2-3 times a month

5. Once a month or less- **Move to question 54**

54. Over the past year, have you regularly engaged in intensive physical activity, lasting for 10 minutes or more, causing rapid breathing and perspiration?

1. Yes –

2. No – **move to question 65**

5. Smoking habits

Interviewer – read: In the following questions I will ask about smoking.

59. Do you now smoke?

1. Yes – **move to question 61**

2. No, I used to smoke – **continue to question 60**

3. No, I have never smoked - **move to question 64**

60. How many years ago did you stop smoking? ☐☐

61. At what age did you start smoking? ☐☐

62. What do you / did you smoke? Mark all the options

Cigarettes – **continue to question 63**

Cigars

Pipe **move to question 64**

Hubble bubble

Other, specify __________

63. How many cigarettes do you / did you smoke? ☐☐

Demographic details

Read: I'd like to ask you some general questions about yourself.

64. How old are you ? ? ☐☐ (Interviewer: check that this matches date of birth)

65. Where were you born?

1. Palestine

2. Other country, specify_____

66. What is your personal status?

1. Single
2. Married
3. Divorced
4. Widowed
5. Separated
6. Other, specify: ___________

70. Over the past three months, have you been/are you? :

1.	Salaried worker (employee)	7.	Not working due to illness/disability/handicap
2.	Self-employed	8.	On Maternity leave
3.	Student (working)	9.	Pensioner
4.	Working as non- paid family member	10.	Not working/unemployed
5.	Full time home manager	11.	Not working for other reasons, specify_____
6.	Student (non-working)	12.	Other, specify__________________

71. If you are working, what is the main work you do at your workplace? ______________________

75. Which is the highest degree you have?

1. National Diploma (Tawjihi)

2. Diploma

3. Bachelor degree

4. Professional certificate

5. Other, specify: ______________

6. None

77. List the people living in the house, and their relationship to you. Mark √ in the suitable columns.

	1	2	3	1	5	6	7	8
Spouse								
Parent								
Grandparent								
Son/daughter								
Brother/sister								
Roommate, friend								
Other, specify:__________								

Anthropometric measurements

To the interviewer – read: With your permission, I would like to weigh and measure you.

80. Height (cm): [ ] [ ]

81. Weight (kg): [ ] [ ]

82. Waist [ ] [ ]

83. Hip [ ] [ ]

Interviewer: If you cannot weigh or measure (refusal, wheelchair etc), specify this, including reason.

B. <u>24-hour food recall</u>

Read: I will now ask you for details about everything you ate and drank yesterday. If asked why from 4:00 - read: "Previous studies show that at 4:00 it is possible to distinguish between one day (24 hours) to the next day (24 hours).

9.What did you eat**: Write each item in a separate row, and when the interviewee has finished, continue to question 10.**			**10.** What time did you begin to eat /drink the ______? Specify the item	Where did you eat? At home (home cooked food) Home-(ready-made /bought food) 3-At work-home- prepared food 4 At work- ready made/bought food 5. At work- cafeteria, dining room 6.restaurant
	The quick list	√		7. other (specify)
a				
b				
c				Which meal?
d				1. Breakfast
e				2. Morning snack
f				3. Breakfast + Lunch(Brunch)
g				4. Lunch
H				5. Afternoon snack
i				6. Lunch/Dinner combined
j				7. Dinner
k				8. Late night snack
l				9. Other (specify)
m				
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				

<u>Food/Drink description.</u>

Item	Hour	Where did you eat/drink this item?	What meal was it?	**Item name**	**11. Food/drink description**	**12. What quantity did you eat/drink?**
1	**2**	**3**	**4**	**5**	**6**	**7**
					1	
					2	
					3	
					4	
					5	
					6	
					7	
					8	
					9	
					10	
					11	
					12	
					13	
					14	
					15	
					16	
1	**2**	**3**	**4**	**5**	**6**	**7**
					17	
					18	
					19	
					20	
					21	
					22	
					23	
					24	
					25	
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					41	
					42	
					43	
					44	

SGA

Subjective Global Assessment Form

MEDICAL HISTORY

Patient name: ______________________ Date: ______ / ______ / ______

NUTRIENT INTAKE

1. ☐ No change; adequate
2. Inadequate; duration of inadequate intake ______
   ☐ Suboptimal solid diet ☐ Full fluids or only oral nutrition supplements ☐ Minimal intake, clear fluids or starvation
3. **Nutrient Intake in past 2 weeks***
   ☐ Adequate ______ ☐ Improved but not adequate ______ ☐ No improvement or inadequate ______

WEIGHT

Usual weight ______ **Current weight** ______

1. **Non fluid weight change past 6 months** Weight loss (kg) ______
   ☐ <5% loss or weight stability ☐ 5-10% loss without stabilization or increase ☐ >10% loss and ongoing
   If above not known, has there been a subjective loss of weight during the past six months?
   ☐ None or mild ☐ Moderate ☐ Severe
2. **Weight change past 2 weeks*** Amount (if known) ______
   ☐ Increased ☐ No change ☐ Decreased

SYMPTOMS (Experiencing symptoms affecting oral intake)

1. ☐ Pain on eating ☐ Anorexia ☐ Vomiting ☐ Nausea ☐ Dysphagia ☐ Diarrhea
   ☐ Dental problems ☐ Feels full quickly ☐ Constipation
2. ☐ None ☐ Intermittent/mild/few ☐ Constant/severe/multiple
3. **Symptoms in the past 2 weeks***
   ☐ Resolution of symptoms ☐ Improving ☐ No change or worsened

FUNCTIONAL CAPACITY (Fatigue and progressive loss of function)

1. No dysfunction
2. Reduced capacity; duration of change ______
   ☐ Difficulty with ambulation/normal activities ☐ Bed/chair-ridden
3. **Functional Capacity in the past 2 weeks***
   ☐ Improved ☐ No change ☐ Decrease

METABOLIC REQUIREMENT

High metabolic requirement ☐ No ☐ Yes

PHYSICAL EXAMINATION

Loss of body fat	☐ No	☐ Mild/Moderate	☐ Severe
Loss of muscle mass	☐ No	☐ Mild/Moderate	☐ Severe
Presence of edema/ascites	☐ No	☐ Mild/Moderate	☐ Severe

SGA RATING

☐ **A** Well-nourished
Normal ☐ **B** Mildly/moderately malnourished
Some progressive nutritional loss ☐ **C** Severely malnourished
Evidence of wasting and progressive symptoms

CONTRIBUTING FACTOR

☐ **CACHEXIA** - (fat and muscle wasting due to disease and inflammation) ☐ **SARCOPENIA** - (reduced muscle mass and strength)

*See page 2 SGA Rating for more description.

April 2017

Canadian Malnutrition Task Force® | le Groupe de travail canadien sur la malnutrition®

Subjective Global Assessment Guidance For Body Composition

SUBCUTANEOUS FAT

Physical examination	Normal	Mild/Moderate	Severe
Under the eyes	Slightly bulging area	Somewhat hollow look, Slightly dark circles,	Hollowed look, depression, dark circles
Triceps	Large space between fingers	Some depth to fat tissue, but not ample. Loose fitting skin.	Very little space between fingers, or fingers touch
Ribs, lower back, sides of trunk	Chest is full; ribs do not show. Slight to no protrusion of the iliac crest	Ribs obvious, but indentations are not marked. Iliac Crest somewhat prominent	Indentation between ribs very obvious. Iliac crest very prominent

MUSCLE WASTING

Physical examination	Normal	Mild/Moderate	Severe
Temple	Well-defined muscle	Slight depression	Hollowing, depression
Clavicle	Not visible in males; may be visible but not prominent in females	Some protrusion; may not be all the way along	Protruding/prominent bone
Shoulder	Rounded	No square look; acromion process may protrude slightly	Square look; bones prominent
Scapula/ribs	Bones not prominent; no significant depressions	Mild depressions or bone may show slightly; not all areas	Bones prominent; significant depressions
Quadriceps	Well defined	Depression/atrophy medially	Prominent knee, Severe depression medially
Interosseous muscle between thumb and forefinger (back of hand)**	Muscle protrudes; could be flat in females	Slightly depressed	Flat or depressed area

FLUID RETENTION

Physical examination	Normal	Mild/Moderate	Severe
Edema	None	Pitting edema of extremities / pitting to knees, possible sacral edema if bedridden	Pitting beyond knees, sacral edema if bedridden, may also have generalized edema
Ascites	Absent	Present (may only be present on imaging)	

A - Well-nourished no decrease in food/nutrient intake; < 5% weight loss; no/minimal symptoms affecting food intake; no deficit in function; no deficit in fat or muscle mass **OR** *an individual with criteria for SGA B or C but with recent adequate food intake; non-fluid weight gain; significant recent improvement in symptoms allowing adequate oral intake; significant recent improvement in function; and chronic deficit in fat and muscle mass but with recent clinical improvement in function.

B - Mildly/moderately malnourished definite decrease in food/nutrient intake; 5% - 10% weight loss without stabilization or gain; mild/some symptoms affecting food intake; moderate functional deficit or recent deterioration; mild/moderate loss of fat and/or muscle mass **OR** *an individual meeting criteria for SGA C but with improvement (but not adequate) of oral intake, recent stabilization of weight, decrease in symptoms affecting oral intake, and stabilization of functional status.

C - Severely malnourished severe deficit in food/nutrient intake; > 10% weight loss which is ongoing; significant symptoms affecting food/nutrient intake;severe functional deficit **OR** *recent significant deterioration obvious signs of fat and/or muscle loss.

Cachexia – If there is an underlying predisposing disorder (e.g. malignancy) and there is evidence of reduced muscle and fat and no or limited improvement with optimal nutrient intake, this is consistent with cachexia.

Sarcopenia – If there is an underlying disorder (e.g. aging) and there is evidence of reduced muscle and strength and no or limited improvement with optimal nutrient intake.

**In the elderly prominent tendons and hollowing is the result of aging and may not reflect malnutrition.

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