Investigation of total antioxidant status and antioxidant activity in pre-dialysis chronic kidney disease patients

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การวิเคราะห์สภาวะต้านออกซิเดชันและความสามารถในการต้านอนุมูลอิสระใน ผู้ป่วยโรคไตเรื้อรังระยะก่อนล้างไต

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ทิ ฮ้อง แลน บุย : การวิเคราะห์สภาวะต้านออกซิเดชันและความสามารถในการต้านอนุมูลอิสระในผู้ป่วยโรคไตเรื้อรังระยะก่อนล้างไต (Investigation of total antioxidant status and antioxidant activity in pre-dialysis chronic kidney disease patients) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ทิพยเนตร อริยปิติพันธ์, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: เกื้อเกียรติ ประดิษฐ์พรศิลป์, หน้า.

โรคไตเรื้อรังเป็นปัญหาทางสาธารณสุขทั่วโลกรวมทั้งประเทศไทย ภาวะเครียดออกซิเดชันเป็นกลไกหนึ่งที่สำคัญของพยาธิสภาพของโรคไตเรื้อรัง การประเมินภาวะของไมโครนิวเตรียนซึ่งเป็นสารอาหารกลุ่มรองที่มีคุณสมบัติต้านอนุมูลอิสระร่วมกับการประเมินพลังงานและโปรตีนที่ได้รับจากอาหารนั้นมีความสำคัญอย่างมากในการแก้ไขปัญหาการได้รับสารต้านอนุมูลอิสระไม่เพียงพอ การลดระดับภาวะเครียดออกซิเดชันและดูแลการสุขภาพโดยรวมให้ดีขึ้น การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อตรวจวิเคราะห์และเปรียบเทียบภาวะเครียดออกซิเดชันและตัวชี้วัดของสารต้านอนุมูลอิสระในผู้ป่วยโรคไตเรื้อรังระยะต่างๆ และอาสาสมัครสุขภาพดี รวมทั้งศึกษาความสัมพันธ์ระหว่างค่าดังกล่าวกับรูปแบบการบริโภคอาหารกลุ่มที่มีสารต้านอนุมูลอิสระ ทำการเก็บข้อมูลแบบ Cross-sectional study ในผู้ป่วยนอกที่มีภาวะไตเรื้อรัง ระยะก่อนได้รับการบำบัดทดแทนไตจากคลินิกต่อมไร้ท่อและเมตาบอลิสม จำนวน 33 คนและอาสาสมัครสุขภาพดี (กลุ่มควบคุม) จำนวน 13 คน โดยกลุ่มตัวอย่างประเมินความถี่ในการเลือกบริโภคอาหารด้วยแบบสอบถาม ตรวจวัดค่าองค์ประกอบของร่างกายและเจาะเลือดเพื่อตรวจวิเคราะห์ระดับมาโลนไดอัลดีไฮด์ สารต้านอนุมูลอิสระรวม กลูต้าไธโอน เปอร์ออกซิเดสการทำงานของเอนไซม์พาราออกโซเนส-1 และคำนวณความถี่ในการบริโภคอาหารกลุ่มสารต้านอนุมูลอิสระในอาหารที่รับประทาน ผลการศึกษาพบว่า กลุ่มผู้ป่วยไตเรื้อรังทุกระยะมีระดับมาโลนไดอัลดีไฮด์สูงกว่ากลุ่มควบคุม (p = 0.01) และระดับพาราออกโซเนส-1 ต่ำกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ (p < 0.05) นอกจากนี้พบมีความสัมพันธ์เชิงบวกระหว่างรูปแบบการบริโภคอาหารกลุ่มผักที่มีวิตามิน ซี สูงกับระดับกลูต้าไธโอน เปอร์ออกซิเดสในพลาสมา จากผลการศึกษานี้แสดงให้เห็นว่า ผู้ป่วยนอกโรคไตเรื้อรังชาวไทยมีระดับภาวะความเครียดออกซิเดชันในร่างกายสูงขึ้นและการทำงานของเอนไซม์ต้านอนุมูลอิสระลดลง ดังนั้น การประเมินการได้รับอาหารกลุ่มที่มีสารต้านอนุมูลอิสระจึงมีความสำคัญ เนื่องจากการได้รับสารอาหารที่มีคุณสมบัติต้านอนุมูลอิสระกลุ่มนี้ไม่เพียงพอในผู้ป่วยโรคไตเรื้อรัง อาจส่งผลกระทบต่อสมดุลระหว่างภาวะเครียดออกซิเจนและสารต้านอนุมูลอิสระในร่างกาย

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THI HOANG LAN BUI: Investigation of total antioxidant status and antioxidant activity in pre-dialysis chronic kidney disease patients. ADVISOR: ASST. PROF. TIPAYANATE ARIYAPITIPUN, Ph.D., CO-ADVISOR: PROF. KEARKIAT PRADITPORNSILPA, M.D., pp.

Chronic kidney disease (CKD) has still been a worldwide public health problem including Thailand. Oxidative stress is considered as an important pathogenic mechanism in CKD. Evaluating the status of micronutrients that have antioxidant properties along with energy and proteins intake, is extremely important to combat antioxidant deficiencies, minimize oxidative stress, and improve the overall health status. This study aimed to measure and compare oxidative stress, antioxidant markers and their relationships with dietary antioxidant food pattern. This study was a cross-sectional study and was performed in outpatients Metabolic clinic. Thirty-three Thai pre-dialysis CKD outpatients and 13 healthy participants were recruited. All patients and controls completed a food frequency questionnaire. Then, anthropometric measurements, general biochemical and antioxidant lab tests were performed. Malonaldehyde (MDA), Total antioxidant status (TAS), Glutathione peroxidase (GPx), Paraoxonase 1 (PON-1) and dietary antioxidant food pattern score were investigated. The results showed that MDA significantly increased (p = 0.01), and PON-1 significantly decreased among CKD patients and controls (p <0.05). There was a positive correlation between the rich-vitamin C vegetable pattern with plasma GPx. Based on this study indicated that oxidative stress increase and antioxidant enzyme activity decrease in Thai CKD outpatients. Therefore, the assessment of dietary antioxidants was important, as deficiency of these nutrients might influence on the balance of the oxidative stress and antioxidants in CKD patients.

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CHAPTER 1

INTRODUCTION

1.1. Rationales

Chronic kidney disease (CKD) is defined as the presence of kidney damage, confirmed by kidney biopsy or markers of damage; or decreased level of kidney function as the presence of a glomerular filtration rate (GFR) less than 60 mL/min/1.73 m^2; each for three months or more [1]. Over the last decades, CKD has still been a worldwide public health problem, affecting approximately 13% of the USA population [2]. Incidence is now as high as 200 cases per million per year in many countries. It is nearing 400 cases per million in the USA, Taiwan, and some regions in Mexico, and has risen fastest in older individuals. Thailand is also one of countries that have rising incidence and prevalence of kidney failure with over 100 cases per million and 600 cases per million, respectively, every year [3]. Prevalence seems to be increasing particularly in older people, and mostly because of a developing prevalence of diabetes and hypertension [4, 5]. CKD patients have a high risk of death caused by stroke or heart attack, and CKD may progress to renal failure or end-stage renal disease (ESRD). Then renal replacement therapy, including dialysis or transplantation, is essential, but this is along with loss of quality of life, decreased individual life expectancy, and increased costs to health-care systems [6].

Oxidative stress is an imbalance between free radical productions and reduced anti-oxidant defenses. Free radical productions usually increased through dysfunctional mitochondria formed with rising age, type 2 diabetes mellitus, and inflammation. Distresses in cellular oxidant control influence downstream cellular signaling and, in the kidney, promote renal cell apoptosis and senescence, decreased regenerative ability of cells, and fibrosis [6]. These factors have a spontaneous harmful effect on kidney function. Therefore, oxidative stress considered as an important pathogenic mechanism in CKD.

One of the markers for oxidative stress is serum malondialdehyde (MDA), which is a marker of lipid peroxidation. It is the breakdown product of chain reactions leading to oxidation of polyunsaturated fatty acids. MDA is raised in CKD,

inversely related to glomerular filtration rate (GFR), and positively correlated with uremic toxins and severity of glomerulosclerosis [7-9].

In order to protect the cells and organ systems of the body against oxidative stress, particularly reactive oxygen species (ROS), humans have developed a highly sophisticated and complex antioxidant protective system included a variety of components, both endogenous and exogenous. The important components of antioxidant defense, which can be impaired in CKD patients, are antioxidant enzymes such as catalase, glutathione peroxidase, superoxide dismutase, and paraoxonase.

Glutathione peroxidase (GPx) is an enzyme that is responsible for protecting cells from damage due to free radicals, such as hydrogen and lipid peroxides in the presence of reduced glutathione. Several types of GPx have been identified. Two of them are cellular GPx (cGPx) found in blood cells and extracellular GPx (eGPx) present in plasma. An impaired activity in the glutathione antioxidant system that occurs early in the course of chronic uremia, progresses with the stages of CKD, and is further aggravated by hemodialysis. [10].

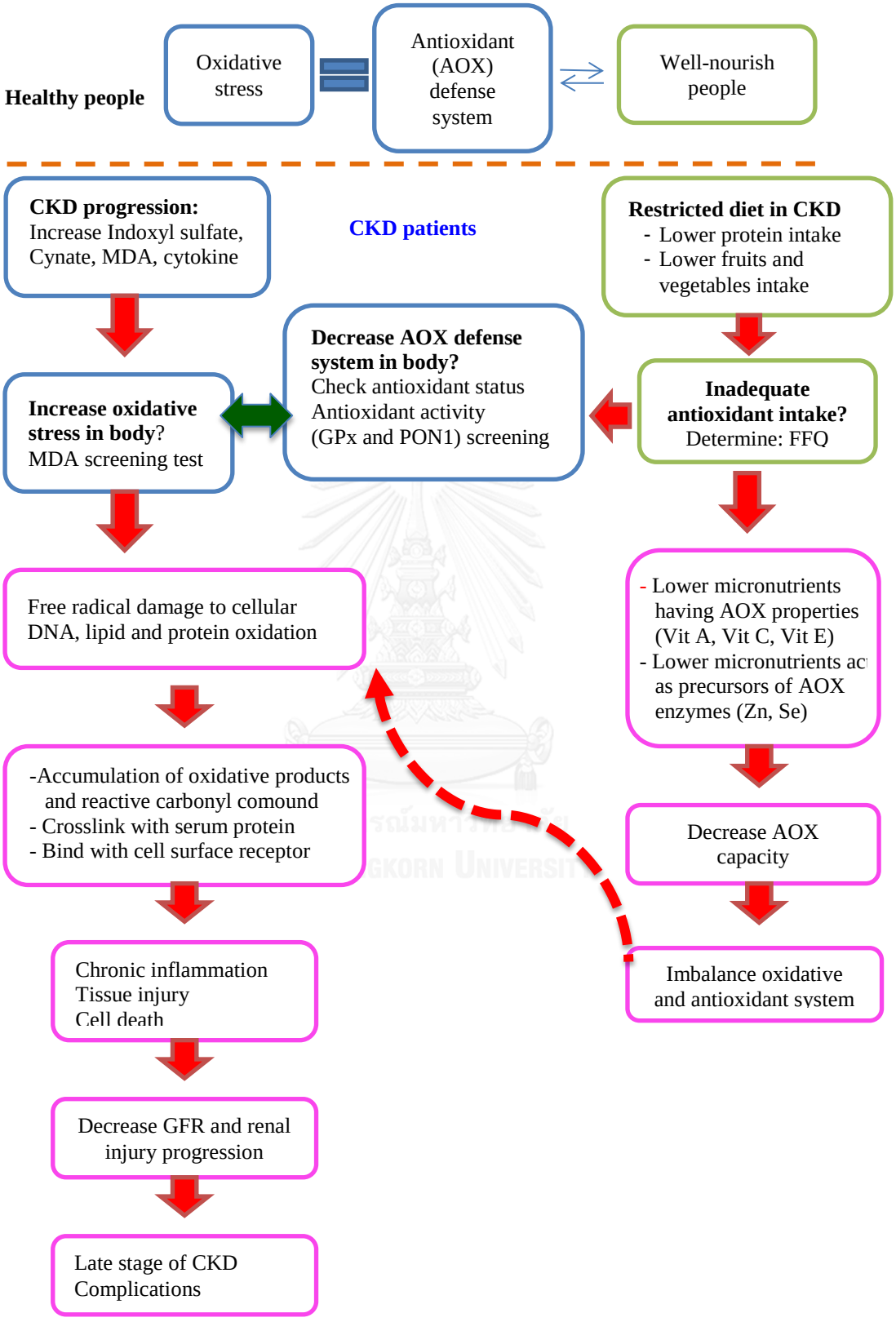
Another component of enzymatic antioxidant defense, especially important in the context of atherosclerosis development risk, is paraoxonase. The paraoxonase family consists of three members, including PON-1, PON-2, and PON-3. All of them share structural properties and enzymatic activities have the ability to hydrolyze oxidized lipids in low-density lipoprotein (LDL). In which, PON-1 is a high-density lipoprotein (HDL) - associated enzyme which catalyses the breakdown of phospholipid and cholesteryl-ester lipid peroxides, and has been shown to reduce the susceptibility of LDL to peroxidation. Mass and activity of PON-1 in the plasma significantly influence the risk of developing cardiovascular disease. This likely mediated by its antioxidant properties on LDL and/or macrophages. HDL associated protein such as PON-1 prevents or attenuates oxidation of LDL and the oxidative stress of macrophages by againsting foam cell formation via Reduction of cholesterol and oxidized lipids influx, inhibition of macrophage cholesterol synthesis, and stimulation of macrophage cholesterol efflux [11]. Because of the important role in maintaining the prooxidant-antioxidant balance, the markers of antioxidant activities, such as GPx and PON-1 in different stages of CKD still requires further analysis.

Many markers could describe antioxidant status and activities. However, the validation of certain factors in renal failure is still unclear, especially the estimation of total antioxidant capacity in simple tests such as total antioxidant status (TAS). However, the relationship between antioxidant status and kidney function is intensely influenced by confounding variables such as uric acid, which is poorly regulated in renal failure [12].

In addition, malnourished predialysis patients have biochemical evidence of more oxidative stress than well-nourished ones have [13]. Complex systems of multiple types of antioxidants include antioxidants (such as glutathione, vitamin C, and vitamin E) and enzymes (such as catalase, superoxide dismutase, and various peroxidases) to respond the damaging oxidative reactions. Dietary antioxidants may be especially important in protecting against human diseases associated with free-radical damage [13, 14]. However, current data is not sufficient to quantitate micronutrient requirements to protect against oxidative damage. Assessment of dietary intake, including the intake of dietary antioxidants, in CKD patients should be important and obligatory. Evaluating the status of micronutrients having antioxidant properties or acting as precursors of antioxidant enzymes along with macronutrients, such as energy and proteins, is extremely important to combat antioxidant deficiencies, minimize oxidative stress, and improve the overall health status. Therefore, this study was conducted in order to evaluate the MDA as an oxidative stress marker and TAS, GPx, and PON-1 as antioxidant markers in pre-dialysis CKD patients. Also, we investigated the correlation of these markers with dietary antioxidant patterns.

There is some evidence indicating that decrease renal function is associated with imbalance oxidative stress and antioxidant. Yet, the number of studies assessing total antioxidant status and markers of antioxidant activities like GPx and PON-1 in patients in the various stages of CKD is limited, and results are inconsistent. Therefore, this study was conducted in order to describe the oxidant - antioxidant imbalance by analyzing MDA, which is an oxidative stress marker, total antioxidant status, and activity markers (GPx and PON-1) in patients with different stages of CKD.

1.2. Conceptual framework



1.3. Research questions

1. Whether are levels of plasma MDA, total antioxidant status, and markers of antioxidant activity (GPx and PON-1) in Thai pre-dialysis CKD outpatients different from those of the control group?
2. Whether are levels of plasma MDA, total antioxidant status, and markers of antioxidant activity (GPx and PON-1) in Thai pre-dialysis CKD outpatients different from various stages?
3. Whether is there a relationship between oxidative stress and antioxidant markers with dietary antioxidant pattern in Thai pre-dialysis CKD outpatients?

1.4. Objectives

1. To measure levels of plasma MDA, total antioxidant status, and markers of antioxidant activity (GPx and PON-1) in Thai pre-dialysis CKD outpatients and compare with those of the control group
2. To measure levels of plasma MDA, total antioxidant status, and antioxidant activity (GPx and PON-1) in various stages of Thai pre-dialysis CKD outpatients.
3. To determine dietary antioxidant pattern and their relationship with oxidative stress and antioxidant markers in Thai pre-dialysis CKD outpatients

1.5. Hypothesis

1. There are difference in levels of plasma MDA, total antioxidant status, and markers of antioxidant activity (GPx and PON-1) between Thai pre-dialysis CKD outpatients and the control group.
2. There is difference in levels of plasma MDA in Thai pre-dialysis CKD outpatients with various stages.
3. Total antioxidant status and levels of plasma PON and GPx reduce in Thai pre-dialysis CKD outpatients with decreasing renal function.
4. There is a negative relationship between oxidative stress and dietary antioxidant pattern, and a positive relationship between antioxidant markers and dietary antioxidant pattern in Thai pre-dialysis CKD outpatients.

CHAPTER 2

LITERATURE REVIEW

2.1. Prevalence of chronic kidney disease

Over the last decades, CKD has still been a worldwide public health problem, affecting nearly 3% of the USA population [2]. Incidence is around 200 cases per million per year in many countries, including Thailand. Some countries, such as USA, Taiwan, and some regions in Mexico, have the incidence nearly 400 cases per million, and has increased fastest in older individuals. Dialysis is the common method for treatment in most countries. With average survival of 3 – 5 years, prevalence is reaching 1800 cases per million in the USA. High survival explains to high prevalence reaching 2400 cases per million in Japan and Taiwan. Diabetes is one of the main causes of kidney failure, approximately 40% or more of new cases in most countries [3].

Thailand is also one of countries that have rising incidence and prevalence of kidney failure with over 100 cases per million and 600 cases per million, respectively, every year [3]. The research conducted in the year of 2004 showed that the prevalence of CKD in Thai adults by stage was 8.1%, 0.2%, and 0.15% for stage 3, stage 4, and 5, respectively. CKD patients were older, had a higher level of cholesterol, and higher blood pressure, compared to non-CKD individuals. People with cardiovascular risk factors were more possibly lead to CKD than those without, including hypertension (OR 1.6, 95%CI 1.1, 3.4), diabetes (OR 1.87, 95%CI 1.0, 3.4). About region distribution, northeast of Thailand had the higher prevalence than central region (OR 2.1, 95%CI 1.3, 3.3) [15].

2.2. Kidney function

Two kidneys locate on either side of the spine at the lowest level of the rib cage. There are approximately a million functioning units called nephron per kidney. Each nephron consists of a filtering unit of tiny blood vessels called a glomerulus attached to a tubule. The kidney plays an important role in the body such as clean the blood, keep the balance of salt and minerals in blood, help control blood pressure,

make erythropoietin, which stimulates red blood cell production and make an active form of vitamin D, needed for bone health.

When kidney get some types of abnormality, or markers, such as protein in the urine and having decreased kidney function for three months or longer, chronic kidney disease might be diagnosed. There are many causes of chronic kidney disease. The kidneys may be affected by diseases such as diabetes and high blood pressure. Some kidney conditions are inherited or congenital.

2.3. Definition and classification of chronic kidney disease

Chronic kidney disease has been defined according to the criteria developed by National Kidney Foundation's Kidney Disease Outcomes Quality Initiative [1]

- Kidney damage for ≥ 3months, as defined by structural and functional abnormalities of kidney, with or without GFR (Glomerular Filtration Rate), manifest by either:
  - Pathological abnormalities, or
  - Markers of kidney damage, including abnormalities in composition of the blood and urine, or abnormalities in imaging tests
- GFR < 60 mL/min/1.73 m^2 for ≥ 3months with or without kidney damage

Classification of CKD patients in these following stages based on Glomerular filtration rate

- Stage 1: GFR ≥ 90 mL/min per 1.73 m^2 and persistent albuminuria
- Stage 2: GFR between 60 to 89 mL/min per 1.73 m^2
- Stage 3: GFR between 30 to 59 mL/min per 1.73 m^2
- Stage 4: GFR between 15 to 29 mL/min per 1.73 m^2
- Stage 5: GFR < 15 mL/min per 1.73 m^2 or end-stage renal disease

According to an update of the this guidelines in 2012, the classification of CKD also includes the addition of albuminuria stages based on urine albumin to creatinine ratio (UACR) by these categories: 10 – 29, 30 – 299, 300 - 1999 and > 2000 mg/g are high normal, high, very high and symptoms of nephritic syndrome respectively. Since UACR is recommended for estimation of 24 - hour urine albumin

excretion rather than using non-standardized urine dipstick for total urinary protein measurement. [16]

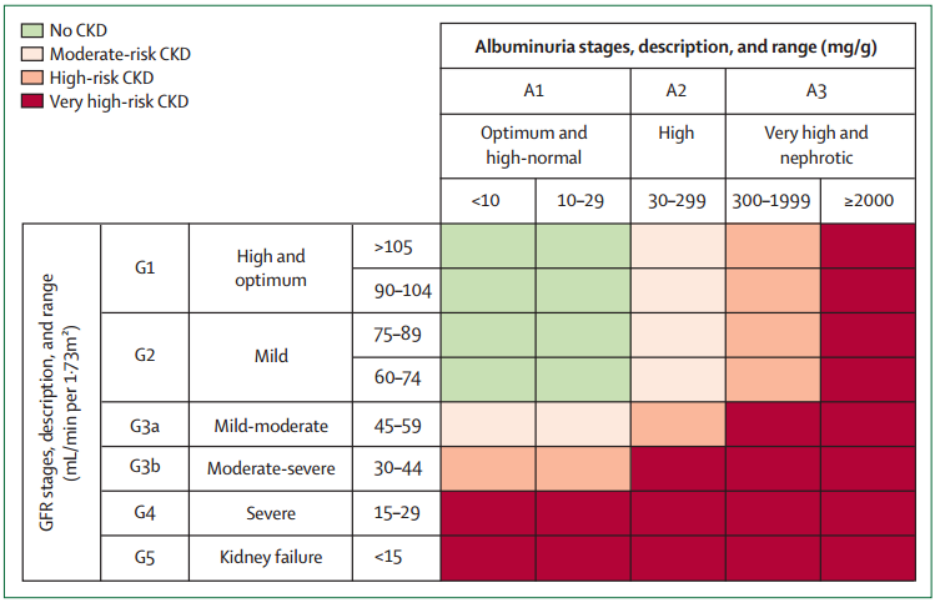


Figure 2.1 Prognosis of CKD by GFR and albuminuria [16]

2.4. Estimation of GFR

The estimate GFR (eGFR) is calculated by using Chronic kidney disease Epidemiology Collaboration (CKD-EPI) creatinine equation. [17, 18]

$$GFR=141 \times \min(S_{cr}/K,1)^{\alpha} \times \max(S_{cr}/K,1)^{-1.209} \times 0.993^{Age} \times 1.018 \text{ (if female)} \times 1.15 \text{ (if black)}$$

Where:

- S_{Cr} is serum creatinine in mg/dL
- K is 0.7 for females and 0.9 for males
- α is -0.329 for females and -0.411 for males
- min indicates the minimum of S_{Cr}/K or 1, and max indicates the maximum of S_{Cr}/K or 1

The Thai eGFR formula was expressed as [19]:

$$eGFR = 375.53 \times Cr_{Enz}^{(-0.848)} \times Age^{(-0.364)} \times (0.712 \text{ if female}), (r^2 = 0.869)$$

2.5. Risk factors of chronic kidney disease

In principle, risk factors for development of chronic kidney disease would include susceptibility factors and initiation factors. In addition, because it can be difficult to detect the onset of chronic kidney disease, some risk factors for faster progression may appear to be to susceptibility or initiation factors [1].

Progression factors may be associated with progression either because initial damage cannot be resolved or because damage is ongoing. In addition, numerous factors have been shown to be associated with worse outcomes in patients with kidney failure, such as inadequate dialysis dose, temporary vascular access, anemia, and low serum albumin concentration.

In developed countries, chronic kidney disease is generally associated with old age, diabetes, hypertension, obesity, and cardiovascular disease. Diabetic glomerulosclerosis and hypertensive nephrosclerosis are the supposed pathological causes; however, it is difficult to diagnose exactly. In developing countries, common causes of chronic kidney disease also include glomerular and tubulointerstitial diseases resulting from infections and exposure to drugs and toxins [3]

Table 2.1 Types and examples of risk factors for chronic kidney disease [1]

Types	Examples
Susceptibility factors	• Older age, family history • US ethnic minority status: African American, American Indian, Hispanic, Asian or Pacific Islander • Exposure to certain chemical and environmental conditions • Low income or low education
Initiation factors	• Diabetes • High blood pressure • Autoimmune diseases, systemic infections, • Urinary tract infections, urinary stones, lower urinary tract obstruction, • Drug toxicity
Progression factors	• Higher level of proteinuria, higher blood pressure level, • poor glycemic control in diabetes, smoking

2.6. Co-diseases

2.6.1. Hypertension

Hypertension is a traditional cardiovascular risk factor which contributes to cardiovascular disease in CKD. Patients with hypertension increased risk of new or periodic cardiovascular events in stage 2–3 CKD [20]. Anemia and hypertension are two CKD associated complications, offered to play a role in the development of left ventricular hypertrophy which rises in relation to progressively lower levels of eGFR [21]. KDIGO guidelines recommend target blood pressure equal and less than 140/90 mmHg for all patients both diabetes and non-diabetes adults with kidney disease and urine albumin excretion < 30 mg/24 hours. For whose with CKD and urine albumin excretion > 30 mg/24 hours, blood pressure should maintain equal and less than 130/80 mmHg [16].

2.6.2. Diabetic nephrology

Diabetes is associated with adverse outcomes in all stages of CKD. Moreover, lower fasting plasma glucose and/or glycated hemoglobin levels are associated with lower risk of all cause and cardiovascular death in individuals with moderate to severe renal impairment [22]. In people with CKD and diabetes, glycemic control should be part of a multifactorial intervention strategy addressing blood pressure control and cardiovascular risk, promoting the use of angiotensin-converting enzyme inhibition or angiotensin receptor blockade, statins, and antiplatelet therapy where clinically indicated. According to KDIGO guideline, a target hemoglobin A_1c (HbA_1c) of around 7.0 % (53 mmol/mol) is suggested to prevent or delay progression of the microvascular complications of diabetes, including diabetic kidney disease [16].

2.7. Complications of CKD

2.7.1. Hyperuricemia

It is the fact that approximately 70% of uric acid is excreted from the kidney, thus, hyperuricemia occurs when renal function worsens. Hyperuricemia is diagnosed by urate concentrations above 7.0 mg/dL (420mmol/L). It has not been clear if the hyperuricemia plays a role in the progression of renal disease. However, recent clinical studies indicated that the serum uric acid value is closely associated with

hypertension in hyperuricemic patients. It is important to recognize the association of hyperuricemia with CKD and adverse cardiovascular outcomes. Therefore, hyperuricemia was defined as a potential contributor to progression [16].

According to the KDIGO guideline, there is lacking evidence to support the use of agents to lower serum uric acid concentrations CKD patients and either symptomatic or asymptomatic hyperuricemia in order to delay progression of CKD [16].

2.7.2. Anemia

Anemia usually tends to appear in progressive CKD. Almost 50% of patients with CKD-associated anemia was analyzed [23]. A strong correlation between the prevalence of anemia and the severity of CKD was demonstrated. One quarter of stage 1 CKD patients, half of those progresses to CKD stages 2, 3, and 4, and three quarters of CKD patients starting dialysis was diagnosed anemia [23].

Anemia may occur in CKD by many mechanisms such as iron, folate, or vitamin B12 deficiency, gastrointestinal bleeding, severe hyperparathyroidism, systemic inflammation, and shortened red blood cell survival. However, one of the most important specific risk factor causing CKD-associated anemia is erythropoietin synthesis and decreased this process is necessary. Erythropoietin is a glycoprotein secreted by the kidney interstitial fibroblasts and is essential for the growth and differentiation of red blood cells in the bone marrow [24]. In CKD, tubular atrophy generates tubulointerstitial fibrosis, which cooperation renal erythropoietin synthetic capacity and results in anemia [25].

Anemia in CKD with cardiovascular complications, such as angina, left ventricular hypertrophy, may increase morbidity and mortality [26]. It may make renal function worsen and lead to a vicious cycle called the “cardio-renal anemia syndrome” [25]. Left ventricular hypertrophy is associated with decreased survival of patients on dialysis. Moreover, anemia is an independent predictor of death in stable coronary artery disease patients with CKD [27]. Therefore, it is important to develop primary care for anemia diagnosis and management in CKD patients.

2.7.3. Hyperphosphatemia and bone disorder

Phosphate excretion and 1-α-hydroxylation of vitamin D primary happen in kidney. Hyperphosphatemia is developed in patients with CKD because of inadequate 1, 25 dihydroxy-vitamin D levels and reduced renal phosphate excretion. As a result, serum calcium levels fall leading to increase secretion of parathyroid hormone, thus, increase the calcium levels by increasing bone reabsorption and promoting 1-α-hydroxylation of 25-hydroxy vitamin D synthesized by the liver [25]. It is the fact that hyperphosphatemia is one of the most important risk factors associated with cardiovascular disease in CKD patients [28].

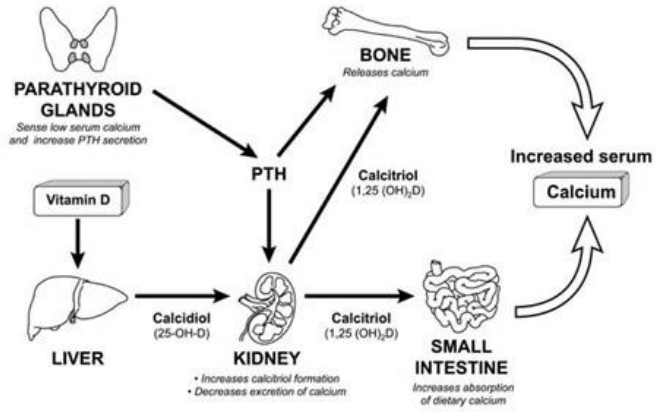


Figure 2.2 Calcium regulation [28]

Changes in bone architecture can be caused by either a high bone turnover state or a low bone turnover state. Four types of renal osteodystrophy can be diagnosed in CKD patients are osteitis fibrosa cystica (high bone turnover with secondary hyperparathyroidism), osteomalacia (low bone turnover and inadequate mineralization, related to diminished vitamin D synthesis), a dynamic bone disorder (low bone turnover from excessive suppression of the parathyroid glands), and mixed osteodystrophy (with elements of both high and low bone turnover). The predominant type of renal osteodystrophy and CKD-mineral and bone disorder changes between pre-dialysis and end stage renal disease patients. In pre-dialysis patients, high bone turnover is most prevalent of bone disease. In contrast, low bone turnover predominates in dialysis patients [29]. The cause of this prevalent bone phenotype

results from oversuppression of parathyroid hormone and high calcium dialysate concentrations [30].

Acidosis, the suppressive effect of phosphate maintenance on renal synthesis of 1, 25 dihydroxyvitamin D synthesis, and absence of the physiologic inhibitory effect of vitamin D on parathormone secretion are also minor factors that contributing to the low turnover bone disease in CKD patients [31]. Chronic kidney disease-associated mineral bone disorders significantly increase mortality in CKD patients.

2.7.4. Cardiovascular diseases

In patients with end stage renal disease, the increased cardiovascular risk has been well recognized in clinical practices and studies. It is estimated that mortality rates caused by cardiovascular diseases among dialysis patients are tend to one hundred folds higher than age- and sex-matched individuals in the general population [32].

One of non-traditional risk factors which play a role in mediating cardiovascular risk in CKD is inflammation. Markers of inflammation are often increase in CKD patients and are predictive of cardiovascular risk. Some studies have indicated that high serum C-reative protein (CRP) was an independent predictor of all cause and cardiovascular mortality after adjusted for confounding variables [25, 33].

Proteinuria, a reliable marker of renal impairment, increased risks for cardiovascular disease and early cardiovascular mortality in patients with and without diabetes and hypertension [34].

2.7.5. Hyperlipidemia

Dyslipidemia is prevalent in CKD patients. It is a major risk factor for cardiovascular morbidity and mortality. Overall, the incidence of hyperlipidemia rises as renal function decreases, with the degree of hypertriglyceridemia and elevation of LDL cholesterol being related to the severity of renal impairment [25].

There are many factors contributing to the development dyslipidemia associated with CKD. Patients with CKD have a reduction in the activities of lipoprotein lipase and hepatic triglyceride lipase. This interferes with uptake of rich-triglyceride lipoproteins, apolipoprotein B by the liver and in peripheral tissue, yielding increased circulation of these atherogenic lipoproteins. Hypercholesterolemia

in nephrotic syndrome may occur due to the increased production of lipoproteins and its decreased catabolism. The degree of lipoprotein abnormality is associated to the amount of proteinuria and inversely related to serum albumin levels [35]. However, infusions of albumin or dextran both normalize lipoprotein concentrations, suggesting that oncotic pressure changes rather than hypoalbuminemia signals increased lipoprotein synthesis by the liver. In-vitro study indicated that increased hepatic apolipoprotein-B gene transcription in cells exposed to reduced oncotic pressure [35]. Hyperparathyroidism and the accumulation of calcium in pancreatic islet cells likely contribute to dyslipidemia of CKD as well [36]. It is the fact that several observational studies of chronic kidney disease patients suggest that lower total cholesterol levels are associated with higher mortality rate [25]. In a prospective study, the relation between total cholesterol levels and mortality was conducted in 1,167 stage 5 kidney disease patients. Hypercholesterolemia, which is defined as total cholesterol levels > 200 mg/dL, was associated with the increase of mortality rate [37].

A complete fasting lipid profile with assessment of total, LDL and HDL cholesterol, and triglyceride levels should be included in the evaluation of patients with CKD and hyperlipidemia. Individuals with elevated cholesterol or other forms of hyperlipidemia should undergo evaluation for secondary dyslipidemias before initiation of lipid lowering therapy [38]. In the past, KDOQI guidelines recommend that all stages of CKD be considered cardiovascular disease risk equivalent and LDL-cholesterol levels should be lowered below 100 mg/dL (2.6 mmol /L) [1]. Recently, the KDIGO guideline indicated that targets for LDL-Cholesterol (1.8 or 2.6 mmol/L [70 or 100 mg/dL]), which required repeated measurements of LDL-cholesterol and treatment growth with higher doses of statin or initiation of combination lipid-lowering therapy when the LDL-cholesterol target is not met [39]. CKD patients may achieve LDL goals via implementation of lifestyle modification, including dietary modification with dietitian consultation, increased physical activity, moderate alcohol intake, and smoking ending. All adults with CKD should be evaluated for lipid abnormalities.

2.8. Oxidative stress in CKD

Oxidative stress (OS) is prevalent in CKD patients and is considered as an important pathogenic mechanism in this population. Oxidative stress develops from an imbalance between formation of reactive oxygen species (ROS), occurring when there is excessive free radical production and low antioxidative defense. This leads to chemical alterations of bio-molecules, causing structural, and functional modifications. Therefore, finding of ROS only has not defined oxidative stress yet. In a situation where antioxidative defense mechanisms reduce, oxidative stress occur as a result of the imbalance between formation of ROS and defense mechanisms [14].

Chronic kidney disease is a pro-oxidant state [40]. Previous studies showed that lipids, proteins, and DNA oxidation markers increase in the plasma of CKD patients [41, 42]. In addition, other oxidative markers may present in atherosclerotic injuries of CKD patients, such as hypochlorous acid - modified lipoproteins [43], and advanced glycation end products (AGEs) [44].

2.8.1. Oxidative stress mechanism

The pathogenesis of oxidative stress in CKD patients is multifactorial and includes several possible causes, for example, uremia-related factors (hyperhomocysteinemia or AGEs), intravenous iron supplementation, and dialysis-related factors (bio-incompatible membranes or endotoxin-contaminated dialysate) [40].

Renal sources for ROS are activated macrophages, vascular cells, and various glomerular cells [45]. The fundamental mechanisms responsible for oxidative stress in CKD patients include increased production and decreased clearance of ROS, as well as a dysfunctional antioxidant defense system [46, 47]. The balance between formation of ROS and antioxidative defence mechanisms depends on the activities of enzymes such as superoxide dismutases (SOD), catalase, NO-synthase, and glutathione peroxidase [47, 48] This balance, however, is rather fragile and strongly dependent on environmental conditions [49]. Taking SOD for example, once O_2^- is formed, the activity of SOD will transform it to H_2O_2. Then in the presence of sufficient catalase activity, H_2O_2 will be converted to harmless H_2O and O_2. However, too much SOD relative to H_2O_2- removing catalase can be poisonous,

giving rise to the formation of the highly reactive hydroxyl radical in the presence of metal ions such as Fe^{2+} or Cu^{2+}(Fenton reaction) [49]. In contrast, when there is too little SOD activity, $OH^{\cdot}$ also can be produced from O_2^{-} *via* the Haber Weiss reaction. Reactive oxygen species can be formed from vascular and glomerular cells including fibroblasts, from leucocytes, and from renal interstitial cells [50]. Cellular sources of ROS formation include different cellular enzymes, such as mitochondrial oxidases, lipoxygenase, cyclooxygenase, myeloperoxidase, NADPH oxidase, xanthine oxidase, and in the case of L-arginine or tetrahydrobiopterin reduction, NO-synthase [48, 51-53]

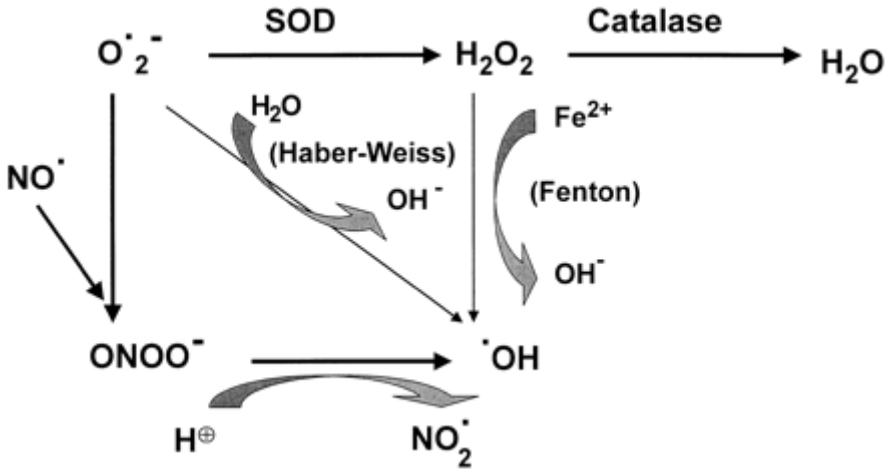


Figure 2.3 Formation of reactive oxygen species [54]

It should be noted that high serum levels of urea (0.4–1.4 mg/mL or 40–140 mg/dL) can change the reversible reaction between H_2O_2 and urea toward the formation of stable urea hydrogen peroxide, which is a stable form of H_2O_2, and a cytotoxic agent accumulating in the tissues of CKD patients [55]. The increased urea hydrogen peroxide in CKD enhances the formation of pentosidine and carboxymethyllysine via the Fenton reaction [40].

2.8.2. Biological effects of oxidative stress

Oxidative stress can cause inflammation, which plays a role in a variety of renal diseases, such as glomerulonephritis, acute or progressive renal failure, or tubulointerstitial nephritis [45, 56], contributing to proteinuria. Reactive oxidative stress also contributes to the pathogenesis of ischemia-reperfusion injury [57].

Additionally, as a result of their impact on cell cycle regulation, oxygen radicals may contribute to hypertrophy of tubular cells [58]. In the vascular system, the interaction of O_2^- with NO is a major importance, particularly in the setting of hypercholesterolaemia, atherosclerosis, and hypertension. The important endothelial vasodilator autacoid NO is inactivated by O_2^- [59], and the reaction product peroxynitrite ($ONOO^-$) favors formation of even more ROS such as OH [60]. Consequence, endothelial dysfunction and alterations of cellular turnover occur.

Increased lipid peroxidation and reduced enzymatic antioxidant defense have been detected in pre-dialysis patients [13]. Renal dysfunction is frequently associated with oxidative stress, as levels of different oxidative stress markers like malondialdehyde (MDA) are increased in patients with varying degrees of renal function [61, 62]. In conclusion, perturbations in cellular oxidant handling influence downstream cellular signaling and promote renal cell apoptosis and senescence, decreased regenerative ability of cells, and fibrosis in the kidney. These factors have a stochastic deleterious effect on kidney functions.

2.8.3. Markers of oxidative stress in CKD patients

Because oxidants are highly reactive compounds with only seconds half-life, their determination in vivo is normally not practicable. However, lipids, proteins, carbohydrates and nucleic acids, after being modified by oxy-radicals, have lifetimes ranging from hours to weeks, making them ideal markers of oxidant stress [63]. Oxidative stress biomarkers have a positive correlation between increasing oxidative stress with increasing stages of CKD [12]. These markers can be measured in urine, serum, tissues, cell cultures or other biological products such as breath, skin, or food samples [6]. Some of oxidative stress biomarkers from lipids, proteins, carbohydrates and nucleic acids oxidation can be shown in Table 2.2 (63)

Table 2.2 Biomarkers of oxidative stress [64]

	Markers
Lipid peroxidation	Malondialdehyde (MDA)
	F2-isopronstanes
	Oxidized low-density lipoproteins (LDL)
	Oxidized LDL antibodies
	Advanced lipid oxidation products
	Acrolein
	4-hydroxynonenal
	Thiobarbituricacid-reactive substances
Protein oxidation	Protein carbonyls
	Advanced oxidation protein products (AOPPs)
	Thiol oxidation
	Advanced glycation end products (AGEs)
	3-nitrotyrosine
Carbohydrate oxidation	Reactive aldehydes
	Reducing sugar (ascorbate, ribose, etc)
Nucleic acid oxidation	8-hydroxy-2-deoxyguanosine (abbre)

2.8.3.1. Biomarkers of lipid peroxidation

Malondialdehyde (MDA) is generated by the peroxidation of polyunsaturated fatty acids with two or more methylene interrupted double bonds. It has been used to determine increased oxidative stress during CKD progression [65]. Furthermore, MDA is more than a lipid peroxidation product. Several impaired physiological mechanisms which react with DNA and proteins can be formed MDA during physiological metabolisms [65].

Malondialdehyde is elevated in CKD [7-9], in particularly, it inversely related to eGFR [8], and positively correlated with uremic toxins [66] and severity of glomerulosclerosis [7]. Moreover, MDA is diminished in ESRD patients having undergone a kidney transplant when compared to patients receiving dialysis [67]. It is diminished using non-traditional dialysis techniques including vitamin E-coated regenerated cellulose hollow fiber dialyzers [41], and antioxidant therapies such as

trimetazidine, erythropoetin-vitamin E therapy [68], and amino/keto acids with vitamins A, vitamin C, and vitamin E [69].

The analysis of MDA by the thiobarbituric acid assay has been widely employed over many years. The principle of this spectrophotometric assay is based on heating of the sample under acidic conditions to form an adduct MDA - $(TBA)_2$, which can be detected at 532 nm [70]. However, the specificity of the assay can be questioned because aldehydes, other than MDA, can react with TBA and various other pigments may absorb at the wavelength of 532 nm, giving an over-estimation of MDA concentrations. Then, high-performance liquid chromatography (HPLC) extraction of MDA from plasma, with subsequent quantification, is considered a reliable measure of oxidative stress [70, 71]. The separation of the complex MDA - $(TBA)_2$ from other interfering compounds by reverse phase HPLC techniques has led to a reduction in observed MDA levels in various biological fluids [70]. In addition, improved methods derivative MDA with 2,4-dinitrophenylhydrazine (DNPH), which forms specific hydra zones for MDA separated by HPLC and quantified using methyl-MDA as an internal standard. However, the values of MDA are particularly high, approximately two orders of amount higher than the common plasma MDA values obtained with other recent and validated methods, despite the relatively mild reaction conditions allowed by DNPH (10 minutes at room temperature) and the great attention put into the method validation steps [72].

Urinary MDA as a measure of the impaired kidney function in patients can be difficult to interpret. It is given that renal clearance of MDA possibly provides an adaptive mechanism to prevent lipid peroxidation accumulating within kidney tubular cells [62].

2.8.3.2. Biomarkers of protein oxidation

Advanced oxidation protein products (AOPPs) accumulate in the serum of CKD patients, especially those with uraemia and diabetes [73]. They are principally derived from serum albumin following hypochlorous acid free radical attack and they provide a valuable indicator of oxidant-damaged proteins [74]. The incidence of albuminuria or proteinuria in CKD and its impact on AOPP has not yet been studied [6].

Protein carbonyl assays quantify the carbonyl groups associated with protein oxidation. Protein carbonyls are not specific for oxidative stress as they also measure glycated proteins and bound aldehydes [75]. An increase in protein carbonyls was demonstrated in CKD patients in stages 3 to stage 5. However, there was no correlation found between protein carbonyl levels and decreased GFR yet [76]. Protein carbonyls was also found to be increased in plasma and lymphocytes of diabetes patients compared with healthy control subjects [77].

2.9. Antioxidant protection systems

2.9.1. Antioxidant mechanism

To protect the cells and organ systems of the body against oxidative stress, humans have evolved a highly sophisticated and complex antioxidant protective system. It involves a variety of components, both endogenous and exogenous, those function interactively and synergistically to neutralize free radicals. Whenever the balance between reactive oxidative species production and antioxidant defense is lost, oxidative stress results through a series of events. It deregulates the cellular functions leading to various pathological conditions.

These antioxidant components include as follows [78, 79].

- Enzyme antioxidants: such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx)
- Chain breaking antioxidants: include lipid phase (such as tocopherols, carotenoids, flavonoids, ubiquinol) and aqueous phase (such as albumin, ascorbate, urate, glutathione, and other thiols)
- Metal binding proteins: such as transferrin, ferritin, lactoferrin, ceruloplasmine

There are some defense mechanisms against free radical-induced oxidative damage. Taking enzymes antioxidants as examples, CAT, SOD, GPx and thiol-specific antioxidants can act as catalytic removals of free radicals and reactive species. Binding proteins (such as transferrin, metallothionein, haptoglobins, ceruloplasmin) contain pro-oxidant metal ions, such as iron and copper, and have protection against macromolecular damage by proteins such as stress or heat shock

proteins. Besides, there are some reduction of free radicals by electron donors, such as GSH, vitamin E, vitamin C, bilirubin, and uric acid [79].

The most important defense against radical-induced damage are enzymatic antioxidants which decrease oxidant concentrations in tissues. Antioxidants have two classes including the primary antioxidant and the secondary or preventative antioxidant. The former delays or inhibits the initiation step of radical production by reacting directly with a radical or inhibiting the propagation step by reacting with peroxyl or alkoxyl radicals. The latter slows the oxidation rates via substrate removal or quenching of singlet oxygen, a highly reactive form of molecular oxygen [80]. Researchers use different terms to express the functions of antioxidant including total antioxidant efficiency, effectiveness, action, power, parameter, potential, potency, and activity [81]

2.9.2. Biomarkers of antioxidant in kidney disease

Choosing biomarkers is very important for measuring antioxidant status and activity, and finding the relationship between antioxidant system and CKD patients as well. According to a review of Tucker et al in 2013, there were many oxidative stress and antioxidant status markers in human. Researchers and physicians should carefully choose which markers are most appropriate to monitor in CKD patients. As a result that these markers have relationship with other well characterized markers of a toxic environment and clinical indicators of kidney function and health. Moreover, its reliability and validity, and ability to make useful cross-study comparisons also need to be concerned [80].

2.9.2.1. Total antioxidant capacity or status

Patients with renal insufficiency have decreased antioxidant defense and suffered from overstated OS when compared to healthy controls [82]. Several techniques are used to assess the overall antioxidant status, such as total radical-trapping antioxidant potential, total antioxidant capacity, total antioxidant status. However, results are difficult to compare across studies due to different measurement techniques, tissues, and the environment.

Total antioxidant status (TAS) assays include enhanced chemiluminescence (ECL) assay [83], spectrophotometric methods, such as FRAP assay [84], CUPRAC

assay [85] or methods based on the formation of the ABTS+ radical [86], fluorometric methods, such as ORAC assay [87], and electrochemical methods like colorimetry [88], voltammetry [89] or electron spin resonance assay [90]. Some of the above spectrophotometric and fluorometric assays are now commercially available. The total (peroxyl) radical-trapping antioxidant potential (TRAP) assay is the most widely use of those methods. However, it is unfortunately too lengthy to permit the analysis of large sets of samples and is technically difficult, requiring specialized equipment. A more recent technique measures the ability of antioxidants within physiological fluids to quench the absorbance of the radical cation formed by the reaction of 2,2'-azmnobis-(3-ethylbenzothiazolmne-6-sulfonic acid) (ABTS) with a peroxidase and hydrogen peroxide. This method is suitable for automation with a centrifugal analyzer and thus permits rapid throughput of samples [91].

However, the relationship between antioxidant system and kidney health is strongly influenced by confounding variables, such as uric acid, which is poorly regulated in renal insufficiency [12]. It was proposed that uric acid might act as an antioxidant, a free radical scavenger and a chelate of transitional metal ions which were converted to poorly reactive forms [92]. *In vitro* experiment showed that uric acid was a powerful scavenger of reactive oxygen species [93]. Moreover, the association of the greater serum uric levels and the higher TAS levels in individuals with atherosclerosis was observed in a prospective case-control study [94]. Nevertheless, the role of uric acid as an antioxidant remains elusive. Due to enzyme xanthine oxidase in the path way producing uric acid involve in the ROS production, which is an important role in the increased vascular oxidative stress and atherogenesis [93, 95]. Therefore, it should be under the consideration when choosing the TAS test for assessing the antioxidant capacity of patients with hyperuricemia.

There is a research conducted to investigate the relationship between antioxidant-rich food intakes and blood total antioxidant status and vitamin C and E levels. This study found that there is associations between antioxidant rich food consumption and serum TAS and plasma levels of antioxidants in a generally healthy older population and suggest that increased intakes of these foods may confer significant health benefits [96]. Antioxidant rich foods were defined as plant-based foods containing high amounts of vitamins C, vitamin E, and phytochemicals (such as

polyphenols, terpenes and organosulfur compounds)[97]. Negative associations between the consumption of antioxidant rich foods and the risk of chronic diseases were demonstrated in some epidemiological studies [98]. It has been proposed that antioxidant food may act to reduce oxidative damage [99].

2.9.2.2. Glutathione peroxidase activity

The antioxidant defense system can be divided into two major sources including endogenous enzymes and small, mostly exogenous compounds, acting as free radical scavengers [100]. In aerobic organisms several enzymes are involved in scavenging free radicals, such as superoxide dismutases, catalases and glutathione peroxidases (GPx). Glutathione peroxidases is responsible for the conversion of H_2O_2 and other organic peroxides, to water and oxygen [101]. Five isoforms of GPx have been identified. Glutathione peroxidases in RBC and GPx (eGPx) in plasma are two existing in human blood [101].

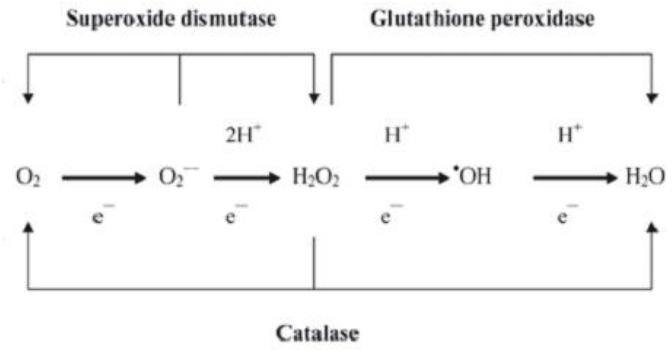


Figure 2.4 Participation of antioxidant enzymes in neutralization of reactive oxidative species in mammalian tissues [100]

Selenium (Se) is known as an integral structural component of the active site of red blood cell GPx. It is the most widely characterized selenoprotein, which present in erythrocytes and cytosol of nearly all tissues of mammals, birds, and several other organisms [102].

2.9.2.3. Superoxide dismutase

Superoxide dismutase (SOD) is classified into three groups including cytosolic (CuZn-SOD), mitochondrial (Mn-SOD), and extracellular (E-SOD) [81]. All of which dismutase superoxide to hydrogen peroxide and molecular oxygen and

especially, no other enzymes catalyze this reaction [103]. Superoxide and SOD have a delicate relationship. Overproduction of superoxide starts stimulate lipid peroxidation, protein oxidation, and DNA damage, all of which can cause cell death [103].

There are convinced that research measuring SOD in CKD are inconsistent. Some studies reported diminished activity of SOD [104] while others reported that SOD activity was normal [105] or increased [7] even when other markers of antioxidants, such as GPx were reduced [105]. Thus, SOD activity must be carefully interpreted in CKD condition. It was found that SOD had an inverse relationship with serum creatinine [106] and was positively correlated with GFR in CKD patients [8]. Nevertheless, it was suggested that the lack of stability in SOD should be carefully inferred.

2.9.2.4. Catalase

Catalase (CAT) is an antioxidant enzyme found mainly in peroxisomes but it also exists in cell cytosol. It is able to detoxify various phenols, alcohols, and hydrogen peroxide. This ubiquitous enzyme protects body from oxidative damage by reducing hydrogen peroxide to water and oxygen [64].

Some studies showed that CAT activity diminished in CKD patients [107]. Similar to SOD, interpretation of CAT activity in CKD patients should be careful, as a result that CAT activity was normal [108] or elevated in CKD even when other antioxidants were decreased [82]. Less data exist to characterize the relationship between CAT activity and kidney health [81]. Researches indicated a more steady relationship between CAT and diabetic complications [109, 110] suggesting that CAT might reflect antioxidant in diabetes, rather than CKD [81].

2.9.2.5. Thioredoxin

Thioredoxin (TRX) is a 12 kD protein, secreted by most cell types, with a redox-active dithiol/disulfide in the active site consensus sequence (-Cys-Gly-Pro-Cys-) showing antioxidative properties [111]. Serum TRX is known to be elevated in patients with increased oxidative stress, such as cancer, cardiac conditions [112], and CKD [111].

Thioredoxin has a redox-active cysteine pair through which interacts with other proteins to regenerate proteins damaged by ROS. For example, reduced TRX can restore activity to H_2O_2–inactivated glyceraldehyde–3–phosphate dehydrogenase. Thioredoxin is also a cofactor for methionine sulfoxide reductase, which can reduce methionine sulfoxide residues in oxidized protein caused by ROS. It acts as an electron donor to peroxiredoxin or thioredoxin peroxidase and glutathione peroxidase to reduce hydrogen peroxide. Besides, it also functions in redox-sensitive signal transduction, transcriptional activation of stress response genes, ribonucleotide reduction in the synthesis of deoxyribonucleotides for DNA repair, and post-injury cell proliferation [112].

Although normal concentrations of plasma TRX are low, the TRX dithiol motif makes it well-suited to reverse oxidative changes to proteins [112]. There is an inverse relationship between TRX and GFR, suggesting a protective mechanism [111].

2.9.2.6. Paraoxonase

Paraoxonase or aryl**e**sterase are proteins whose physiological significance has not been fully elucidated. The paraoxonase family consists of three members including PON-1, PON-2, and PON-3 sharing structural properties and enzymatic activities. They have the ability to hydrolyze oxidized lipids in LDL [113].

Human PON-1 (aryldialkylphosphatase) is an esterase associated with apolipoprotein AI (apoAI) and clusterin (apolipoprotein J) in HDL. The PON-1 displays both paraoxonase and arylesterase activities because it hydrolyzes paraoxon, an organophosphate compound and phenylacetate, an aromatic carboxylic acid esters, respectively. Moreover, PON-1 possesses peroxidase-like activity contributing to its protective effect against lipoprotein oxidation seen in CKD [114]. It also displays homocysteine-thiolactonase activity that may be linked with its antiatherogenic properties. Lipids in lipoproteins, macrophages, and erythrocytes are protected from oxidation by PON-1. Besides of its antioxidant properties, PON-1 has also added antiatherogenic activities against macrophage foam cell formation. This function helps reduce cholesterol and oxidized lipids influx, inhibit macrophage cholesterol synthesis, and stimulate of macrophage cholesterol efflux [115, 116]. Therefore, PON-1 is also called as a cardioprotective enzyme.

There are many markers that are used to investigate antioxidant status in CKD. Paraoxonase-1 (PON-1) has recently known as one of reliable markers [116]. In contrast to other antioxidant markers especially, SOD and CAT, some studies showed that PON-1 was diminished in CKD patients compared to the healthy control [117]. Therefore, PON-1 might be a sensitive measurement of antioxidant status [81].

There was evidence showed that extra virgin olive oil had been particularly effective in increasing PON-1 activity. It could be due to low saturated fatty acid intake, oleic acid enrichment of phospholipids present in high-density lipoproteins that favor the activity, and increasing hepatic PON-1 mRNA and protein expressions induced by minor components present in this oil [118, 119]. There were some studies showed that there was association between PON-1 and Mediterranean diet. Mediterranean diet is based on the basics of healthy eating, such as eating fruits and vegetables, whole grains, legumes and nuts, using olive oil, reducing red meat, and replacing by fish and poultry. They also indicated compounds isolated from all natural products, mainly phenolic compounds and carotenoids which were particularly effective. This might enhance the use of nutraceuticals and functional foods capable of potentiating PON-1 activity [119-121].

Beside some common markers for CKD patients, such as GPx, CAT, and SOD, there are some novel markers of antioxidant for example TRX and PON-1. However, these markers received less attention by the researchers. Results might be hard to interpret due to a marker's relationship to kidney disease has yet to be fully elucidated or the marker's activities or roles are not fully understood [81]. In which, based on literature review, it is convinced that GPx is a more stable indicator of the antioxidant marker than other markers, such as SOD and CAT. Moreover, PON-1 is also a sensitive measurement of antioxidant in CKD patients and needs more attention. Therefore, beside total antioxidant status, this study was conducted and focused on GPx and PON-1.

2.10. Nutrition status and chronic kidney disease

Uremic malnutrition is very common among CKD patients. Several studies have established a correlation between malnutrition and poor clinical outcome. There are some evidences to suggest that a poor pre-dialysis nutritional status increases patient morbidity and mortality after beginning renal replacement therapy.

2.10.1. Nutritional assessment

Current nutrition assessment and management in adult CKD patients relies on analysis of biochemical parameters revealed by blood indices, including blood urea nitrogen (BUN), creatinine, albumin, potassium, phosphorus, calcium, sodium, cholesterol, triglycerides, and glucose. Other important components of the nutrition assessment include anthropometric measurements for example body weight, height, triceps skinfold, abdominal circumference, calf circumference, and midarm muscle circumference. Physical and clinical evaluations, and food intake information are also assessed. In this chapter, we will focus only on biochemical assessment and dietary assessment.

2.10.1.1. Biochemical assessment

2.10.1.1.1. Blood urea nitrogen

Pre-dialysis blood urea nitrogen **(**BUN) concentration is highly associated with dietary protein intake when patients are clinically stable. Thus, blood urea nitrogen can be used to indirectly monitor the patient's protein intake. Optimal BUN values for adult dialysis patients are in the range of 60 to 80 mg/dL, whereas values above 100 mg/dL suggest excessive dietary protein intake. Values below 60 mg/dL suggest inadequate protein intake, anabolism, residual kidney function, or intense dialysis [122].

2.10.1.1.2. Albumin

Albumin is most often used to assess visceral stores, likely reflecting the wide availability of the albumin assay and the association between albumin and clinical outcomes. Serum albumin is the most widely studied nutritional marker used to assess nutritional status in all patient populations because of its availability and strong association with hospitalization and risk of death [123]. Albumin, which indicates serum proteins, is a one of biochemical parameter for nutrition status assessment and has the relationship with body protein turnover in clinically stable conditions. However, the abnormalities in serum protein synthesis may not be directly related to nutrition status changing [124]. Low levels of serum albumin are highly predictive of poor clinical outcomes in all stages of CKD. Thus, serum albumin is considered a reliable marker of general clinical status [125]. However, serum

albumin has a long half-life about 18 to 20 days, and it is often a late marker of malnutrition. As known that prealbumin is more sensitive than albumin for monitoring the early stage of malnutrition [25].

A twofold increase in the relative risk for death has been reported for hemodialysis patients with serum albumin levels between 3.5 to 4.0 g/dL, compared with those with levels of 4.0 to 4.5 g/dL, whereas patients with serum albumin concentration of 2.5 g/dL may be at 20-fold higher risk for death [122].

Clinical guidelines recommend maintenance of a value of 4.0 g/dL or greater for serum albumin in stage 5 CKD patients. Non-nutritional causes of hypoalbuminemia, such as tissue injury, hepatic disease, gastrointestinal disorders, and volume overload, can affect the specificity of this marker [126].

2.10.1.1.3. Serum creatinine

Low serum creatinine concentrations are associated with poor clinical outcome for maintenance of stage 5 in CKD. Patients with serum creatinine concentration less than 10 mg/dL should be evaluated for muscle wasting because of poor nutrition. Need more info about creatinine, creatine, muscle wasting.

2.10.1.1.4. Cholesterol

Serum cholesterol concentration is an independent predictor of mortality in chronic dialysis patients, and low levels can suggest low dietary and energy intake. Serum cholesterol concentrations less than 150 mg/dL also permit careful evaluation of nutritional status [25].

2.10.1.2. Dietary assessment

Obtaining patient-reported food intake is an important element of the nutritional care of patients with CKD. Quantify food intake helps reveal sources of problems related to food intake and tolerance, food habits, patterns, and allergies. Dietary assessment include dietary recalls over short periods of time, such as 24-hour recall, food records with or without supplementary dietary interviews, conducted over short periods of time (3 to 7 days), and food frequency for longer term, for example weeks to months [127].

2.10.1.2.1. Dietary recall

Dietary recall is usually conducted by an experienced dietitian during a face to face or telephone interview and concerns to the food intake during the day before, which is during the entire 24 hours. The key strength of 24 hours recall is convenience and rapidity and the fact the patients do not need to provide or prepare records of diaries. Its main limitations are reliance and accurate on individual's memory, interviewer's comprehensiveness, the effectiveness of their prompts, and the accuracy of extrapolating 24 hours of dietary intake to a longer period [127, 128]. Taking dialysis patients for example, food intake pattern on dialysis and non-dialysis days may be significantly different [129]. To overcome these limitations, several recalls are took in order to yield more accurate averaged data [128].

2.10.1.2.2. Food record

Diet diaries and records give dietary information over several days, usually 3 or 7 days. Researchers may provide a booklet with color photographs showing small, medium, or large portions and instructions to guide the details and types of information to be reported [130]. Otherwise, household measures and standard units are also used to describe amounts of foods consumed. This method's advantages are the expected real time recording of the food intake and the extended period of time beyond 24 hours. Its disadvantages include varying instructions of patient compliance, missing or inaccurate recordings of food items, and inability to capture seasonal or other cycling variations in dietary pattern [127].

2.10.1.2.3. Food Frequency Questionnaire

In food frequency questionnaire (FFQ), dietary intake is estimated from a self- or interviewer managed. The FFQ usually includes a large number of commonly intake food items with multiple choices for the frequency of food, for example, once or more a day to one a week or a month or less often. Food item questions may also be associated with specified serving sizes, which might be natural portions or standard weight. For each food item, the participants indicate their average frequency of consumption over the past several months to years. The selected frequency category for each food item is then converted to a daily intake value [130]. Recently, FFQ was

found useful in evaluating the dietary intake of a cohort of hemodialysis patients because of their advantages, such as convenience, large temporal catchment, then less sensitivity to seasonal variations, relatively high reliability in ranking subjects across each food item, and feasibility and low cost for large scale epidemiologic studies. However, there are some limitations of FFQ which should be considered, for example, lack of accuracy for estimation dietary intakes of individuals or small groups of people, inadequate coverage to include all available food items, inclusion of diverse varieties of a given food under one single food item question, and hence, failure to capture significant differences among different food subtypes [127, 130].

2.10.1.3. Questionnaire validation

2.10.1.3.1. Importance of validity of questionnaire

Validity is the ability of an instrument to measure what it is intended to measure. It is extent to which an empirical measure adequately reflects the real meaning of the concept under consideration. Therefore, validity is importance because it answer the question whether research use appropriate methods and procedures [131].

2.10.1.3.2. Types of validity of questionnaires

There are many types of validity of questionnaires, such as content validity, criterion validity, and construct validity. Content validity addresses the match between test questions and the content or subject area they are intended to assess. This concept of match is sometimes referred to as alignment, while the content or subject area of the test may be referred to as a performance domain.

Criterion validity measure instrument successfully predict a specific criterion. Criterion-related validity looks at the relationship between a test score and an outcome. There are two types of criterion validity, which are predictive validity and concurrent validity.

Construct validity refers to the degree to which a test or other measure assesses the underlying theoretical construct that it is supposed to measure. Construct validation requires the compilation of multiple sources of evidence. In order to demonstrate construct validity, evidence that the test measures what it purports to

measure as well as evidence that the test does not measure irrelevant attributes are both required. These are referred to as convergent and discriminant validity [131].

2.10.1.3.3. Content validity index

Content validity index (CVI) is the degree to which an instrument has an appropriate sample of items for construct being measured. There are two kinds of CVI, which is the content validity index for items (I-CVI) and content validity index for scale (S-CVI) [132]. In I-CVI, some studies recommended a minimum of three experts, but more than 10 was probably unnecessary. Using 4-point scale was suggested with several different labels along the item-rating continuum have appeared in the literature. One of those labels was as follows: 1 is not relevant, 2 is somewhat relevant, 3 is quite relevant, and 4 is highly relevant. Then, for each item, the I-CVI is computed as the number of experts giving a rating of either 3 or 4, divided by the total number of experts. The I-CVI should be 1.00 when there are five or fewer judges. When there are six or more judges, the standard can be relaxed, but I-CVIs are recommended no lower than 0.78. The S-CVI is defined as ‘‘the proportion of items given a rating of quite/very relevant by both raters involved’’ and ‘‘the proportion of items given a rating of 3 or 4 by both raters involved’’. Many writers have indicated that an S-CVI of 0.80 or higher is acceptable. There are 2 types of S-CVI, which are S-CVI/UA and S-CVI/Ave. The S-CVI/UA is a proportion of items on a scale that achieves a relevance rating of 3 or 4 by all the experts while S-CVI/Ave is an average of the I-CVIs for all items on the scale. The acceptability of S-CVI/Ave should be more than 0.9 [132, 133].

2.10.2. Dietary antioxidant therapy and its effects on antioxidant status

There was evidence to suggest that the effect of antioxidant therapy differed according to CKD stages, especially significant renal benefits for patients with CKD stage 3 and stage 4, and kidney transplant patients. There was a significant decline in the risk of ESRD, absolute reductions in serum creatinine levels, and improvements creatinine clearance [134]. Many free-radical scavengers showed beneficial antioxidant effects, such as vitamin E (α-tocopherol), vitamin C, β-carotene, N-acetyl cysteine, and coenzyme Q10 [6].

2.10.2.1. Vitamin A

The intake of vitamin A was also found to be significantly less in severe renal failure group as compared to moderate renal failure group and was significantly less than the control group [13]. The daily average vitamin A intake was 208 μg retinol per day and 190 μg retinol per day in moderate and severe renal failure groups, respectively. These amounts were found to be quiet less than the recommendations for healthy controls which remained the same for CKD patients [13]. The low levels of plasma vitamin A might effect on the activity of the non-enzymatic antioxidant defense system, hence, consequence for increased oxidative stress occurring in chronic renal failure patients [135]. Therefore, it should be increased the vitamin A intake in this population in order to balance the oxidative-antioxidative system.

2.10.2.2. Vitamin C

In the previous study, the vitamin C intake was calculated at an average of 36 mg per day in CKD patients. It was also observed that vitamin C deficiency might occur with restricted potassium diets recommended for CKD patients [136]. As a result of fruits and vegetables being rich source of potassium, the diets of renal failure patients are restricted for potassium intake. Therefore, unmonitored restrictions might decrease the intake of antioxidants from diet [136]. The health protection provided by fruit and vegetables could increase through an combined reductive environment transported by plant antioxidants of differing solubility in each of the tissue, cellular, and macromolecular phases [137]. The DRI for vitamin C for pre-dialysis CKD patients is same as that for normal adults [138].

2.10.2.3. Vitamin E

Vitamin E is considered as a scavenge free radicals by integrating into the plasma membrane of cells, then preventing lipid peroxidation chain reactions. Vitamin E supplements enhance α-tocopherol levels in cell plasma membranes to prevent lipid peroxidation and resultant oxidative stress. The supplementation of vitamin E is often accompanied with vitamin C because vitamin C has been shown to assist in recycling vitamin E, thus increasing the anti-oxidant efficacy. One weakness of α-tocopherol is that it takes several days of pretreatment to exhibit antioxidant effects [139]. Supplementation of α-tocopherol in an ESRD may reduced the risk

associated cardiovascular disease, decreased oxidative stress, and increased erythrocyte antioxidants SOD, GPx and CAT [140].

2.10.2.4. Zinc

Zinc (Zn) is a trace element containing a strong antioxidant potential and available in protein rich foods. Zinc is a powerful antioxidant as it is required for the enzymes to catalyse vital oxidation reactions [141]. The richest dietary sources of Zn are the organs and the flesh of mammals, fowl, fish, and crustaceans, and Zn fortified foods, eggs, and dairy products [138]. Dietary zinc intake levels were also positively correlated to serum zinc levels as well as antioxidant enzyme levels but inversely correlated with malondialdehyde levels [13]. Therefore, low protein vegetarian CKD diet might further has lower zinc content and is required careful planning by renal dietitian. Supplementation with zinc may be recommended to achieve its requirements. Zinc requirement from diet remains same for predialysis CKD patients as that for normal persons [13, 138]

2.10.2.5. Selenium

Selenium (Se) is known as an integral structural component of the active site of red blood cell GPx [102]. The effect of dietary Se intake on red blood cell GPx appears and lasts about 100 – 120 days, closely matching to the life span of these cells. It is suggested that Se is combined into the enzyme only during erythropoiesis [142]. A study, investigating in Se-deficiency individuals, found that after Se supplementation, it took 4 – 5 weeks for plasma GPx activity returned to normal levels and 3 – 4 months for the red blood cell GPx to reach this effect [143]. Therefore, some studies also indicated that supplementation with selenium leads to an increase in GPx activity in red cells, plasma, and other body fluids [100].

2.10.2.6. Omega-3

Omega-3 polyunsaturated fatty acids enhance endogenous antioxidant defense systems, such as γ-glutamylcysteinyl ligase and glutathione reductase [144]. In models of progressive renal fibrosis, kidney function, and structure were improved using eicosapentanoic acid and docosahexanoic acid supplementation, with reduced oxidative stress, inflammation, and tubulointerstitial fibrosis [145]. N-acetyl cysteine (NAC) is an essential precursor of many endogenous antioxidants involving in the

breakdown of peroxides. It replenishes intracellular glutathione stores, thus diminishes oxidative stress. N-acetyl cysteine reduced kidney MDA levels in a mouse model of diabetic nephropathy [146].

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1. Study design

This study was a cross-sectional study to measure and compare total antioxidant status and markers of antioxidant activities in various stages of Thai pre-dialysis CKD outpatients and control subjects. The data were collected in the Metabolic clinic at Chulalongkorn Memorial hospital, Thailand. This study was also approved by The Ethics Committee of Chulalongkorn Memorial hospital, Thailand. (IRB No. 576/58)

3.2. Subjects

3.2.1. Sample size calculation

$$n = \frac{2(Z_{1-\alpha/2} + Z_{1-\beta})^2 \sigma^2}{d^2}$$

Where

$Z_{\alpha/2}$ is the normal deviate at a level of significance ($Z_{\alpha/2}$ = 1.96 for 5% level if significance)

$Z_{1-\beta}$ is the normal deviate at 1-β% power with β% of type II error ($Z_{1-\beta}$ = 1.64 at 95% statistical power)

d is difference of means between groups

σ is the pooled standard deviation

$$\sigma^2 = [(n_1 - 1) \text{ X } \sigma_1^2 + (n_2 - 1) \text{ X } \sigma_2^2]/(n_1 + n_2 - 2)$$

[147]

Numbers of participants were calculated based on the levels of plasma GPx found in 159 CKD patients (stage 1 to stage 5) and 30 healthy volunteers as a control group from the previous study [8]. The mean and standard deviation values of plasma GPx from six groups (one group of control and five groups of CKD patients) were 44.79 ± 2.32 U/mL (control group), 39.46 ± 2.33 U/mL (CKD stage 1), 33.92 ± 2.95 U/mL (CKD stage 2), 28.85 ± 2.71 U/mL (CKD stage 3), 23.09 ± 2.75 U/mL (CKD stage 4), 20 ± 2.51 U/mL (CKD stage 5), with *p-value* < 0.001.

Based on calculation, the number of participants in each group was eight. After adjusting for 20% dropping out rate by using formula $n_1 = n/(1-d)$; with n = 8 and d = 0.2, the number of each was 10 persons per group.

3.2.2. Inclusion criteria

Patients enrolled into this study were pre-dialysis CKD outpatients at Chulalongkorn Memorial hospital with these following criteria: age more than 18 years old and diagnosed as CKD patients by physicians. They were divided into 3 groups including stage 1&2, stage 3 and stage 4, based on estimated glomerular filtration rate of CKD Epidemiology Collaboration (eGFR CKD-EPI) equation [17]. There were 4 stages of CKD including stage 1, stage 2, stage 3, and stage 4 with eGFR more than 90, 60-89, 30-59, and 15-29 mL/min/1.73 m^2 surface area, respectively, regardless of kidney damage [17]

For a control group, Thai healthy subjects with a normal eGFR and no previous diagnosis of chronic kidney diseases were recruited. Both of the patient group and the control group had to be able to cooperate in performing the food frequency questionnaire and blood sampling after reading the information sheet and signing the inform consent.

3.2.3. Exclusion criteria

Participants were excluded if they had one of some following criteria: receiving dialysis therapy or renal transplantation, active infection, autoimmune disease, malignancy, stroke, pregnancy and lactation, and liver dysfunction. Patients who use antibacterial or anti-inflammation or immunosuppressant drugs, Thai or Chinese herbs or dietary supplement were also excluded.

3.3. Questionnaire

3.3.1. Development of food frequency questionnaire:

A questionnaire was composed of three parts including general information, patient's history, and food frequency in the past three months as follow.

Part I: General information

General information was demographic characteristics including age, gender, religion, living status, education, occupation, and salary. Also two risk factors of

noncommunicable diseases such as smoking habits and alcohol consumption were collected.

Part II: Patient's history

This part aimed to collect the information related to CKD complications and co-diseases such as hypertension, diabetes, dyslipidemia, anemia, hyperkalemia, osteoporosis, gout, and others.

Part III: Food frequency questionnaire

Database from INMUCAL V3 program (INMUCAL- Nutrients V.3, Institute of Nutrition, Mahidol university) were used for selecting food and food products to be sources of antioxidants. This database categorized food and food products into twelve food groups including meat, fish and egg; fruits; vegetable; cereals, legumes and starchy vegetable; milk and dairy products; fat and oil; condiment and seasoning; sweet, bakery and snacks; beverage; appetizer and local dishes; fast food; and medical food. Food items containing at least one of five antioxidant micronutrients including vitamin A, vitamin C, vitamin E, zinc, and selenium at levels of equal and more than 15% of average Thai-Dietary Reference Intake (Thai DRI) from male and female at age of equal and more than 19 years old [148] were selected for preparing food frequency tables (Appendix I). This study categorize food items contains antioxidant micronutrient 15 - 29% and $\geq$ 30% of average Thai-DRI as good source and excellent source of antioxidants, respectively (Table 3.1) based on the concept of establishing Thai Recommended Daily Intakes for Thais ages of 6 years and up (Thai RDI) (Notification of the Ministry of Public Health, 1998) [149]. Finally, one hundred and sixty items of food and food products containing one or more antioxidant micronutrients were used to create lists of food choices in the food frequency questionnaires. Frequencies of food intake over the past 3 months were divided into six levels including never or less than once per month, 1-3 times per month, once a week, 2-4 times per week, 5-6 times per week, and every day (Appendix IV).

Table 3.1 Thai dietary reference intake (Thai DRI) of some micronutrients for male and female at the age of 19 years old and above [148]

Micronutrients	Thai dietary recommendation intake (Thai DRI)				
	Female	Male	Average	15% Thai DRI	30% Thai DRI
Vitamin A (RAE[1])	600	700	650	97.5	195
Vitamin C (mg)	75	90	82.5	12.37	24.75
Vitamin E (mg[2])	15	15	15	2.25	4.5
Zinc (mg)	7	13	10	1.5	3.0
Selenium (μg)	55	55	55	8.25	16.5

[1] 1 Retinol activity equivalent (RAE) = 1 μg retinol, 12 μg β-carotene, 24 μg α-carotene, or 24 μg β-cryptoxanthin

[2] 1 α-tocopherol equivalent (TE) = 1 mg D- α-tocopherol = 1.5 IU [149]

3.3.2. Questionnaire validation

A questionnaire was validated by computing content validity index (CVI) based on experts' ratings of item relevance. All questions in three parts of the questionnaire were used to create an evaluation form (Appendix II) for three experts in the field of nutrition and dietetics to evaluate. Experts were asked to rate the relevance of each question and its objective by a 4-point scale: not relevant (score 1), somewhat relevant (score 2), quite relevant (score 3), and highly relevant (score 4). The Item-level CVI (I-CVI) values were computed from rating scores of each question and each food item by calculating the proportion in agreement of experts giving a rating of either score 3 or score 4 to all three experts (Appendix III). Food items with an I-CVI of approximately 0.8 or higher were considered as good content validation [132, 133]. In this case, if only one expert did not agree with any items, the questionnaire will be revised and returned to the experts to evaluate again.

3.3.3. Data collection and food frequency questionnaire analysis

After reading the information sheet and signing the inform consent, all CKD patients and healthy subjects were interviewed by using the food frequency questionnaire as mentioned above.

3.3.3.1. Frequency of food intake per week scores

The frequencies of food intake in each food item were transformed to the frequencies of food intake per week scores (FFW_I). The scores were the average time that each food item consumed per week, such as score “0” for never or less than once a month, score “0.5” for 1-3 times per month (average time per month = 2 then, divided by 4 week = 0.5 per week), score “1” for once a week, score “3” for 2-4 times per week, score “5.5” for 5-6 times per week, and score “7” for every day. Each FFW_I score indicated average time per week of food consumption in each food item containing high antioxidant micronutrients (> 30% of average Thai DRI). The FFW_G scores for each of twelve food groups were calculated from the FFW_I scores of all food items in each group and presented as mean ± SEM.

3.3.3.2. Food pattern scores

Food pattern scores were made from principal components analysis (PCA), which was used for producing the new variables from weekly frequency of food items consumption (FFW_I) (APPENDIX VII). In the other word, food pattern score is the weekly frequency of food groups (FFW_G). Principal components analysis is a procedure for identifying a smaller number of uncorrelated variables, called "principal components", from a large set of data. The goal of principal components analysis is to explain the maximum amount of variance with the fewest number of principal components [13].

3.4. Determination Anthropometry

Body mass index (BMI): Body weight (in kilograms) and height (in meters) were measured. BMI was calculated as followed formula [150]:

$$\text{BMI} = \text{Body weight (kg)} / \text{Height squared (m}^2\text{)}$$

Waist to hip ratio: Waist circumference (in centimeters) and hip circumference (in centimeters) were also assessed with a non-stretchable tape

measure. Waist circumference was measured 1 inch above navel. According to the National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK), women with a waist-to-hip ratio (WH ratio) of less than 0.8 and men with a ratio of less than 0.9 are considered healthy [150].

Mid-arm muscle circumference: Mid-arm circumference (MAC) (in centimeters) and skinfold thickness of triceps (in millimeters) were performed on the participant's left arm. Mid-arm muscle circumference (MAMC) was calculated using the following formula[150]:

MAMC (cm) = MAC (cm) – [0.314 x triceps skinfold thickness (cm)]

Body composition: Muscle (kilogram), total body fat (%), visceral fat (%), total body water (%) bone (kilogram), and basal metabolic rate (BMR; kilocalorie) were assessed by bioelectrical impedance analysis (BIA) (Tanita Corporation, Tokyo, Japan).

3.5. Clinical examination

Vital sign: Heart rate and blood pressure (BP) were also measured. Patients seated quietly for at least five minutes in a chair with their backs supported and their arms bared and supported at heart level [1]. Hybrid sphygmomanometers were used to measure blood pressure at arm position and blood pressure is recorded from the brachial artery by placing a cuff around the upper arm and inflating to above systolic pressure block the brachial artery. Systolic pressure and diastolic pressure were recorded. Reading blood pressure by auscultation is considered the gold standard by the Heart, Lung and Blood Institute of the NIH [151].

Table 3.2 Classification of hypertension [151]

Blood pressure Classification	Systolic BP (mm Hg)	Diastolic BP (mm Hg)
Normal	<120	<80
Prehypertensive	120-139	80-89
Stage 1 hypertension	140-159	90-99
Stage 2 hypertension	≥ 160	≥ 100

3.6. Determination of blood biochemistry

3.6.1. Blood sampling

Blood samples were collected from CKD patients and healthy volunteers for measurement of biochemical parameters, oxidative and antioxidant markers by venipuncture into polypropylene tubes containing EDTA or heparin (3 mL in EDTA tubes for investigation of MDA, 5 mL in heparin tubes for the TAS, GPx and PON-1 investigation). Plasma was separated from red blood cells by centrifugation at 2,000 rpm for 10 minutes at 4°C and stored at –20°C until analysis [8].

3.6.2. Biochemical parameters

Hemoglobin (Hb), fasting blood sugar, blood urea nitrogen (BUN), creatinine, albumin, uric acid, and lipid profiles including total cholesterol, triglycerides, low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol were measured and undertaken at a Central laboratory, Chulalongkorn Memorial hospital.

3.7. Determination of plasma malondialdehyde by high-performance liquid chromatography

Chemicals

Chemicals and reagents included included 1,1,3,3-tetraethoxypropane (TEP), trichloroacetic acid (TCA), 2-thiobarbituric acid (TBA), butylated hydroxytoluence (BHT), methanol (HPLC grade), absolute ethanol, and potassium phosphate, were obtained from Sigma-Aldrich Co. Ltd, USA.

Materials

Some glassware, which need to prepare were beakers, cylinders, flasks, duran bottles. Other materials and equipment including magnetic stirrers, automatic pipette and tips, solvent filters, filtration paper, water bath, and high-performance liquid chromatography (HPLC) were used in this experiment.

Preparation of MDA standards

Stock standard solutions of 10 mM TEP were prepared and diluted to the concentration of 100 μM for making the working standard solutions of 0.25, 0.5, 0.75, 1 in absolute ethanol with ratio 400 mL/L. Four concentrations of TEP working

standard solutions were used to generate the standard curve. All solution preparation for MDA assay were presented in Appendix V.

Sample preparation and assay procedure

Plasma MDA, an oxidative stress marker of lipid oxidation, was measured by modified high-performance liquid chromatography (HPLC) method. Malondialdehyde (MDA)-$(TBA)_2$ adduct was separated from other interfering compounds. Two hundred fifty microliters of plasma or TEP standard solutions in ethanol were treated with 25 μL of 0.2% BHT (in absolute ethanol), followed by addition of 1 mL 5% TCA (aqueous), then vortexed, and centrifuged at 2,000 rpm for 10 minutes. Then, the 700 μL of deproteinized supernatant were added into 500 μL of 0.6% TBA (aqueous), vortexed, and then reacted in water bath at 90°C for 45 minutes. After cooling at 4°C, a final centrifugation at 2,000 rpm for 10 minutes was performed and an aliquot was filtrated before injected into HPLC (LC-20A, Shimazu, Kyoto, Japan) using the mixture of methanol and potassium phosphate buffer (45:55) as the mobile phase and a reverse-phase Inertsustain C18 column (GL Sciences, Tokyo, Japan) as the stationary phase. The condition for HPLC as follows: ejection volume 20 μL, flow rate 1 mL/min, running time 12 min, visible detector at wavelength 532 nm. Mean peak area was determined for each sample run in duplicate. The MDA levels were calculated directly from the calibration curve of TEP standards and reported in μM. [70].

3.8. Determination of antioxidant markers

3.8.1. Determination of total antioxidant status

Chemicals and reagents

Total antioxidant status test kits were obtained from Randox Laboratories Ltd, Ardmore, UK. A test kit was composed of phosphate buffered saline, chromogen: Metmyoglobin, ABTS®, substrate: hydrogen peroxide (in stabilised form), standard: 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid.

Materials

Some glassware, which need to prepare were beakers, cylinders, flasks, duran bottles, test tubes. Other materials and equipment including magnetic stirrers, automatic pipette and tips, and spectrophotometer were used in this experiment.

Sample preparation and assay procedure

Plasma TAS levels were estimated by means of a quantitative chromatometric method using commercial test kits (Randox Laboratories Ltd, Ardmore, UK) [12]. The principle of this assay was that ABTS® (2, 2'-Azino-di-[3-ethylbenzthiazoline sulphonate]) was incubated with a peroxidase (metmyoglobin) and hyperoxidase (H2O2) to produce the radical cation ABTS®*+. From this reaction, a stable blue-green color was produced, which was measured at wavelength 600 nm. Antioxidants in the added sample cause suppression of this color production to a degree, which was proportional to their concentration.

Each of 20 µL of plasma or 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (standard) or distilled water (reagent blank) were added into 1 mL of chromogen, mixed well, incubated to bring to 370C, and read the initial absorbance (A1) by spectrophotometer (Humalyzer 3000, Human, Germany) at wavelength 600 nm. Then each of 200 µL of hydrogen peroxide substrate was added into test tubes, containing samples, standard, or reagent blank, and mixed well. After adding the substrate, the sample was measured absorbance after exactly 3 minutes (A2). This step was required to perform one sample at a time. Total antioxidant status was calculated as follows.

A2 - A1 = ΔA of sample/standard/blank

$$\text{Factor} = \frac{Concentration\ of\ standard}{(\Delta A\ blank - \Delta A\ standard)}$$

TAS (mmol/l) = Factor x (ΔA Blank - ΔA Sample)

3.8.2. Determination of glutathione peroxidase activities

Chemicals and reagents

Glutathione peroxidase test kits (Ransel kits) were obtained from Randox Laboratories Ltd, Ardmore, UK. A test kit was composed of reagent: glutathione, glutathione reductase, NADPH, buffer: Phosphate buffer and EDTA, cumence hydroperoxide, and diluting agent.

Materials

Some glassware, which need to prepare were beakers, cylinders, flasks, duran bottles, test tubes. Other materials and equipment including magnetic stirrers, automatic pipette and tips, and spectrophotometer were used in this experiment.

Sample preparation and assay procedure

Glutathione peroxidase (GPx) activities in plasma and in erythrocytes were measured using a commercially available kit (Ransel; Randox Laboratories Ltd, Ardmore, UK) using spectrophotometer (Humalyzer 3000, Human, Germany) at absorbance 340 nm. The principle of this assay was that GPx catalyzes the oxidation of glutathione by cumene hydroperoxide. In the presence of glutathione reductase and NADPH the oxidized glutathione is immediately converted to the reduced form with a concomitant oxidation of NADPH to NADP+. Plasma GPx activity was measured in plasma, and red blood cell GPx (RBC GPx) activity was measured in whole blood, then converted into unit/ mg Hemoglobin.

Each of 20 µL of sample or distilled water (for reagent blank) was added into 1 mL of reagent and 40 µL of cumene hydroperoxide, mix and read the initial absorbance of sample and reagent blank after 1 minute and then read again 2 minute after adding reagent and cumene. The activity unit of plasma GPx was expressed as µmol NADPH oxidized per minute per liter of plasma, and the activity unit of RBC GPx was expressed as µmol NADPH oxidized per minute per gram of hemoglobin [117]. GPx was calculated as follows.

Plasma GPx (U/L) = 8412 x ΔA of plasma/ min

Whole blood GPx (U/L) = 8412 x ΔA of whole blood/ min

Subtraction WB GPx = (Whole blood GPx - blank) x Dilution factor

$$\text{RBC GPx} = \frac{Subtraction\ WB\ GPx\ (U/L)}{10 * Hemoglobin\ (g/dL)}$$

3.8.3. Determination of paraoxonase 1

Chemicals and reagents

All chemicals and reagents including paraoxon, sodium chloride (NaCl), and calcium chloride (CaCl2) were obtained from Sigma-Aldrich Co. Ltd, USA.

Materials

Some glassware, which need to prepare were beakers, cylinders, flasks, duran bottles, test tubes. Other materials and equipment including magnetic stirrers, automatic pipette and tips, and spectrophotometer were used in this experiment.

Sample preparation and assay procedure

The PON assay was performed using paraoxon as the substrate according to Furlong et al. [152]. Plasma was thawed at room temperature before used. Each of 760 µL of paraoxon assay buffer, which contained 2.63 M NaCl and 1.32 mM CaCl2 in 132 mM Tris Buffer (pH 8.5), was added to 40 µL of thawed plasma. The assay reaction was initiated by the addition of 200 µL of 6.0 mM freshly prepared paraoxon substrate solution at 37ºC. The activity of PON was assayed by monitoring the formation of p-nitrophenol at the wavelength 405 nm. The absorbance was monitored continuously for 2 minutes. All solution preparation for PON-1 assay were presented in Appendix VI.

3.9. Statistical analysis

Some data from questionnaire part I and part II were expressed as frequency and percentage for categorical variables. Chi-square or Fisher exact tests were used to compare the significant differences among categorical variables.

Continuous variables were test for distribution by Shapiro-Wilk test. Data were expressed as mean ± SD if there were normal distribution or median and range for the non-normal distribution data. Non-normal distribution variables including systolic blood pressure, height, weight, BMI, waist, hip, water, bone, BMR, muscle, MAMC, creatinine, eGFR, BUN, uric acid, HDL, triglyceride, FBG, RBC GPx, MDA were transformed to normality using a logarithm transformation before further statistical analysis.

In order to investigate whether there were the confounding factors that might affect oxidative stress and antioxidant markers, multiple regression between these

markers and age or some biochemical parameters were presented in CKD patients and control groups (Table 4.12 and Table 4.13).

Oneway ANOVA and post-hoc tests were used to compare means among groups when variables were normal distribution. Kruskal Wallis test was used to compare means among groups when variables were non-normal distribution. Tukey's test was used for multiple comparisons among the control group and CKD patient groups at significant level of 0.05 ($p < 0.05$).

Principal components analysis (PCA) was used for create food pattern scores (FP scores) by producing the new variables from weekly frequency of food consumption (FFW_I). Principal components analysis is a procedure for identifying a smaller number of uncorrelated variables, called "principal components", from a large set of data. The goal of principal components analysis is to explain the maximum amount of variance with the fewest number of principal components [13]. Food pattern scores (FP scores) were expressed as mean ± SEM.

The correlations between oxidative stress (plasma MDA) or antioxidants markers (TAS, GPx, PON-1) with biochemical parameters or dietary food pattern (FP scores) were examined by using Spearman's coefficient for nonparametric data such as correlation of MDA, TAS, GPx, or PON-1 with FP scores of each food group. Correlation was considered statistically significant at $p < 0.05$. Statistical analysis was performed using Stata 10 (StataCorp, USA).

CHAPTER 4

RESULTS

4.1. Content validity index resuts

After a questionnaire was validated based on the Item-level CVI (I-CVI) values computed from rating scores of each question and each food item by calculating the proportion in agreement of experts giving a rating of either score 3 or score 4 to all three experts as shown in Table 4.1 to Table 4.6 and Appendix III. Food items with an I-CVI of approximately 0.8 or higher were considered as good content validation [132, 133].

Table 4.1 The content validity index of the food frequency questionnaire: Meat, fish, aquatic, egg and products

Question 1: Did you eat Meat/ Fish and Aquatic/ Egg and products? ท่านรับประทานจำพวกเนื้อสัตว์ ปลาและอาหารทะเลไข่หรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
06040	Beef meat medium fat	เนื้อวัวติดมัน	0.7	07060	Cockle / Ark shell, blanched	หอยแครง ลวก	1
06042	Beef meat lean	เนื้อวัวไม่ติดมัน	1	07062	Mussel green, dried	หอยแมลงภู่แห้ง	1
06053	Pork spare ribs (Fat 14.7%)	ซี่โครงหมู	1	07073	Black pomfret	ปลาจะละเม็ดดำ	1
06068	Pork loin (Fat 7.7%)	เนื้อหมูสันนอก (ไขมัน 7.7%)	1	07083	Jellyfish, dried, salted	แมงกระพรุนแห้ง เค็ม	1
06069	Pork tenderloin (Fat 3.2%)	เนื้อหมูสันใน /หมูเนื้อแดง (ไขมัน 3.2%)	1	07116	Crab mud/mangrove meat	เนื้อปูทะเล	1
06095	Chicken wing, fried	ปีกไก่ทอด	1	07200	Fish salmon atlantic farmed, raw	ปลาแซลมอน	1
06165	Beef meat sundried, fried	เนื้อวัวทอดแดดเดียว (ฮาลาล)	1	08023	Finfish roe mixed species	ไข่ปลา (เฉลี่ย)	1
07001	Shrimp sea	กุ้งทะเล เปลือกขาว หัวแข็ง	1	08004	Duck egg, whole	ไข่เป็ด ทั้งฟอง	1
07003	Shrimp common	กุ้งน้ำจืด (ตัวเล็ก)	1	08006	Duck egg, salted	ไข่เป็ด เค็ม	1
07041	Squid splendid	ปลาหมึกกล้วย / หมึกหลอด	1	08011	Hen egg, whole	ไข่ไก่ ทั้งฟอง	1

Table 4.2 The content validity index of the food frequency questionnaire: Fruits and vegetables

Question 2: Did you eat Fruits? ท่านรับประทานผลไม้หรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
05002	Banana (Namwa variety), unripe	กล้วยน้ำว้า ดิบ	1	05059	Kalanchoe	ส้มจีน เช้ง	1
05008	Rambutan	เงาะ	1	05061	Tangelo / Tangerine / Mandarin	ส้มเขียวหวาน	1
05009	Rose apple, green	ชมพู่ เขียว	1	05066	Cantaloupe	ส้มโอ	1
05012	Durian	ทุเรียนหมอนทอง	1	05079	Persimmon, dried	แคนตาลูป	1
05015	Guava common	ฝรั่ง	1	05082	Strawberry	ลูกพลับ แห้ง	1
05016	Jujube apple	พุทรา	1	05096	Mango, ripe	สตรอเบอรี่	1
05042	Papaya, ripe	มะละกอ สุก	1	05098	Mango, unripe	มะม่วงทองดำ สุก	1
05049	Longan	ลำไย	1	05107	Cherries eating, raw	มะม่วงเขียวเสวย ดิบ	1
05050	Santol	กระท้อน	1	05123	Kiwi fruit	เชอรี่	1
05056	Litchi	ลิ้นจี่	1	05157	Longkong	กีวี	1
Question 3: Did you eat Vegetables? ท่านรับประทานผักหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
04002	Horse tamarind, tender tips	กระถิน ยอดอ่อน	1	04070	Water mimosa	ผักกระเฉด	1
04005	Cauliflower	กะหล่ำดอก	1	04077	Mustard green stem and leaves	ผักกาดเขียว	1
04009	Cabbage	กะหล่ำปลี	1	04081	Kale Chinese	ผักคะน้า	1
04010	Okra (lady's finger), young pods	กระเจี๊ยบมอญ ฝัก อ่อน	1	04082	Celery	ผักขึ้นฉ่าย /ซีจีน	1
04011	Garlic flowers	ดอกกระเทียม	1	04087	Ivygourd	ผักตำลึง	1
04023	Cassia leaves	ขี้เหล็ก ใบ	1	04092	Thai water morning glory red stem	ผักบุ้งไทย ต้นแดง	1
04025	Sesbania flowers	ดอกแค	1	04106	Chilli pepper	พริกหยวก	1
04027	Acacia pennata	ชะอม	1	04109	Gourd wax	ฟักเขียว	1
04035	Mungbean sprout	ถั่วงอก	1	04114	Gourd bitter young leaves	มะระ ยอดอ่อน	1
04040	Yard long bean green, boiled	ถั่วฝักยาว ต้ม	1	04117	Egg plant	มะเขือพวง	1
04042	Wing bean pods	ถั่วพู ฝัก	1	05062	Pomelo	ส้มโอ	1
04044	Garden peas pods	ถั่วลันเตา ฝักอ่อน	1	05066	Cantaloupe	แคนตาลูป	1
04050	Holy basil leaves	ใบกะเพรา	1	05079	Persimmon, dried	ลูกพลับ แห้ง	1
04051	Crawdaisy leaves	ใบดังโอ้	1	05082	Strawberry	สตรอเบอรี่	1
04052	Indian penny wort leaves	ใบบัวบก	1	05096	Mango, ripe	มะม่วงทองดำ สุก	1
04059	Tiliacora triandra Diels	ใบย่านาง	1	05098	Mango, unripe	มะม่วงเขียวเสวย ดิบ	1
04061	Gourd sponge round	บวบหอม / บวบกลม	1	05107	Cherries eating, raw	เชอรี่	1
04063	Mint leaves	ใบสะระแหน่	1	05123	Kiwi fruit	กีวี	1
04065	Sweet basil leaves	ใบโหระพา	1	05157	Longkong	ลองกอง	1

Table 4.3 The content validity index of the food frequency questionnaire: Cereals, legumes/ starchy vegetables, milk and dairy products

Question 4: Did you eat Cereals and legumes/ starchy vegetables? ท่านรับประทานข้าว/แป้ง/ธัญพืชหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
01007	Biscuits plain / Buttermilk commercially baked	ขนมปังบิสกิต ธรรมดา / ขนมปังกรอบ	0	03005	Sesame seeds, white and black	งา ดำ หรือ ขาว ดิบ	1
01008	Bread white sliced	ขนมปัง ขาว แผ่น	1	03016	Cowpea seeds, black color, dried	ถั่วดำ เมล็ด แห้ง	1
01035	Job's tear whole seeds	ลูกเดือย	1	03021	Peanut, boiled	ถั่วลิสง ต้ม	1
01043	Corn flakes (Kellogg's Frosties supercharged)	ข้าวโพด แผ่นอบกรอบ / คอนเฟลกเคลือบน้ำตาล	1	03024	Mung bean	ถั่วเขียว เมล็ด แห้ง	1
01045	Macaroni, cooked, unenrich	มักกะโรนี ต้ม	1	03027	Soybean seeds, dried	ถั่วเหลือง เมล็ด แห้ง	1
01048	Bread whole wheat	ขนมปังโฮลวีท	1	03029	Rice bean seeds, dried	ถั่วแดง เมล็ด แห้ง	1
01056	Rice whole grain milled by machine, steamed	ข้าวเจ้ากล้อง นึ่ง	1	03030	Pigeonpea immature seeds, fresh	ถั่วแระ เมล็ดอ่อน สด	1
01127	Cereal soy based supplementary food (NesVita brand)	ธัญญาหาร รสดั้งเดิม เครื่องดื่มสำเร็จรูป ตราเนสวิต้า	1	03033	Lotus seeds, dried	เมล็ดบัว แห้ง	1
02005	Potato	มันฝรั่ง	1	03037	Cashew nut, fried	เมล็ดมะม่วง หิม พานต์ ทอด	1
02008	Cassava	มันสำปะหลัง	1	03050	Ginkgo seeds, whole	แป๊ะก๊วย ดิบ	1
02026	Arrow roots, white	สาคูขาว	1	03053	Sunflower seeds, dry, roasted without salt	เมล็ดทานตะวัน แห้ง คั่วไม่ใส่เกลือ	1
02030	Lotus root, raw	รากบัว	1	03077	Almonds dry roasted with salt added	เมล็ดอัลมอนด์ คั่ว ใส่เกลือ	1
03002	Chinese chestnut	เกาลัดจีน	1				
Question 5: Did you eat Milk and dairy products? ท่านดื่มนมหรือรับประทานผลิตภัณฑ์จากนมหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
09002	Milk condensed sweetened	นมข้นหวาน	1	09081	Milk powdered, Bear brand (plain)	นมผงตราหมี	1
09009	Milk powdered, full cream	นมผง ฟูลครีม	1	09082	Milk powder defatted, high calcium (Anlene)	นมผง ขาดมันเนย แคลเซียมสูง	1
09037	Cheese, Cheddar	เนยแข็ง เชดดาร์	1	09087	Milk powder reduced fat	นมผงพร่องมันเนย เสริมแคลเซียม	1
09050	Milk powdered, Bear brand (yellow)	นมผงตราหมี	1	09096	Milk tablet, sweet	นมปรุงแต่งรสหวาน ชนิดเม็ด	1

Table 4.4 The content validity index of the food frequency questionnaire: Fat, oils, condiment, seasoning, sweet, bakery, snacks and ice cream

Question 6: Did you eat Fat and oils? ท่านใช้น้ำมัน/เนยในการประกอบอาหารหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
10003	Peanut oil	น้ำมันถั่วลิสง	1	10026	Shortening bread soybean (hydrogenated) and cottonseed	ชอทแทนนิ่ง ขนมปัง น้ำมันถั่วเหลือง และฝ้า	1
10008	Butter, salted	เนยสด เค็ม	1	10029	Shortening confectionery fractionated palm	ชอทแทนนิ่ง คอนแฟกชั่นนารี แฟรกชั่นแนท น้ำมันปาล์ม	0.3
10021	Olive oil salad or cooking	น้ำมันมะกอก	1	10032	Cream whipped, cream topping, pressurized	วิปปิ้งครีม	0.7
10024	Rice bran oil	น้ำมันรำข้าว	1				
Question 7: Did you eat Condiment and seasoning? ท่านเติมเครื่องปรุงรสหรือใช้เครื่องแกงในการประกอบอาหารหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
12003	Shrimp paste, fermented, first class quality / Kapi (Thai)	กะปิกุ้ง คุณภาพดี	1	12042	Chilli bird ground	พริกขี้หนู ป่น	1
12005	Tomato ketchup	ซอสมะเขือเทศ / แคทชับ	1	12058	Coriander seeds	ผักชี เมล็ด	1
12013	Curry paste, red	น้ำพริกแกงแดง	1	12059	Coriander root	ผักชี ราก	1
12015	Curry powder	ผงกะหรี่	1	12073	Soup, chicken broth or bouillon, dry	ซุปผง รสไก่	0.7
12030	Bitter orange peels	ผิวมะกรูด	1	12077	Garlic, deep fried	กระเทียมเจียว กรอบแห้ง	0.3
12033	Garlic, dried bulbs	กระเทียม หัว	1	12082	Soup, beef broth or bouillon, powder, dry	ซุปผง รสเนื้อ	0.7
12036	Bitter orange; leech leaves, semidried	ใบมะกรูด ค่อนข้างแห้ง	1	12083	Soup instant, pork / chicken broth, cube, dry (Knor brand)	ซุปก้อนปรุงรส หมู / ไก่	0.7
12038	Cumin / Yeera, seeds	ยี่หร่า	1				
Question 8: Did you eat Sweet/ Bakery/ Snacks/ Ice cream? ท่านรับประทานของหวาน เบเกอรี่ อาหารว่างหรือไอศครีมหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
09100	Ice creams vanilla	ไอศกรีมวานิลา	0.3	18101	Gold threads egg yolk strained in heavy syrup / Foithong (Thai)	ฝอยทอง	0.7
18005	Karipubsaichem (Thai)	กะหรี่ปั๊ปไส้เค็ม	0.3	18133	Roti with sweet condented milk and sugar	โรตีโรยนมข้นและน้ำตาล ไม่ใส่ไข่	0.7
18017	Bread magarine, toast	ขนมปังทามาการีนโรยน้ำตาล	0.3	18170	Cream puffs, prepared from recipe, shell, with custard filling	เอแคร์ ไส้ครีม	0.7
18025	KanomPia (black bean) (Thai)	ขนมเปี๊ยะไส้ถั่วดำ	0.3	01129	Doughnuts yeastleavened with cream filling	โดนัท ไส้ครีม	0.7
18027	Peanut bake / Khokhea (Thai)	ถั่วอบโก๋แก่	0.3	18114	Egg custard, baked	ขนมหม้อแกงไข่	0.7
18073	Kanombali (Thai)	ขนมสาลี่	0.7	18121	Native melon in coconut milk	กะทิแตงไทย	0.7
18097	Egg yolk sheeted in heavy syrup cupped	ทองหยิบ	0.7				

Table 4.5 The content validity index of the food frequency questionnaire: Beverages, appetizer, and local dishes

Question 9: Did you drink Beverages? ท่านดื่มน้ำหวาน น้ำผลไม้หรือเครื่องดื่มหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
14002	Orange juice	น้ำส้มคั้น	1	14096	Tomato Juice with Mixed Fruit Juice 60% (Malee brand)	น้ำมะเขือเทศผสมน้ำผลไม้รวม 60% (ตรา มาลี self plus)	1
14030	Passion fruit juice	น้ำเสาวรสคั้น	1	14098	Red Apple red Juice 100% (Tesco brand)	น้ำแอปเปิ้ลแดง 100% (ตรา Tesco)	1
14055	Chocolate flavoured drink 3 in 1 instant powder mix (Milo brand)	เครื่องดื่มรสช็อก โก แลต ผง กึ่งสำเร็จรูป 3 in 1 (ตราไมโล)	1	14099	Grape red Juice 100% (Tesco brand)	น้ำองุ่นแดง 100% (ตรา Tesco)	1
14087	Guava Juice 100% UHT	น้ำฝรั่ง 100% แคลเซียมสูง UHT (ตราดอยคำ)	1	14101	Pomegranate Juice 100% (Tipco brand)	น้ำทับทิม 100% (ตรา Tipco)	1
14091	Strawberry Juice 100% UHT (DoiKhum brand)	น้ำสตรอเบอรี่ 100% UHT (ตราดอยคำ)	1	14110	Carrot with mixed fruit juice 100% (Unif brand)	น้ำแครอทผสมผลไม้รวม 100% (ตรา Unif)	1
14095	Pineapple Juice 100% (Malee brand)	น้ำสับปะรด 100% (ตรามาลี)	1	14124	Soymilk, Cereal Flavour	นมถั่วเหลือง ผสมนม ผง รสธัญญาหาร 5 ชนิด	1
Question 10: Did you eat Appetizer or local dishes? ท่านรับประทานอาหารว่างหรือเมนูอาหารท้องถิ่นหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
16004	Wide rice noodles with pork, egg and soysauce	ก๋วยเตี๋ยวเส้นใหญ่ผัดซีอิ๊วใส่ไข่	0.7	16098	Bun steamed, red pork filled	ซาลาเปา ไส้หมูแดง	1
16009	Rice with shrimp paste	ข้าวคลุกกะปิ	0.7	16123	Spring roll, deep fried	ปอเปี๊ยะทอด	1
16010	Rice fried with pork, vegetable and egg	ข้าวผัดหมูใส่ไข่	0.7	17020	Mashed fresh chilli mixed with condiments	แจ่วพริกสด	1
16043	Noodle sheets soup with meat and tofu	ก๋วยจั๊บ	1	17036	Unripe mango salad	ตำมะม่วงดิบ	1
16049	Southern style rice salad : rice with assorted vegetables served with southern fish sauce	ข้าวยำปักษ์ใต้	1	17064	Saute Chinese water morning glory	ผัดผักบุ้งจีน	0.3
16073	Rice noodles, big size with pork and soup	เส้นใหญ่ หมู น้ำ	0.7	17065	Saute mungbean noodle and hen egg	ผัดวุ้นเส้นใส่ไข่ไก่	1
16076	Macaroni fried with pork	ผัดมักกะโรนี หมู	0.7	17076	Meat salad, Northeastern style	ลาบเนื้อ	1
16082	Crab and ground pork wrapped with tofu skin fried	หอยจ้อทอด	1	17079	Green papaya salad	ตำมะละกอ	1

Table 4.6 The content validity index of the food frequency questionnaire: Fast foods, medical foods

Question 11: Did you eat Fast food? ท่านรับประทานอาหารฟาส์ตฟู้ด (อาหารจานด่วน) หรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
16023	Pizza, supreme (Pizza Hut)	พิซซ่าสุพรีม (พิซซ่าฮัท)	0.3	16110	Croissants butter	ครัวซอง เนย	0.3
16040	Sandwich with tuna fish	แซนวิชทูน่า	0.3	16118	Chicken broilers, drumstick, fried flour	ไก่ น่อง เนื้อ หนัง ชุบแป้งทอด	0.3
16093	Sanwich, pork and ham shreede chinese style filled	แซนวิช ไส้หมูหยอง +แฮม	0.3	16122	Chicken breaded and fried, boneless pieces plain	ไก่ ไม่มีกระดูก ชุบแป้งขนมปังทอด	0.3
16107	Rice sausage pork mixed, grilled (Fat 19.3%)	ไส้กรอก ข้าว มีหมูสับย่าง (Fat 19.3%)	0.3	16183	WENDY'S Jr. Hamburger without cheese	แฮมเบอร์เกอร์ ไม่มีเนยแข็ง	0.3
Question 12: Did you eat Medical food? ท่านได้รับอาหารทางการแพทย์เพิ่มเติมหรือไม่?							
Food items			**I-CVI**	**Food items**			**I-CVI**
22001	Nutren Optimum (powder)	นิวเทรน ออฟติมัม	1	22013	Blendera (powder)	เบลนเดอรา (ชนิดผง)	1
22002	Nutren Balance (powder)	นิวเทรน บาลานซ์	1	22014	Glucerna SR (powder)	กลูเซอนา เอสอาร์	1
22003	Nutren Fibre (powder)	นิวเทรน ไฟเบอร์	1	22015	Ensure FOS (powder)	เอนชัวร์ เอฟโอเอส รสวนิลา ฝาน้ำเงิน	1
22010	GenDM (powder)	เจ็นดีเอ	1	22018	Nepro (liquid per 100 mL)	เนโปร ชนิดน้ำ พร้อมดื่ม หน่วย มล.	1

4.2. Characteristic data

After subject enrollment, the number of final participants satisfied the inclusive and exclusive criteria for further analysis was 13, 8, 15 and 10 people in the control group, stage 1&2, stage 3 and stage 4 CKD patients, respectively.

Generally, there were no significant differences of demographic variables, such as gender, religion, living status, education, and salary among stage 1&2, stage 3, stage 4 CKD patients and control subjects. However, the mean ages of stage 3 and stage 4 CKD patients was significantly higher than the control groups (p <0.001). (Table 4.7)

It was obvious that hypertension was the highest co-disease in CKD patients approximately 50% for all CKD groups, followed by diabetes and dyslipidemia. Diabetes was the secondary co-disease found 37.5% in stage 1&2 and 40% in stage 4 CKD groups, while the percentage of diabetes in stage 3 group was 13.3%. Dyslipidemia was 25%, 20.0%, and 30% in stage 1&2, stage 3, and stage 4, respectively. (Figure 4.1 and Table 4.8)

Table 4.7 Characteristics of CKD patients and control subjects

Characteristics	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Number of subjects	13	8	15	10	
Gender					
Male	3 (23.1)	3 (37.5)	11 (73.3)	5 (50.0)	0.06
Female	10 (76.9)	5 (62.5)	4 (26.7)	5 (50.0)	
Age (years old)*	41.9 ± 11.8‡	55.4 ± 15.8‡,§	64.5 ± 14.6§	64.2 ± 12.3§	<0.001
Heart rate*	75.9 ± 8.7	77.4 ± 5.5	71.5 ± 13.1	80.9 ± 11.9	0.19
Systolic blood pressure (mmHg)†	118 (100- 127)‡	144 (120 – 149)‡,§	140 (117 – 156)§	142 (117 – 155)§	<0.001
Diastolic blood pressure (mmHg)†	74 (56 – 91)	82 (76 – 86)	74 (56 – 104)	74.5 (60 – 92)	0.24
Religion					
Buddhism	13 (100)	8 (100)	14 (93.3)	10 (100)	1.0
Christianity	0	0	1 (6.7)	0	
Living					
Alone	5 (38.5)	2 (25.0)	3 (20.0)	4 (40.0)	0.48
With family	8 (61.5)	6 (75.0)	12 (80.0)	6 (60.0)	
Education					
Never study	0	0	3 (20.0)	1 (10.0)	0.66
Primary	2 (15.4)	1 (12.5)		2 (20.0)	
Secondary	1 (7.7)	0	1 (6.7)	1 (10.0)	
High school	0	0	2 (13.3)	0	
Bachelor	5 (30.8)	3 (37.5)	5 (33.3)	4 (40.0)	
Post-graduate	6 (46.1)	4 (50.0)	4 (26.7)	2 (20.0)	
Salary					
< 9000 baht	2 (15.4)	1 (12.5)	6 (40.0)	4 (40.0)	0.23
9000 – 13000 baht	3 (23.1)	0	0	1 (10.0)	
>13000 baht	9 (61.5)	7 (87.5)	9 (60.0)	5 (50.0)	

Results were expressed as frequency and percentage: n (%). Data were analyzed using Fisher's exact test

* Results were expressed as mean ± SD (data had normal distribution). Data were analyzed using oneway ANOVA to compare difference among groups

† Results were expressed as median (range) (data had non-normal distribution). Data were analyzed using Krussal Wallis to compare difference among groups

‡,§ Different symbols mean significant difference among groups at $p < 0.05$

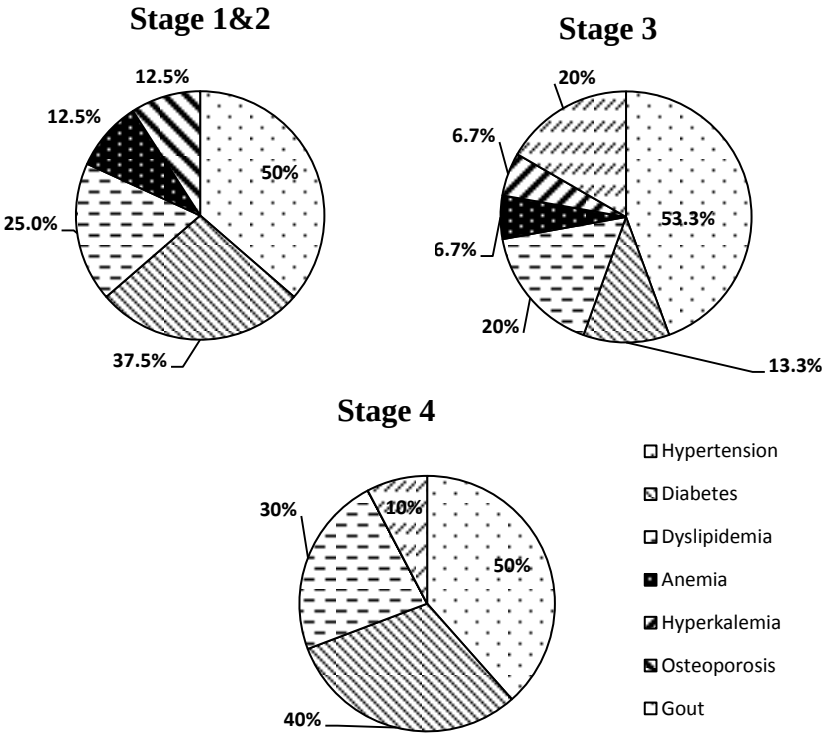


Figure 4.1 Complication and co-diseases in CKD patients

Table 4.8 Complications in patients with chronic kidney disease

Complications	Stage 1&2	Stage 3	Stage 4	p-value
Number of subjects	8	15	10	NS
1 complication				
Hypertension	2 (25%)	5 (33.3%)	1 (10%)	NS
Anemia		1 (6.7%)	1 (10%)	NS
Hyperkalemia		1 (6.7%)		NS
Gout		1 (6.7%)		NS
2 complications				
HT + DM	1 (12.5%)	1 (6.7%)	1 (10%)	NS
DL + Gout		1 (6.7%)		NS
HT + DL		1 (6.7%)		NS
3 complications				
HT + DM + DL			3 (30%)	NS
DM + DL + Anemia	1 (12.5%)			NS
>3 complications				
HT + DM + DL + Osteoporosis	1 (12.5%)			NS
HT + DM + DL + Gout		1 (6.7%)		NS

Results were expressed as frequency and percentage: n (%). Data were analyzed using Fisher's exact test

4.3. Anthropometric variables

Table 4.9 Anthropometric variables of CKD patients and control subjects

	Control (n=13)	Stage 1&2 (n=8)	Stage 3 (n=15)	Stage 4 (n=10)	*p-value*
Height (m) †	1.56 (1.51 – 1.80)	1.59 (1.49 – 1.78)	1.65 (1.49 – 1.75)	1.61 (1.54 – 1.76)	0.92
Weight (kg) †	57.1 (45.9 – 87.8)	70.9 (54.4 – 134.1)	69 (49.5 – 116.2)	65.1 (45.6 – 94.6)	0.21
BMI (kg/m^2) †					
Male	25.1 (23.4 – 27.1)	31.1 (25.4 – 42.3)	26.2 (19.9 – 37.9)	26.7 (17.2 – 36.5)	0.48
Female	22.5 (18.8 – 28.5)	23.0 (21.7 – 32.7)	25.5 (22.3 – 28.6)	21.7 (18.7 – 28.1)	0.33
Wrist circumferenc (cm)*	15.9 ± 1.0	16.6 ± 1.8	16.7 ± 1.3	15.7 ± 1.6	0.28
Waist circumference (cm) †					
Male	87.5 (80.5 – 94.2)	98.5 (96.5 – 130)	97 (82.5 – 122)	95 (70 – 117.5)	0.2
Female	81 (69 – 95)	84 (72 – 96)	91.8 (75 – 96.5)	79 (70 – 90)	0.48
Hip circumference (cm) †	97.5 (87.5 – 105.6)	102.5 (92 – 130)	99 (88.5 – 120)	98 (88 – 117)	0.34
Waist/ hip ratio*					
Male	0.86 ± 0.03	0.96 ± 0.04	0.98 ± 0.08	0.94 ± 0.09	0.15
Female	0.84 ± 0.05	0.84 ± 0.07	0.92 ± 0.05	0.84 ± 0.04	0.11
Triceps skinfold thickness (mm)*	20.2 ± 7.9	25.9 ± 9.2	19.5 ± 9.9	19.1 ± 13.7	0.47
Mid-arm circumference (cm)*	28.5 ± 3.0	32.1 ± 4.2	29.0 ± 5.1	28.7 ± 5.6	0.35
Mid-arm muscle circumference (cm)†	20.3 (17.3 – 34.2)	25.0 (20.6 – 26.5)	22.6 (11.9 – 33.0)	21.6 (18.1 – 28.2)	0.45
Muscle (kg) †	36.3 (34.1 – 63.5)	38 (34.1 – 76.4)	47.7 (24.3 – 72.6)	41.4 (33.4 – 60.4)	0.74
Total fat (%)*	28.9 ± 7.2	35.0 ± 8.9	29.7 ± 9.9	25.2 ± 10.3	0.16
Visceral fat rating*					
Male	10.7 ± 4.1	17.3 ± 4.0	16 ± 2.8	14 ± 8.4	0.3
Female	5.5 ± 1.8	8.4 ± 3.1	8.5 ± 1.9	8.2 ± 7.0	0.35
Water (%)†	50.4 (44.1 – 89.9)	47.5 (40.6 – 58.6)	51.2 (46.4 – 62.6)	54.8 (45.1 – 66.8)	0.06
Bone (kg)†	2.2 (2.0 – 3.4)	2.3 (2.0 – 4.1)	2.8 (1.8 – 3.9)	2.7 (1.9 – 3.3)	0.44
BMR (Kcal)†	1176 (1042 – 1900)	1246.5 (1045 – 2431)	1474 (989 – 2305)	1332.5 (1019 – 1793)	0.47

BMI= body mass index, BMR= basal metabolic rate

* Results were expressed as mean ± SD (data had normal distribution). Data were analyzed using oneway ANOVA to compare difference among groups †Results were expressed as median (range) (data had non-normal distribution). Data were analyzed using Krussal Wallis to compare difference among groups.

As seen from Table 4.9, the median BMI of CKD stage 1&2 was higher than those of control, stage 3 and stage 4, but no significant difference (28.3 kg/m^2 in stage 1&2 group, 23.4 kg/m2 in the control group, 26.2 kg/m^2 in stage 3 CKD group, and 24.2 kg/m^2 in stage 4 CKD group). Non-significant difference of other anthropometric variables was observed among the control, stage 1&2, stage 3, and stage 4 CKD patients.

4.4. Biochemical parameters

According to Table 4.10, fasting blood glucose in all stages of CKD patients was significantly higher than those of the control group (p-value < 0.001). However, there was a significant decrease in fasting blood glucose of stage 3 group compared to stage 1&2 (99.5 and 135 mg/dL). Blood urea nitrogen and creatinine of stage 3, and stage 4 CKD patients were significantly higher than those of control and stage 1&2 groups ($p < 0.001$). Obviously, eGFR in all stages of CKD patients is significant lower than the control groups and the higher stage have the lower eGFR. In the other hand, albumin in stage 4 CKD patient was significantly lower than those of control (4.0 ± 0.2 g/dL compared with 4.4 ± 0.2 g/dL, $p = 0.03$). In some CKD patients in stage 3 and stage 4 developing hyperuricemia, the median of uric acid was significantly higher than that of control (6.8 and 8.0 compared to 4.7 mg/dL, respectively, $p = 0.003$).

We also found that the median of total cholesterol in blood circulation in stage 3 was significantly lower than that of control and stage 1&2 (164.5 compared to 196.5 and 191.1 mg/dL, respectively). There was no significant difference of other biochemical parameters among control and various stages CKD patients.

4.5. Oxidative stress and antioxidant markers

The median levels of plasma MDA in all stages of CKD were significantly higher than those in the control group (approximately 0.2 compared to 0.09 μM, respectively, $p = 0.01$). Interestingly, the levels of total antioxidant status in the stage 3 and stage 4 CKD patients were also significantly increase than those of the control group (1.7 ± 0.2 and 1.7 ± 0.1 compared to 1.5 ± 0.2 mmol/L, respectively, $p = 0.02$).

In the other hand, the levels of plasma glutathione peroxidase activity in all CKD groups showed a trend to be decreased when comparing to those of the control group, but no statistical significance (p = 0.06). Moreover, there was a significant decrease trend in plasma PON-1 among control and various stage of CKD groups (307.7 ± 67.4, 267.0 ± 101.2, 244.2 ± 99.9, and 201.9 ± 89.9 mmol/L, respectively, p = 0.04). However, RBC GPx showed no significant difference among CKD patient group and the control group ($p > 0.05$). In order to identify the cofounding factors, the multiple regressions were presented between oxidative stress, antioxidant markers with age and biochemical parameters in CKD patients and the control group, as shown in Table 4.12 and Table 4.13. We found that age and other biochemical parameters did not add statistically significant to the prediction of MDA, TAS, GPx and PON-1.

Table 4.10 Biochemical parameters of CKD patients and control subjects

	Control (n=13)	**Stage 1&2 (n=8)**	**Stage 3 (n=15)**	**Stage 4 (n=10)**	***p-value***
FBG (mg/dL) †	90 (45 – 105)‡	135 (121 – 165)§	99.5 (81 – 122)ǁ	111 (94 – 247)§	< 0.001
Hb (g/dL)*	13.5 ± 2.6	13.9 ± 1.7	13.4 ± 1.9	12.1 ± 1.5	0.24
BUN (mg/dL) †	11.3 (8.1 – 20.6)‡	13 (9 – 15)‡	21 (12 – 45)§	36 (29 – 52)§	< 0.001
Creatinine (mg/dL) †	0.7 (0.5 – 1.0)‡	0.9 (0.6 – 1.0)‡	1.6 (1.1 – 2.2)§	2.6 (2.1 – 3.5)§	< 0.001
eGFR (mL/min/1.73 m^2)†	100.7 (90.6 – 120.8)‡	86.1 (72.8 – 97.5)§	40.1 (30.5 – 55.5)ǁ	20.5 (15.7 – 28.0)¶	< 0.001
Albumin (g/dL)*	4.4 ± 0.2	4.3 ± 0.4	4.2 ± 0.3	4 ± 0.2*	0.03
Triglyceride (mg/dL) †	62 (40 – 252)	172 (68 – 405)	141 (60 – 277)	158.5 (74 – 231)	0.06
Total cholesterol (mg/dL) †	201 (169 – 260)‡	191.1 (149 – 250)‡	164.5 (122 – 205)§	180.7 (139 – 277)‡,§	0.007
LDL (mg/dL)*	126.3 ± 28.7	121.8 ± 31.2	100.9 ± 27.3	102.8 ± 33.2	0.18
HDL (mg/dL) †	51 (33 – 82)	42 (33 – 50)	40 (34 – 65)	44.5 (25 – 66)	0.07
Uric acid (mg/dL) †	4.6 (3.7 – 8.3)‡	5.0 (4.2 – 11.2)‡,§	6.8 (5.3 – 9.7)§	8.0 (4.8 – 10.2)§	0.003

FBG = Fasting blood glucose, Hb = Hemoglobin, BUN = Blood urea nitrogen, eGFR = Estimated glomerular filtration rate, LDL = Low-density lipoprotein cholesterol; HDL = High-density lipoprotein cholesterol.

* Results were expressed as mean ± SD (data had normal distribution). Data were analyzed using oneway ANOVA to compare difference among groups.

† Results were expressed as median (range) (data had non-normal distribution). Data were analyzed using Krussal Wallis to compare difference among groups.

‡,§,ǁ,¶ Different symbols mean significant difference among groups at $p < 0.05$

Table 4.11 Oxidative stress and antioxidant markers of CKD patients and control subjects

	Control (n=13)	Stage 1&2 (n=8)	Stage 3 (n=15)	Stage 4 (n=10)	*p-value*
MDA (μM) †	0.09 (0.01 – 0.37)‡	0.29 (0.9 – 0.69)§	0.2 (0.06 – 0.55)§	0.2 (0.07 – 0.55)§	0.01
TAS (mmol/L)	1.5 ± 0.2‡	1.6 ± 0.3‡,§	1.7 ± 0.2§	1.7 ± 0.1§	0.02
RBC GPx (g Hb/L) †	57.6 (31.1 – 164.0)	65.9 (44.7 – 110.1)	63.1 (40.2 – 92.5)	59.1 (32.6 – 90.1)	0.68
Plasma GPx (U/L)*	792.5 ± 150.6	793.3 ± 179.2	727.6 ± 139.4	634.9 ± 149.9	0.06
PON-1 (U/L)*	307.7 ± 67.4‡	267.0 ± 101.2‡,§	244.2 ± 99.9‡,§	201.9 ± 89.9§	0.04

MDA = malonodialdehyde, TAS = total antioxidant status, RBC GPx = glutathione peroxidase in red blood cell, Plasma GPx = Glutathione peroxidase in plasma, PON-1 = Paraoxonase 1

* Results were expressed as mean ± SD (data had normal distribution). Data were analyzed using oneway ANOVA to compare difference among groups

† Results were expressed as median (range) (data had non-normal distribution). Data were analyzed using Krussal Wallis to compare difference among groups

‡,§ Different symbols mean significant difference among groups at $p < 0.05$

Table 4.12 Multiple regressions of oxidative stress, antioxidant markers with age in CKD patients and control subjects

Parameters	Regression coefficient	T	*p-value*
MDA			
Intercept	0.04	0.46	0.65
CKD	0.003	0.18	0.85
Age	0.02	1.62	0.11
TAS			
Intercept	1.56	13.39	< 0.001
CKD	0.065	2.71	0.01*
Age	-0.001	-0.46	0.64
Plasma GPx			
Intercept	784.36	9.43	<0.001
CKD	-38.6	-2.25	0.02*
Age	0.54	0.33	0.74
RBC GPx			
Intercept	57.49	4.18	<0.001
CKD	-4.17	-1.47	0.148
Age	0.28	1.03	0.307
PON-1			
Intercept	343.9	7.12	<0.001
CKD	-18.33	-1.84	0.072
Age	-0.88	-0.91	0.36

Data were analyzed using multiple regression

* Significant difference among groups at $p < 0.05$

Table 4.13 Multiple regressions of oxidative stress, antioxidant markers with some biochemical parameters CKD patients and control subjects

Biochemical parameters	Regression coefficient	T	*p-value*
MDA			
Intercept	-0.87	-0.77	0.456
CKD	0.23	2.34	0.038*
FBG	0.001	0.77	0.456
BUN	-0.0002	-0.02	0.982
Creatinine	-0.18	-1.1	0.292
Cholesterol	0.03	0.43	0.675
Uric acid	0.05	1.89	0.083
Hb	-0.14	-0.58	0.57
eGFR	0.005	1.05	0.313
Albumin	0.017	0.09	0.928
Triglyceride	-0.0002	-0.19	0.856
LDL	-0.004	-0.6	0.559
HDL	0.001	0.18	0.862
TAS			
Intercept	0.58	0.4	0.7
CKD	0.004	0.03	0.974
FBG	0.0004	0.15	0.881
BUN	0.01	0.93	0.371
Creatinine	-0.02	-0.12	0.909
Cholesterol	-0.004	-0.38	0.709
Uric acid	0.06	1.83	0.09
Hb	0.05	1.58	0.141
eGFR	0.002	0.31	0.76
Albumin	-0.09	-0.39	0.705
Triglyceride	0.001	0.96	0.357
LDL	0.001	0.16	0.874
HDL	0.007	0.58	0.572
Plasma GPx			
Intercept	-925.6	-0.69	0.501
CKD	92.06	0.79	0.446
FBG	0.32	0.11	0.911
BUN	2.52	0.24	0.814
Creatinine	-26.72	-0.13	0.895
Cholesterol	-1.16	-0.12	0.906
Uric acid	27.52	0.85	0.41
Hb	-16.48	-0.57	0.579
eGFR	5.14	0.77	0.454
Albumin	290.73	1.33	0.208
Triglyceride	-0.58	-0.42	0.679
LDL	0.99	0.11	0.916
HDL	2.34	0.2	0.844

Data were analyzed using multiple regression

*Significant difference among groups at $p < 0.05$

Table 4.13 Multiple regressions of oxidative stress, antioxidant markers with some biochemical parameters CKD patients and control subjects (continue)

Biochemical parameters	Regression coefficient	T	*p-value*
RBC GPx			
Intercept	78.27	0.42	0.683
CKD	3.05	0.19	0.856
FBG	-0.5	-1.41	0.184
BUN	-1.31	-0.89	0.392
Creatinine	27.4	0.98	0.345
Cholesterol	-0.97	-0.72	0.485
Uric acid	-3.32	-0.73	0.477
Hb	-4.11	-1.01	0.331
eGFR	0.52	0.56	0.583
Albumin	14.6	0.48	0.642
Triglyceride	0.29	1.5	0.159
LDL	0.71	0.56	0.587
HDL	1.26	0.77	0.454
PON-1			
Intercept	183.09	0.33	0.75
CKD	44.82	0.91	0.381
FBG	-0.13	-0.11	0.914
BUN	0.96	0.22	0.831
Creatinine	-30.36	-0.36	0.724
Cholesterol	-6.86	-1.7	0.115
Uric acid	10.61	0.78	0.451
Hb	18.03	1.48	0.165
eGFR	4.41	1.57	0.142
Albumin	-124.77	-1.35	0.201
Triglyceride	1.11	1.91	0.08
LDL	5.95	1.54	0.149
HDL	8.95	1.83	0.09

Data were analyzed using multiple regression

* Significant difference among groups at $p < 0.05$

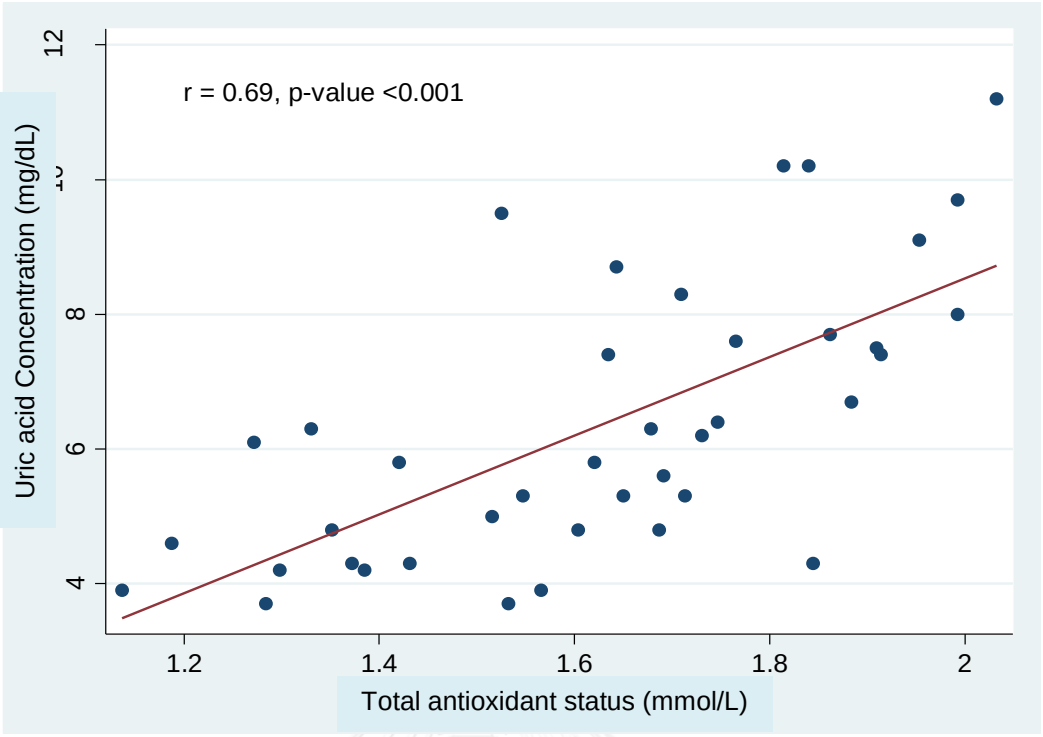


Figure 4.2 Correlation between uric acid and total antioxidant status

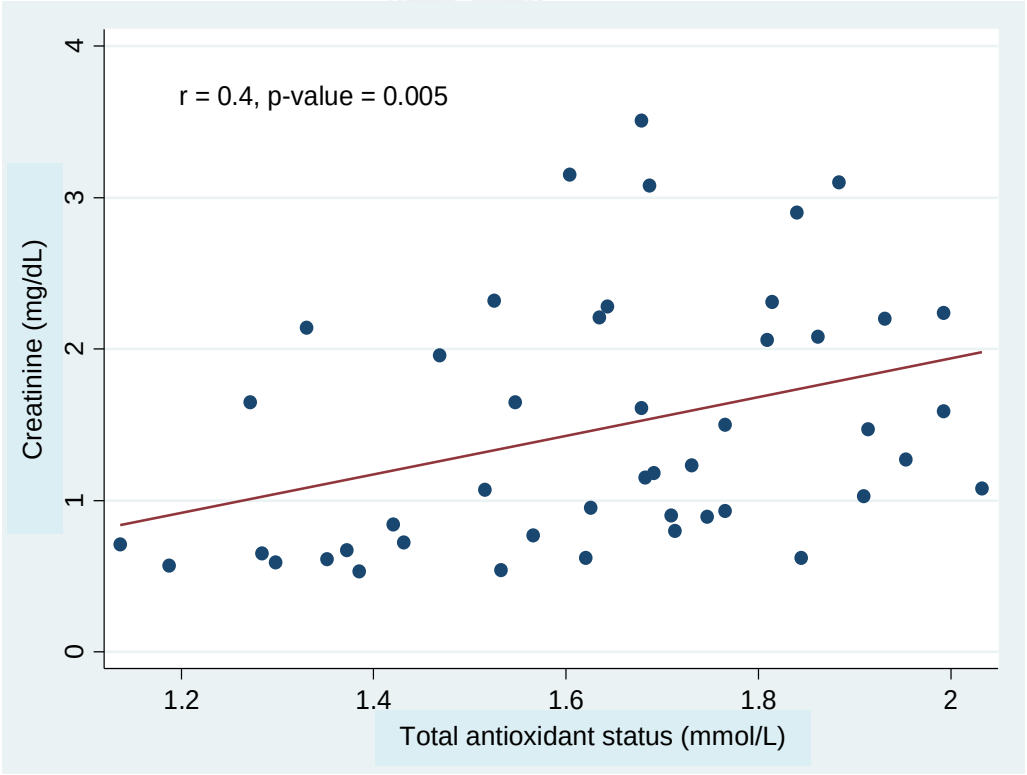


Figure 4.3 Correlation between creatinine and total antioxidant status

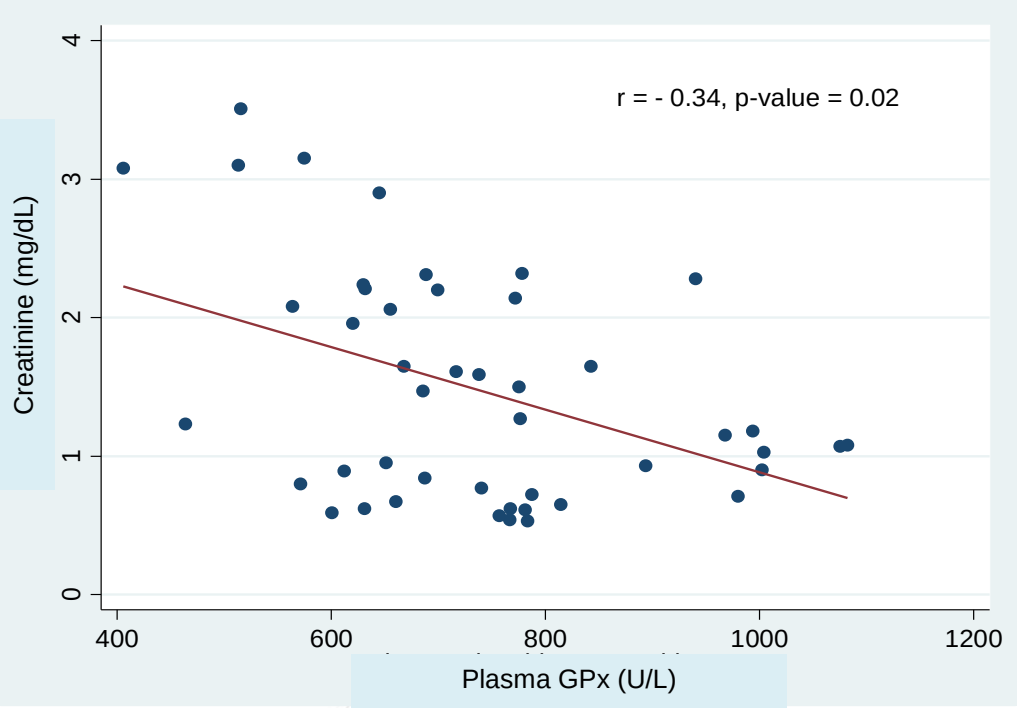


Figure 4.4 Correlation between creatinine and plasma glutathione peroxidase

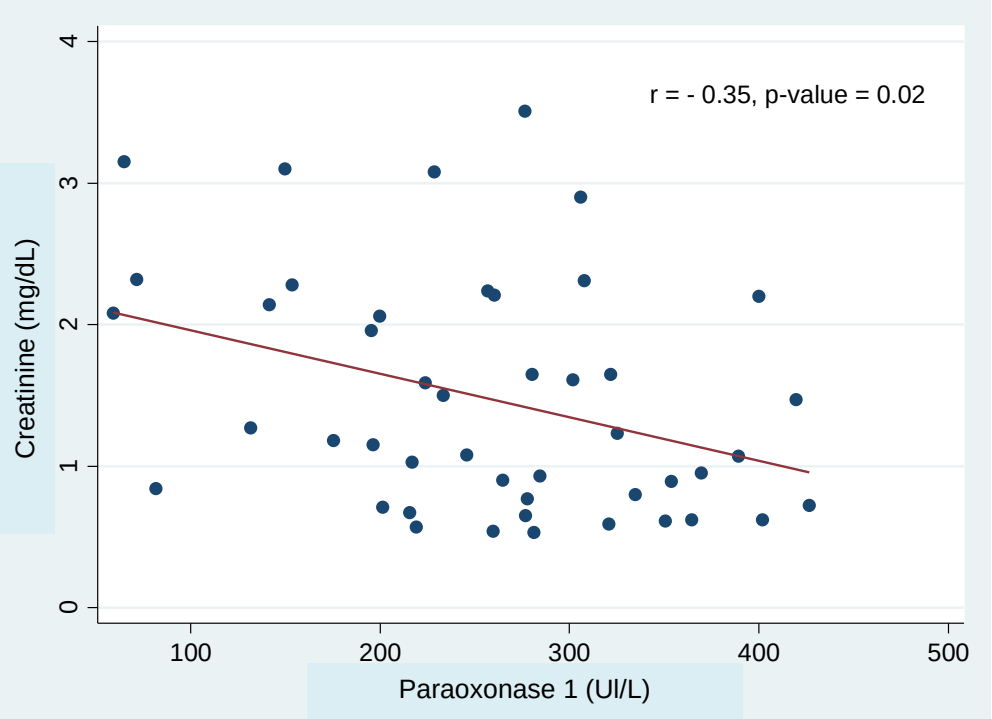


Figure 4.5 Correlation between creatinine and paraoxonase 1

It was obvious that there was a positive correlation between total antioxidant status and uric acid (r = 0.69, p <0.001) (Figure **4.2**). There was a positive correlation between creatinine and TAS (r = 0.4, p = 0.005) (Figure **4.3**). In contrast, a negative correlation between creatinine and antioxidant markers such as plasma GPx and PON-1 was observed in this study (r = - 0.34 and r = - 0.35, respectively, with p = 0.02) (Figure 4.4 and Figure 4.5).

4.6. Dietary antioxidants

Using PCA to transform data, the weekly food intake of all food groups (FFW_G) were presented in Table 4.14. Our study found that FFW_G of sweet, bakery, and snack was significantly different among CKD patient groups and control group. Subjects in the control group consumed sweet, bakery, and snack per week significantly higher than all groups in CKD patients (p = 0.03).

The FFW_G of rich-antioxidant food groups, containing ≥ 30% of Thai adult DRI were presented in Table 4.15. It is shown that weekly intake of rich – vitamin E fat was significantly higher in CKD stage 3 group than the control and stage 1&2 CKD group (p = 0.04).

Table 4.14 Food pattern scores of all food groups in CKD patients and control subjects

Food groups	Control (n=13)	Stage 1&2 (n=8)	Stage 3 (n=15)	Stage 4 (n=10)	*p-value*
Meat/ fish/ egg	0.26 ± 0.34	0.32 ± 0.87	-0.68 ± 0.17	0.41 ± 0.72	NS
Fruits	0.32 ± 0.77	-0.27 ± 0.5	-0.16 ± 0.34	0.01 ± 0.78	NS
Vegetables	-0.67 ± 0.58	1.0 ± 1.1	-0.1 ± 0.81	0.26 ± 1.24	NS
Cereals	-0.58 ± 0.33	1.38 ± 1.98	-0.05 ± 0.37	-0.21 ± 0.51	NS
Milk and dairy	-0.20 ± 0.34	0.78 ± 0.62	-0.1 ± 0.29	-0.19 ± 0.41	NS
Fat and oil	-0.26 ± 0.23	-0.64 ± 0.4	0.55 ± 0.34	0.05 ± 0.21	NS
Condiments	0.17 ± 0.56	-0.01 ± 0.63	-0.12 ± 0.51	-0.05 ± 0.55	NS
Beverages	1.08 ± 0.96	-0.6 ± 0.22	-0.5 ± 0.46	-0.27 ± 0.47	NS
Appetizer/ local dishes	0.76 ± 0.71	-0.31 ± 0.3	-0.26 ± 0.25	-0.42 ± 0.41	NS
Sweet/ Bakery and snack	$1.23 \pm 0.52^{‡}$	$0.12 \pm 0.08^{§}$	$0.43 \pm 0.36^{§}$	$0.9 \pm 0.59^{‡,§}$	0.03
Fast food	0.50 ± 0.23	0.18 ± 0.09	0.13 ± 0.07	0.15 ± 0.1	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. ‡,§ Different symbols mean significant difference among groups at $p < 0.05$

Table 4.15 Food pattern scores of rich-antioxidant and good sources of antioxidant food groups in CKD patients and control subjects

Food groups	Control (n=13)	Stage 1&2 (n=8)	Stage 3 (n=15)	Stage 4 (n=10)	*p-value*
Rich-antioxidant*					
Rich – vitamin A vegetable	-0.30 ± 0.28	0.11 ± 0.51	0.03 ± 0.54	0.28 ± 0.89	NS
Rich – vitamin C vegetable	-0.39 ± 0.46	0.85 ± 0.83	-0.17 ± 0.66	0.13 ± 0.77	NS
Rich – vitamin C fruits	0.34 ± 0.53	0.03 ± 0.49	0.05 ± 0.39	-0.56 ± 0.44	NS
Rich – vitamin C cereals	-0.30 ± 0.21	1.02 ± 1.34	-0.28 ± 0.24	0.01 ± 0.29	NS
Rich – vitamin E cereals	0.23 ± 0.37	0.36 ± 0.66	-0.38 ± 0.14	-0.08 ± 0.38	NS
Rich – vitamin E fat	-0.26 ± 0.26[‡]	-0.57 ± 0.37[‡]	0.49 ± 0.34[§]	0.07 ± 0.21[‡,§]	0.04
Rich – vitamin A, vitamin C, Zn milk	-0.12 ± 0.25	0.6 ± 0.75	-0.16 ± 0.31	-0.08 ± 0.31	NS
Rich – zinc meat/fish	0.19 ± 0.23	0.84 ± 0.9	-0.40 ± 0.19	-0.32 ± 0.17	NS
Rich – selenium meat/fish	-0.55 ± 0.2	0.13 ± 0.3	0.16 ± 0.32	0.36 ± 0.73	NS
Good sources of antioxidant					
Good sources of vitamin A vegetable	-0.18 ± 0.26	-0.08 ± 0.23	0.40 ± 0.59	-0.29 ± 0.26	NS
Good sources of vitamin C vegetable	-0.37 ± 0.42	0.55 ± 0.81	-0.13 ± 0.43	0.24 ± 1.02	NS
Good sources of vitamin C fruits	0.13 ± 0.44	-0.42 ± 0.23	-0.31 ± 0.15	0.63 ± 0.71	NS
Good sources of Zinc cereals	-0.52 ± 0.13	0.80 ± 0.97	0.20 ± 0.41	-0.26 ± 0.27	NS
Good sources of Zinc meat/ fish	0.15 ± 0.25	-0.17 ± 0.21	-0.39 ± 0.13	0.52 ± 0.77	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups

[‡,§] Different symbols mean significant difference among groups at $p < 0.05$

[*] rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI

[#] good source of antioxidant food groups contained antioxidant micronutrients 15 – 29% of Thai adult DRI

Table 4.16 Correlations of food pattern scores (FP scores) and antioxidant or oxidative stress markers in CKD patients and control subjects

Food groups	MDA	TAS	RBC GPx	Plasma GPx	PON-1
Meat/ fish/ egg	-0.22	- 0.15	0.24	0.03	-0.11
Rich- Zn meat/fish/egg‡	-0.14	-0.15	-0.07	0.06	-0.02
Rich- Se meat/fish/egg‡	0.16	0.10	0.12	0.37	-0.001
Good sources of Zn meat/ fish§	-0.04	-0.11	0.19	0.09	-0.25
Fruits	-0.04	-0.14	0.26	0.05	0.03
Rich- vitamin C fruits‡	-0.003	-0.16	0.13	0.32	0.13
Good sources of vitamin C fruits§	-0.13	-0.16	0.11	0.28	-0.01
Vegetables	0.09	-0.26	0.06	0.25	0.02
Rich-vitamin C vegetables‡	0.14	-0.32*	0.11	0.32*	0.02
Rich-vitamin A vegetables‡	0.22	-0.19	0.03	0.18	0.04
Good sources of vitamin C vegetables§	0.18	-0.12	0.23	0.01	-0.02
Good sources of vitamin A vegetables§	-0.12	-0.23	0.09	0.32*	-0.02
Cereals	0.05	-0.03	0.16	0.14	0.01
Rich-vitamin C cereals‡	0.05	0.06	0.01	0.03	-0.03
Rich-vitamin E cereals‡	-0.02	0.01	0.09	0.11	0.28
Good sources of Zn cereals§	0.12	0.19	0.16	0.23	-0.01
Milk and dairy	0.02	0.23	0.20	-0.11	0.12
Rich – vitamin A, vitamin C, Zn milk‡	-0.05	0.11	0.15	-0.01	-0.001
Fat and oil	0.07	0.03	0.004	-0.07	-0.07
Rich-vitamin E fat‡	0.03	0.02	0.11	0.01	-0.12
Condiments	-0.05	- 0.05	-0.01	0.18	-0.13
Beverages	-0.04	0.05	0.002	0.16	0.04
Appetizer and local dishes	0.04	- 0.29	0.16	0.23	-0.01
Sweet/ bakery and snack	-0.22	-0.35*	-0.08	0.13	-0.01
Fast food	-0.18	-0.09	-0.11	0.03	0.07

Results were expressed as correlation coefficients. Data were analyzed using Spearman correlation. Number of observation = 46. * Statistical significance at $p < 0.05$

‡ rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI

§ good sources of antioxidant food groups contained antioxidant micronutrients 15 – 29% of Thai adult DRI

The food pattern score of food-groups intake per week or FFW_G were analyzed for correlation with oxidative stress or antioxidant markers, as shown in Table 4.16. Overall, food pattern scores from food group intake per week could not be found any correlation with oxidative stress or antioxidant markers, except only rich-vitamin C vegetables and good sources of vitamin A vegetables. There was a positive correlation found between the rich-vitamin C vegetables and good sources of

vitamin A vegetables intake pattern score with plasma GPx (r = 0.323, p = 0.02 and r=0.319, p = 0.03, respectively) (Figure 4.6 and Figure 4. 7). However, there was a negative correlation between the rich-vitamin C vegetables intake pattern score with TAS (r = -0.319, p = 0.02) (Figure 4.8).

In the rich-vitamin C vegetables groups, lemon juice, tomato, cabbage, and kale Chinese were some vegetables that people seemed to consume more than the others in this study. The frequency of lemon juice and kale Chinese were almost 3 times per week and once per week, respectively, for all subject groups. While the frequency of tomato intake was less than lemon juice and kale, almost once per week and almost twice per week were found in the control group and CKD patient groups, respectively. However, the frequency of cabbage were only 0.53 ± 0.08, 2.1 ± 0.78, 1.1 ± 0.4 and 0.85 ± 0.38 times per week in the control, stage 1&2, stage 3 and stage 4, respectively (Table 4.17).

According to Table 4.18, it was indicated that only holy basil leaves and sweet basil leaves containing rich vitamin A were consumed often around once per week in all subject groups. In Table 4.19, only rice bran oil which was rich in vitamin E, was consumed more than once per week in control and stage 1&2, and more than twice per week in stage 3 and 4 groups.

Based on the Table 4.21, we found that the meat such as pork and whole hen egg were sources of selenium in all subject groups. Pork intake was approximately more 3 times per week for CKD groups and around twice a week for control group. Whole hen egg was consumed more than twice a week in control, and CKD patients. However, beef and mussel green which were sources of zinc, found that consumed less than once per 2 week (Table 4.20). Besides source of protein and calcium, milk also can be a source of vitamin A, vitamin C and zinc. However, all of control and subjects consumed less than 3 times per week (Table 4.22).

Table 4.17 Frequency of rich-vitamin C and good sources of vitamin C food items intake per week (FFW_I) of CKD patients and control subjects

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Rich-vitamin C vegetables					
Horseradish leaves	0.25 ± 0.21	0.43 ± 0.37	0.06 ± 0.04	0.10 ± 0.06	NS
Tiliacora triandra diel	0.28 ± 0.10	0.25 ± 0.16	0.06 ± 0.04	0.45 ± 0.29	NS
Broccoli	0.89 ± 0.31	1.25 ± 0.62	0.50 ± 0.20	0.80 ± 0.37	NS
Mustard green	1.07 ± 0.43	0.50 ± 0.13	0.67 ± 0.25	0.90 ± 0.36	NS
Brussels sprouts	0.39 ± 0.10	0.37 ± 0.15	0.36 ± 0.2	0.15 ± 0.07	NS
Gourd bitter young leaves	0.10 ± 0.05	0.31 ± 0.09	0.33 ± 0.2	0.15 ± 0.07	NS
Mint leaves	0.42 ± 0.21	0.62 ± 0.35	0.50 ± 0.36	0.40 ± 0.10	NS
Kale Chinese	1.28 ± 0.31	1.18 ± 0.41	0.63 ± 0.19	1.25 ± 0.54	NS
Cauliflower	0.35 ± 0.08	0.62 ± 0.15	0.73 ± 0.39	0.60 ± 0.30	NS
Glory red stem	0.32 ± 0.11	1.12 ± 0.43	1.23 ± 0.42	0.70 ± 0.28	NS
Cassia leaves	0.28 ± 0.08	0.18 ± 0.09	0.30 ± 0.09	0.10 ± 0.06	NS
Chilli pepper	0.21 ± 0.08	0.62 ± 0.35	0.13 ± 0.05	0.50 ± 0.14	NS
Graden pea pod	0.42 ± 0.21	0.68 ± 0.36	0.23 ± 0.09	0.55 ± 0.29	NS
Okra	0.10 ± 0.07	0.18 ± 0.09	0.03 ± 0.03	1.15 ± 0.71	NS
Garlic flower	0.03 ± 0.03	0.06 ± 0.06	0.03 ± 0.03	0.05 ± 0.05	NS
Acacia pennata	0.39 ± 0.09	0.81 ± 0.32	0.13 ± 0.07	0.20 ± 0.08	NS
Celery	0.60 ± 0.21	0.87 ± 0.33	1.20 ± 0.61	0.85 ± 0.37	NS
Gourd wax	0.32 ± 0.06	0.37 ± 0.12	0.36 ± 0.11	0.85 ± 0.37	NS
Tomato	0.78 ± 0.27	1.62 ± 0.83	1.86 ± 0.56	1.85 ± 0.69	NS
Water mimosa	0.25 ± 0.06	0.25 ± 0.13	0.76 ± 0.39	0.15 ± 0.07	NS
Crawdaisy leaves	0.53 ± 0.28	0.25 ± 0.13	0.1 ± 0.05	0.45 ± 0.30	NS
Wing bean pod	0.32 ± 0.09	1.00 ± 0.45	0.46 ± 0.2	0.60 ± 0.28	NS
Sesbania flowers	0.50 ± 0.20	0.37 ± 0.15	0.13 ± 0.05	0.40 ± 0.12	NS
Cabbage	0.53 ± 0.08	2.10 ± 0.78	1.10 ± 0.40	0.85 ± 0.38	NS
Lemon juice	2.57 ± 0.65	2.06 ± 0.66	2.60 ± 0.69	2.65 ± 0.68	NS
Rich – vitamin C fruits					
Banana, unripe	0.82 ± 0.42	1.00 ± 0.73	1.56 ± 0.52	0.65 ± 0.28	NS
Rambutan	1.00 ± 0.30	0.68 ± 0.35	1.16 ± 0.54	1.10 ± 0.56	NS
Durian	0.32 ± 0.09	0.18 ± 0.09	0.43 ± 0.19	0.15 ± 0.07	NS
Guava common	0.89 ± 0.26	1.12 ± 0.41	1.56 ± 0.49	0.70 ± 0.29	NS
Jujube apple	0.10 ± 0.07	0	0.10 ± 0.07	0.10 ± 0.13	NS
Papaya, ripe	0.85 ± 0.41	0.68 ± 0.35	1.33 ± 0.50	0.25 ± 0.11	NS
Kalanchoe	0.32 ± 0.21	0.12 ± 0.08	0.03 ± 0.03	0.30 ± 0.30	NS
Pomelo	0.67 ± 0.27	0.25 ± 0.13	0.70 ± 0.39	0.25 ± 0.11	NS
Cantaloupe	0.89 ± 0.26	1.00 ± 0.45	0.56 ± 0.36	0.10 ± 0.10	NS
Strawberry	0.14 ± 0.08	0.18 ± 0.09	0.13 ± 0.05	0.15 ± 0.10	NS
Mango, ripe	0.25 ± 0.21	0.56 ± 0.35	0.16 ± 0.07	0.25 ± 0.13	NS
Mango, unripe	0.46 ± 0.21	0.31 ± 0.13	0.33 ± 0.19	0.35 ± 0.10	NS
Kiwi fruit	0.14 ± 0.06	0.18 ± 0.09	0.26 ± 0.20	0.10 ± 0.06	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI.
Good source of antioxidant food groups contained antioxidant micronutrients 15% - 19% of Thai adult DRI.

Table 4.17 Frequency of rich-vitamin C and good sources of vitamin C food items intake per week (FFW_I) of CKD patients and control subjects (continue)

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Rich – vitamin C cereals					
Corn flakes	0.19 ± 0.10	0.44 ± 0.37	0.37 ± 0.20	0.15 ± 0.10	NS
Cereal soy based supplementary food	0.11 ± 0.06	0.18 ± 0.13	0.03 ± 0.03	1.00 ± 0.73	NS
Potato	0.30 ± 0.09	0.62 ± 0.35	0.30 ± 0.09	0.40 ± 0.14	NS
Cassava	0.11 ± 0.06	0	0.23 ± 0.09	0.50 ± 0.29	NS
Lotus root, raw	0.15 ± 0.06	0.37 ± 0.37	0.06 ± 0.04	0.10 ± 0.06	NS
Chinese chestnut	0.11 ± 0.06	0.12 ± 0.08	0.10 ± 0.05	0.25 ± 0.11	NS
Pigeonpea immature seeds	0.03 ± 0.03	0.50 ± 0.36	0.06 ± 0.04	0.05 ± 0.05	NS
Ginkgo seeds, whole	0.11 ± 0.06	0.25 ± 0.13	0.10 ± 0.05	0.15 ± 0.10	NS
Good sources of vitamin C vegetables					
Corn baby	0.50 ± 0.23	0.87 ± 0.32	0.56 ± 0.26	0.60 ± 0.28	NS
Holy basil leaves	1.00 ± 0.32	1.81 ± 0.66	1.33 ± 0.4	1.35 ± 0.52	NS
Shallot spring	2.57 ± 0.74	2.18 ± 0.76	1.90 ± 0.53	2.35 ± 0.92	NS
Onion	1.57 ± 0.52	2.00 ± 0.81	1.83 ± 0.41	1.60 ± 0.53	NS
Sweet basil leaves	0.88 ± 0.27	0.62 ± 0.35	1.16 ± 0.49	1.05 ± 0.5	NS
Asparagus	0.53 ± 0.30	0.25 ± 0.09	0.73 ± 0.49	0.10 ± 0.10	NS
Yard long bean green, boiled	0.61 ± 0.22	1.43 ± 0.47	0.90 ± 0.38	1.10 ± 0.42	NS
Carrot	0.84 ± 0.27	1.25 ± 0.40	1.70 ± 0.61	0.35 ± 0.13	NS
Egg plant	0.26 ± 0.09	1.00 ± 0.45	0.23 ± 0.09	1.10 ± 0.56	NS
Spinach	0.11 ± 0.06	0.12 ± 0.08	0.56 ± 0.46	0.10 ± 0.06	NS
Gourd sponge round	0.42 ± 0.11	0.06 ± 0.06	0.53 ± 0.20	0.80 ± 0.37	NS
Mungbean sprout	0.46 ± 0.11	0.75 ± 0.34	0.40 ± 0.11	0.80 ± 0.53	NS
Good sources of vitamin C fruits					
Longkong	0.65 ± 0.22	0.37 ± 0.12	1.13 ± 0.49	0.85 ± 0.36	NS
Longan	0.92 ± 0.55	0	0.26 ± 0.20	0.05 ± 0.05	NS
Litchi	0.15 ± 0.06	0.06 ± 0.06	0.06 ± 0.04	0.65 ± 0.54	NS
Cherries eating, raw	0.07 ± 0.05	0.18 ± 0.13	0.16 ± 0.07	0.05 ± 0.05	NS
Tangelo / Tangerine/ Mandarin	0.57 ± 0.41	0.56 ± 0.35	0.43 ± 0.27	0.55 ± 0.30	NS
Santol	0.53 ± 0.22	0.06 ± 0.06	0.10 ± 0.07	0.40 ± 0.30	NS
Rose apple, green	0.19 ± 0.07	0.12 ± 0.08	0.06 ± 0.04	0.65 ± 0.39	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI.
Good source of antioxidant food groups contained antioxidant micronutrients 15% - 19% of Thai adult DRI

Table 4.18 Frequency of rich-vitamin A and good sources of vitamin A food items intake per week (FFW_I) of CKD patients and control subjects

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Rich-vitamin A vegetables					
Gourd bitter young leaves	0.11 ± 0.06	0.31 ± 0.09	0.33 ± 0.20	0.70 ± 0.54	NS
Holy basil leaves	1.00 ± 0.32	1.80 ± 0.67	1.30 ± 0.41	1.35 ± 0.52	NS
Lettuce red leaves	0.35 ± 0.23	0.88 ± 0.48	0.73 ± 0.49	0.20 ± 0.11	NS
Tiliacora triandra diel	0.31 ± 0.11	0.25 ± 0.16	0.67 ± 0.45	0.45 ± 0.29	NS
Ivy ground	0.46 ± 0.12	0.75 ± 0.34	0.40 ± 0.11	0.80 ± 0.53	NS
Horseradish leaves	0.27 ± 0.23	0.44 ± 0.37	0.07 ± 0.04	0.10 ± 0.07	NS
Water mimosa	0.27 ± 0.07	0.25 ± 0.13	0.77 ± 0.39	0.15 ± 0.08	NS
Mint leaves	0.46 ± 0.23	0.62 ± 0.35	0.50 ± 0.36	0.40 ± 0.10	NS
Crawdaisy leaves	0.58 ± 0.31	0.25 ± 0.13	0.10 ± 0.05	0.45 ± 0.30	NS
Horse tamarind	0.04 ± 0.04	0.06 ± 0.06	0.13 ± 0.08	0.15 ± 0.11	NS
Sweet basil leaves	0.88 ± 0.27	0.62 ± 0.35	1.20 ± 0.49	1.05 ± 0.50	NS
Good sources of vitamin A vegetables					
Mustard green stem and leaves	1.15 ± 0.46	0.50 ± 0.13	0.66 ± 0.25	0.90 ± 0.36	NS
Celery	0.65 ± 0.22	0.87 ± 0.33	1.20 ± 0.61	0.85 ± 0.37	NS
Indian penny wort leaves	0.38 ± 0.22	0.12 ± 0.12	0.56 ± 0.46	0.35 ± 0.29	NS
Carrot	0.84 ± 0.27	1.25 ± 0.40	1.70 ± 0.61	0.35 ± 0.13	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI.
Good source of antioxidant food groups contained antioxidant micronutrients 15% - 19% of Thai adult DRI

Table 4.19 Frequency of rich-vitamin E food items intake per week (FFW_I) of CKD patients and control subjects

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Rich – vitamin E cereals/ legumes/ starchy vegetables					
Rice whole grain milled by machine, steamed	1.15 ± 0.64	2.37 ± 0.97	2.56 ± 0.86	1.75 ± 0.92	NS
Cereal soy based supplementary food	0.11 ± 0.06	0.18 ± 0.13	0.03 ± 0.03	1.00 ± 0.73	NS
Sunflower seeds, dry, roasted without salt	0.23 ± 0.09	0.18 ± 0.13	0.06 ± 0.04	0.20 ± 0.11	NS
Almonds dry roasted with salt added	0.42 ± 0.23	0.56 ± 0.35	0.10 ± 0.05	0.15 ± 0.10	NS
Rich – vitamin E fat and oil					
Peanut oil	0.46 ± 0.42	0.37 ± 0.37	0.46 ± 0.46	0.10 ± 0.06	NS
Olive oil salad or cooking	0.23 ± 0.23	0.31 ± 0.16	1.16 ± 0.57	0.15 ± 0.11	NS
Rice bran oil	1.03 ± 0.64	1.12 ± 0.85	2.96 ± 0.85	2.05 ± 0.91	NS
Shortening bread soybean and cottonseed	0	0.18 ± 0.13	0	0	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI

Table 4.20 Frequency of rich-zinc and good sources of zinc food items intake per week (FFW_I) of CKD patients and control subjects

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Rich – zinc meat/ fish					
Beef meat lean	0.21 ± 0.08	0.56 ± 0.35	0.10 ± 0.07	0	NS
Beef meat sundried, fried	0.07 ± 0.04	0.12 ± 0.08	0.03 ± 0.03	0	NS
Mussel green, dried	0.14 ± 0.06	0.12 ± 0.08	0	0.15 ± 0.07	NS
Good sources of zinc Rich – zinc meat/ fish					
Chicken wing, fried	0.96 ± 0.33	0.43 ± 0.14	0.30 ± 0.20	0.75 ± 0.53	NS
Pork spare ribs (Fat 14.7%)	0.53 ± 0.22	0.75 ± 0.34	0.53 ± 0.19	0.30 ± 0.11	NS
Cockle / Ark shell, blanched	0.11 ± 0.06	0.12 ± 0.08	0	0.40 ± 0.29	NS
Shrimp sea	0.30 ± 0.07	0.87 ± 0.47	1.06 ± 0.40	0.85 ± 0.68	NS
Good sources of zinc cereals					
Cowpea seeds, black color, dried	0.38 ± 0.38	0.18 ± 0.13	0.23 ± 0.09	0.25 ± 0.11	NS
Soybean seeds, dried	0.15 ± 0.06	0.37 ± 0.37	0.26 ± 0.20	0.05 ± 0.05	NS
Mungbean	0.15 ± 0.06	1.18 ± 0.71	0.5 ± 0.36	0.55 ± 0.29	NS
Rice bean seeds, dried	0.03 ± 0.03	0.37 ± 0.37	0.33 ± 0.2	0.10 ± 0.06	NS
Bread whole wheat	0.84 ± 0.45	1.50 ± 0.86	1.90 ± 0.72	0.55 ± 0.28	NS
Peanut, boiled	0.34 ± 0.10	1.31 ± 0.68	0.66 ± 0.35	0.50 ± 0.28	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups contained antioxidant micronutrients ≥ 30% of Thai adult DRI
Good source of antioxidant food groups contained antioxidant micronutrients 15% - 19% of Thai adult DRI

Table 4.21 Frequency of rich-selenium food items intake per week (FFW_I) of CKD patients and control subjects

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Pork loin	0.71 ± 0.20	1.87 ± 0.43	1.80 ± 0.57	2.35 ± 0.95	NS
Pork tenderloin	0.89 ± 0.25	1.87 ± 0.43	1.63 ± 0.51	2.25 ± 0.94	NS
Shrimp common	0.39 ± 0.07	0.62 ± 0.36	0.66 ± 0.39	1.10 ± 0.56	NS
Jelly fish	0.03 ± 0.03	0	0	0	NS
Fish salmon atlantic farmed, raw	0.28 ± 0.08	0.50 ± 0.36	0.20 ± 0.06	0.25 ± 0.11	NS
Finfish roe mixed species	0.14 ± 0.06	0.06 ± 0.06	0.06 ± 0.06	0.30 ± 0.30	NS
Hen egg, whole	2.46 ± 0.59	0.30 ± 0.30	3.13 ± 0.59	2.45 ± 0.63	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups found in the meat/ fish and aquatic/egg food group, containing antioxidant micronutrients ≥ 30% of Thai adult DRI

Table 4.22 Frequency of rich-vitamin A, vitamin C and zinc food items intake per week (FFW_I) of CKD patients and control subjects

Food items	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Milk powdered, full cream	1.15 ± 0.71	0.70 ± 0.58	0.04 ± 0.04	2.12 ± 1.63	NS
Milk powdered, plain	0.15 ± 0.07	0.40 ± 0.24	0.27 ± 0.27	0.75 ± 0.75	NS
Milk powdered defatted, high calcium	0.40 ± 0.29	1.10 ± 1.10	0	0.41 ± 0.22	NS
Milk powder reduced fat	0.25 ± 0.13	0.10 ± 0.10	0.45 ± 0.28	0	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups. Rich-antioxidant food groups found in milk and milk prodcuts, containing antioxidant micronutrients ≥ 30% of Thai adult DRI

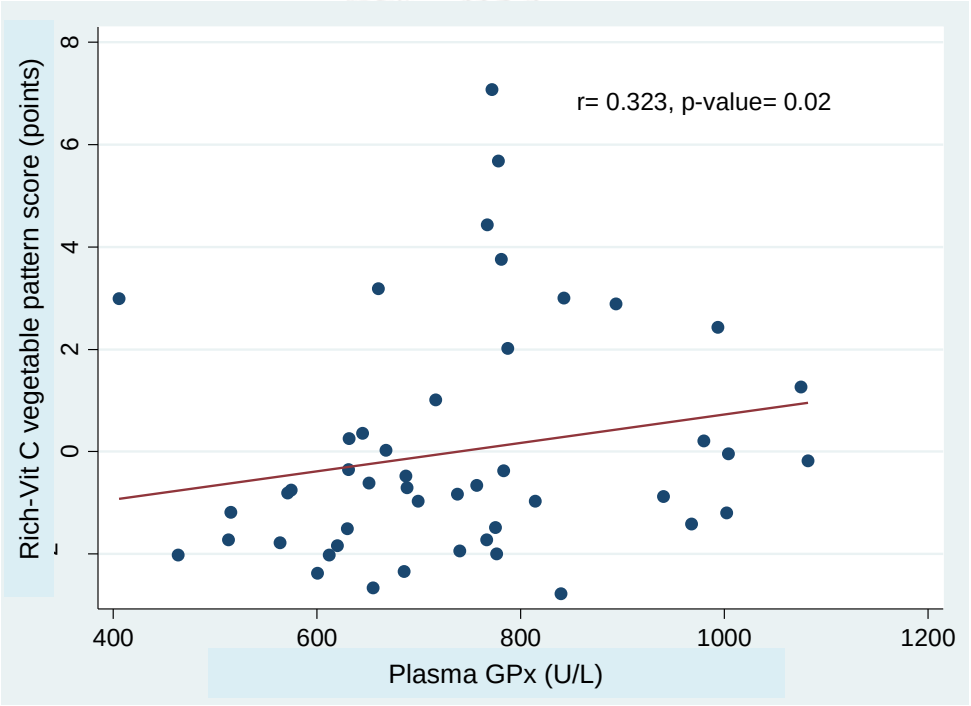


Figure 4.6 Correlation between Rich-vitamin C vegetable pattern score with plasma GPx

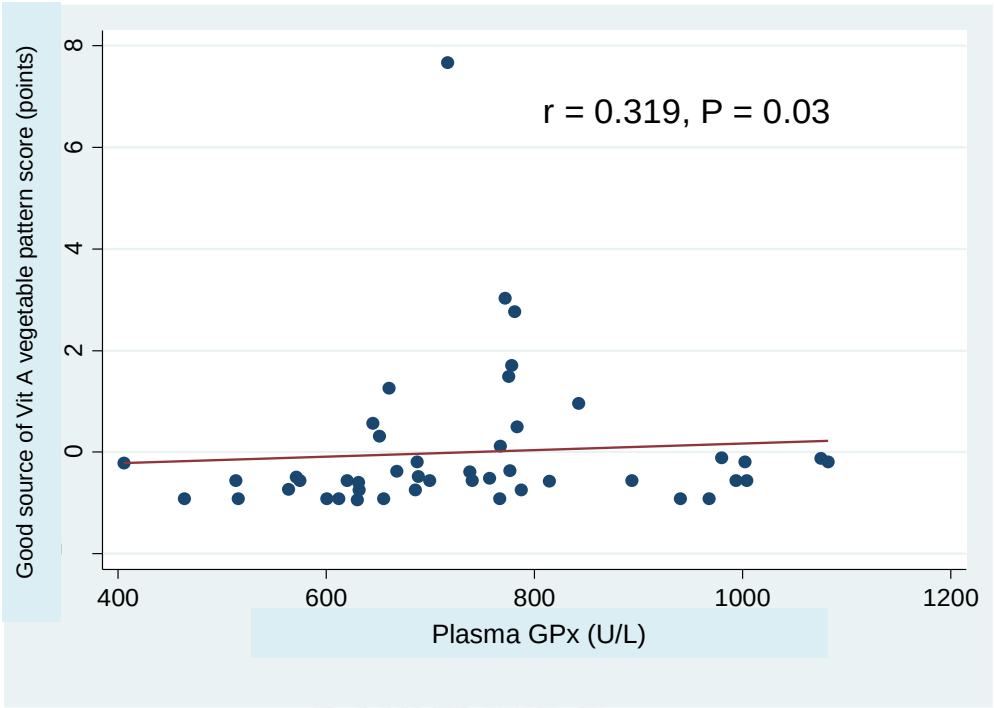


Figure 4. 7 Correlation between good sources of vitamin A vegetable pattern score with plasma GPx

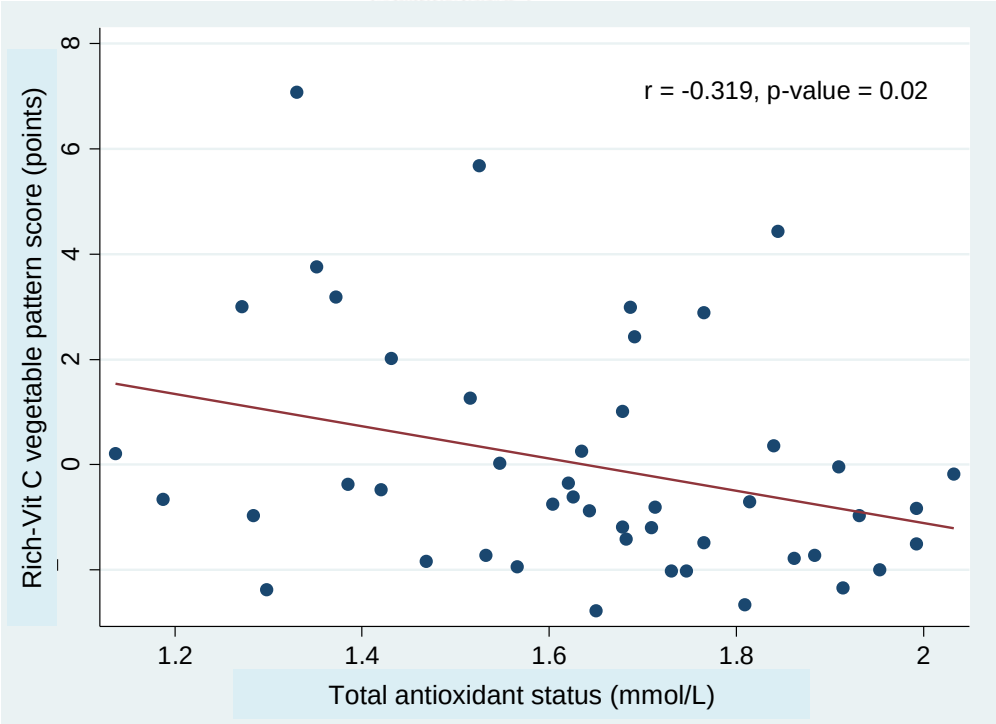


Figure 4.8 Correlation between Rich-vitamin C vegetable pattern score with total antioxidant status

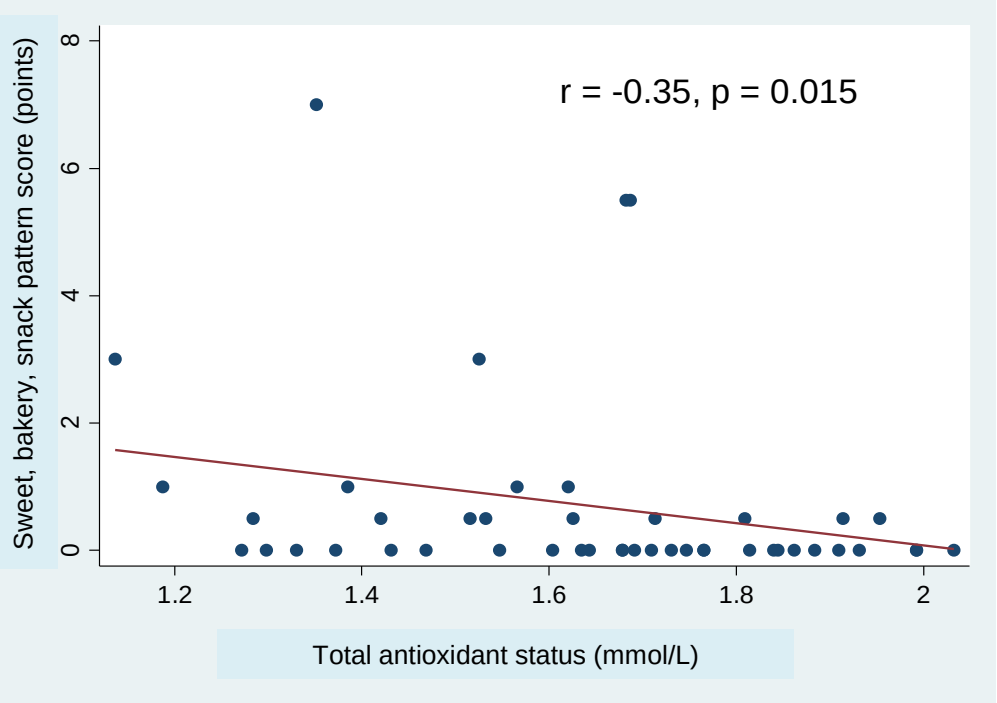


Figure 4.9 Correlation between sweet, bakery, snack pattern score with total antioxidant status

CHAPTER 5

DISCUSSION

Generally, after diagnosis of CKD, staging is classified based on the estimated glomerular filtration rate [1]. This study used the eGFR CKD-EPI (CKD Epidemiology Collaboration) equation to calculated eGFR and classified stage groups [153]. The clinical practice recommendation for the evaluation and management of CKD in Thai adults 2015 classified the severity of CKD in 5 stages, with stage 1 being the mildest and usually causing few symptoms while stage 5 being a severe illness with many complications [154]. Similar to previous studies, our results showed that there were more kinds of complications increased in CKD stage 3 more than CKD stage 1 &2 such as dyslipidemia, gout, and osteoporosis.

Malnutrition may occur in the late stage of CKD. Based on the study in Thai CKD population, BMI of CKD patients might significantly be higher or lower than those of non-CKD groups depending on the formula to calculate eGFR (25.8 ± 3.8 & 24.6 ± 3.7 kg/m^2 by MDRD equation and 22.2 ± 3.7 & 24.9 ± 3.6 kg/m2 by Cockcroft-Gault formula) [155]. Our study using eGFR CKD-EPI equation showed that there was no significant difference of BMI among CKD groups and the control group. It is possible that different formula to calculate eGFR would influence on the stage classification. It was consonance with the finding of the study in Netherland CKD patients, which was not noticed any difference of BMIs among CKD patients at stage 3&4 and the healthy control group [156]. Also, the study in Indian CKD patients showed there was no significant difference among BMI of moderate and severe CKD groups comparing to control [13].

Albumin, which indicates serum proteins, is a one of biochemical parameter for nutrition status assessment and has the relationship with body protein turnover in clinically stable conditions [124]. Low levels of serum albumin are highly predictive of poor clinical outcomes in all stages of CKD. Thus, serum albumin is considered a reliable marker of general clinical status [125]. However, the abnormalities in albumin synthesis may not be directly related to nutrition status changing [124]. Some non-nutritional causes of hypoalbuminemia, such as tissue injury, hepatic disease,

gastrointestinal disorders, and volume overload, can affect the specificity of this marker [126]. As known that prealbumin is more sensitive than albumin for monitoring the early stage of malnutrition [25]. In our study, the control group showed the significantly higher mean levels of albumin compared with the stage 4 CKD patients but no significant difference from those of the stage 1&2 and stage 3 CKD group.

Serum cholesterol concentration is an independent predictor of mortality in chronic dialysis patients, and low levels can suggest low dietary and energy intake. Our study showed that the total cholesterol level of stage 3 CKD patients significantly lower than those of control and stage 1&2 CKD groups. The median of cholesterol level in stage 3 was 164.5 mg/dL. Another study indicated that serum cholesterol concentrations less than 150 mg/dL also permit careful evaluation of nutritional status [25]. Some patients in our study are under treatment with statin for dyslipidemia. That might explain the reason why blood cholesterol level of the stage 3 CKD patients significant lower than control groups.

In addition, there was no significant difference in hemoglobin levels among groups even though there were approximately 7% of patients from CKD stage 1 to 3 developing anemia as a complication. The depletion of erythropoietin (EPO) in the late stage of CKD can cause anemia [25] and some patients may receive EPO based on prescription. It was seen in our result that Hb in the CKD stage 4 trend to be decrease close to the lower border line of normal range.

Oxidative stress and antioxidant markers in Thai CKD patients

The determination of MDA, one of the most common markers for investigating lipid peroxidation, was assessed by using the widely employed TBARS method. Although the frequently spectrophotometric method is fairly sensitive, it is not specific since at wavelength of 532nm, aldehydes other than MDA can react with TBA and various pigments. Therefore, we used a reliable and sensitive HPLC technique to enhance the specificity of MDA-(TBA)2 measurement in this study [70]. Our results showed that MDA levels were lower in the control group as compared to various stages of CKD patient group. It was also possible that persons with CKD had a lower concentration of antioxidant enzymes making them vulnerable.

Our results are in agreement with other studies which also found higher MDA levels in CKD patients as compared to the control group [70, 117].

Taking antioxidant in consideration, the results showed that the levels of TAS elevated in CKD patients compared to the control subjects. Even though this finding was unexpected, there were previous studies confirmed this phenomenon [12, 117]. There was a positive correlation was found in TAS values with uric acid levels in CKD patients (Figure 2). The higher TAS values observed in the all stages of CKD may be explained by the increase of uric acid levels. It was proposed that uric acid might act as an antioxidant, a free radical scavenger and a chelate of transitional metal ions which were converted to poorly reactive forms [92]. In vitro experiment, it was shown to be a powerful scavenger of reactive oxygen species [93]. Moreover, in a prospective case-control study, the greater serum uric levels were associated with the higher TAS levels in individuals with atherosclerosis [94]. Nevertheless, the role of uric acid as an antioxidant remains controversy. Due to enzyme xanthine oxidase in the path way producing uric acid involve in ROS production, which is an important role in the increased vascular oxidative stress and atherogenesis [93, 95]. Therefore, it should be under the consideration when choosing the TAS test for assessing the antioxidant capacity of patients with hyperuricemia.

As mentioned above, plasma GPx in CKD patients had a trend to be lower than those of the control. It was reported that plasma GPx activity decreased from the early stage of CKD to next server stages of renal failure [117, 157]. This decrease in the plasma GPx activity may reflect a consequence of active nephron mass reduction and malfunction of the renal tubules which are the main sites of synthesis of plasma GPx [158]. There are also other possible reasons for the loss of enzyme activity, such as decreased inactivation of reactive oxygen species due to selenium deficiency as well as lowered renal removal [117]. Even though our results did not show the significant difference, the trend of plasma GPx was decrease in the stage 3 and stage 4 CKD patients. It might be due to the small sample size in each group of CKD patients and the control. The previous study showed an inconsistency in RBC GPx activity affected by chronic kidney disease. Several researchers demonstrated that RBC GPx activity was significantly lower in CKD patients than in non-CKD subjects [157,

159]. On the other hand, some studies had shown that RBC GPx activity was not significantly different from that of normal controls [10].

Cardiovascular disease is a major cause of morbidity and mortality in patients with chronic kidney disease. This study also determined the role of PON-1, an esterase enzyme that functions to protect LDL and HDL cholesterol from oxidation. In addition to its antioxidant properties, PON-1 has added anti-atherogenic activities against macrophage foam cell formation. It has been suggested that increased formation of oxygen derived radicals accelerates the development of atherosclerosis [160]. Our results confirmed that there was a significant decrease of PON-1 activity in the stage 4 CKD compared to the control (p = 0.04). Additionally, we noticed gradually decreased PON-1 activity in the next stages of CKD, but the differences between particular stages of CKD did not reach statistical significance (Table 4). In some experimental studies, the reduced activity of PON-1 can also be explained by a modification of HDL cholesterol and its instability [116]. Moreover, uremic toxin may play a mechanistic role in PON-1 inactivation. These could be observed in dialysis patients that PON-1 changes correlate with clearance of uremic toxins in previous study [161].

It is indicated that there are negative correlation between creatinine with plasma GPx and PON-1 in our study. These results are similar with previous studies which were also measured in CKD patients [117, 162]. A progressive decrease in plasma GPx activity is associated with the fact that this enzyme is primarily synthesized in the kidney and the progressing damage of this organ is reflected in increasing creatinine level. Moreover, the research conducted in hemodialysis patients, results in significantly and consistently increasing in the activity of the antioxidant enzyme PON-1. The effect associated with the effectiveness of dialysis to clear creatinine and urea. This strongly suggests that elimination of some inhibiting low molecular factor may be responsible in part for the recovery of PON1 activity. This was proposed explain for the correlation between creatinine and antioxidant enzymes [100, 116, 162].

Dietary antioxidants

Antioxidant system including endogenous antioxidants or enzyme (such as GPx, PON-1, etc.) and exogenous antioxidants which come from food consumed

(such as vitamin A, vitamin C, and vitamin E, zinc and selenium), respond the damaging oxidative reactions. Therefore, dietary antioxidants may be especially important in protecting against human diseases associated with free-radical damage [13, 14]. However, CKD patients at late stage may have to follow the restrict diet based on their condition. This may lead to low intake of food that is the source of antioxidant micronutrients.

Despite our study did not find the significant deference of rich antioxidant micronutrients food between CKD groups and the control group like previous studies, we also found that the subjects consumed rich- vitamin C and A fruits and vegetables at the low level, with the mean of frequency was not reach 3 per week for both control and CKD groups. Similarly, rich- vitamin E food was also intake at low level with 1-2 times per week in CKD patient groups and once per week in the control group. Previous study showed that vitamin A intake significantly less in serve CKD patients as compared to moderate and control group. Moreover, the daily average vitamin A intake were consuming it at a daily average of 208 μg retinol/ day and 190 μg retinol/day in moderate and severe renal failure groups respectively which was found to be quiet less than the recommendations for healthy controls which remain the same for CKD patients [13]. The vitamin C intake was consumed by CKD patients was approximately 36 mg/day and it was also observed that vitamin C deficiency may occur with restricted potassium diets recommended for CKD patients [136]. Because fruits and vegetables being rich source of potassium, but the diets of renal failure patients are restricted for potassium intake, unmonitored restrictions by physician and dietitian might decrease the intake of antioxidants from diet [136]. Based on the Academy of Nutrition and Dietetics CKD Evidence-Based Nutrition Practice Guideline, vitamin C intake for treatment anemia in CKD is around DRI [163]. Even though this recommendation for anemia treatment, it can benefit for antioxidant system as well.

Also, our study indicated the low level intake of rich – zinc food, around once per 2 weeks, while rich – selenium food was 2-3 times per week. Dietary zinc intake levels were also positively correlated to serum zinc levels as well as antioxidant enzyme levels and inversely correlated with malondialdehyde levels [13]. Therefore, low protein vegetarian CKD diet might further have lower zinc content and

requires careful planning by renal dietitian and might be supplementation with zinc to achieve its requirements. Zinc requirement from diet remains same for predialysis CKD patients as that for normal persons [13, 138]. As known that, CKD patients have some restricted food due to their disease status and complications, so it may reduce their food choice and consumption. However, there was no routine data about oxidative stress and antioxidant markers except some biochemical parameters such as creatinine, lipid profiles, uric acid, potassium, etc for consultants [138]. Therefore, it is difficult for dietitians to recommend appropriate about antioxidant food consumption.

The remarkable point is that antioxidant micronutrients consumed by the control group were very low similarly to CKD patients groups. Therefore, the individuals in the healthy group may have the risk to suffer from the imbalance in oxidative – antioxidant system in the future. Refer to Thai DRI for adult at the age of 19 years old and above, requirement intake of vitamin A, vitamin C, vitamin E should be 600 RAE for female and 700 RAE for male, 75 mg for female and 90 mg for male, and 15 mg for both gender, respectively. Besides, zinc and selenium intake should be 7 mg for female and 13 mg for male, and 55 µg for both gender, respectively [148].

The results about consumption of sweet, bakery, snack and fast food showed the lower in CKD patients than the control group. This results might due to some patients were diagnosed CKD for a long time. They might be consulted and followed up by dietitians, medical doctors, or nurses regularly. Therefore, they might have knowledge to minimize or avoid unhealthy diet.

Among antioxidant nutrients including vitamin A, vitamin E, vitamin C, zinc and selenium investigated in this study, only vitamin C showed the relationship with antioxidant enzyme. However, our results also indicated that there is a negative correlation between rich- vitamin C vegetables and TAS. This result might be affected by uric acid, as mentioned in the above result that the levels of TAS elevated in CKD patients compared to the control subjects, which was affected by the correlation between TAS and uric acid.

It was exhibited that rich-vitamin C vegetable intake and plasma glutathione peroxidase activity had a positive correlation. The health protection provided by fruit and vegetables could increase through an combined reductive environment

transported by plant antioxidants of differing solubility in each of the tissue, cellular and macromolecular phases [137]. There were many studies reporting that nutrients such as vitamin A and vitamin C could protect the body by supporting antioxidant efforts [45, 136]. However, our study is different from previous study in Indian CKD patients. They showed that there is no correlation between vitamin C intake and glutathione peroxidase, but there is correlation between vitamin A intake and another antioxidant marker, SOD ($r= 0.175$, $p <0.05$) [13]. Vitamin C is an effective water-soluble antioxidant, and epidemiologic studies suggest that increased ascorbic acid is associated with reduced risk of some degenerative diseases. The low levels of plasma C might reduce the activity of the non-enzymatic antioxidant defense system and also responsible for increased oxidative stress occurring in chronic renal failure [135].

CHAPTER 6

CONCLUSION

There were an increase trend in oxidative stress and a decrease trend in antioxidant enzymes in CKD patients. Malonaldehyde, plasma GPx, and PON-1 were the reliable markers to evaluate the oxidative – antioxidative imbalance in progression of CKD patients. Vitamin C in vegetables, a dietary antioxidant, showed the positive correlation on the antioxidant enzyme activity in the CKD patients. Therefore, it was suggested that there is a need of the assessment of dietary antioxidants along with other macronutrients and micronutrients related to their diseased state. Also, increasing their awareness and changing vegetable consuming behavior may improve the balance of the oxidative stress and antioxidants in CKD patients.

CHAPTER 7

LIMITATION AND FUTURE STUDIES

7.1. Limitation

7.1.1. This cross-sectional study collected data in a single time point, so it is impossible to see clearly how the antioxidant foods influence on the change of oxidative stress and antioxidant enzymes. However, food frequency questionnaire also gave us data about participants' eating habit during the period of time and showed the correlation between rich-vitamin C vegetables and GPx.

7.1.2. There is a few of subjects in each research group might influence on the results.

7.1.3. It is difficult to enroll the older healthy participants who match age with CKD patients subjects.

7.2. Future studies

7.2.1. Investigation of MDA, TAS, GPx, and PON-1 markers should be conducted in cohort study or randomized control trial to see how dietary antioxidants effect on the balance of oxidative-antioxidant in CKD patients

7.2.2. There is a need of the assessment of amounts of dietary antioxidants along with frequency of food intake (semi – food frequency questionnaire) in larger group of CKD patients.

7.3. Applications

7.3.1. It is suggested that oxidative stress and antioxidant activities markers can be used for monitoring the progression of CKD in early stages of CKD in order to manage the balance of oxidation-antioxidant system and delay the disease progression in the routine clinical service.

7.3.2. Assessment of dietary antioxidants along with other macronutrients and micronutrients related to CKD, increasing CKD patients' awareness on dietary antioxidants, and suggesting patients the appropriate amounts of vegetables and fruits containing good and rich sources of dietary antioxidants can be included in the nutrition care process by dietitians or nutritionists as a routine work.

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APPENDIX I

Some dietary antioxidant profiles of Thai fruits and vegetables per 100 grams of ready to eat food which contain at least one of five micronutrients ≥ 15% of Thai DRI

Food name	ENERGY	PRO	CHO	FAT	VIT A	VIT C	VIT E	ZN	SE
Meat/ Fish/ Egg									
Beef meat lean	150	20	0	7.2	16	-	-	3.10	-
Pork spare ribs (Fat 14.7%)	260	21.5	0	18.4	3.7	-	-	1.88	-
Pork loin (Fat 7.7%)	203.5	26.5	0	10.2	2.6	0	0.2	1.20	33.9
Pork tenderloin (Fat 3.2%)	116	21	0	3.2	0	0	0.2	1.00	37.0
Chicken wing, fried	290	25.8	0	19.9	6	0	-	2.50	-
Beef meat sundried, fried	281.7	40.7	3.7	11.5	35.4	0	-	6.86	-
Shrimp sea	100	20.2	1	1	24.1	1.15	-	1.61	-
Shrimp common	94.3	18.6	0.5	1.5	54	2	1.1	1.12	38.0
Squid splendid	68	15.4	0.6	0.4	207.7	0	-	1.10	-
Cockle / Ark shell, blanched	68	10.5	5.4	0.5	-	4	-	2.90	-
Mussel green, dried	272	41.7	15.2	4.9	-	54.2	-	4.93	-
Black pomfret	116	18.6	0.5	3.6	102	-	-	0.30	-
Jellyfish, dried, salted	36	5.5	0	1.4	2	0	0.02	0.42	42.2
Crab mud/mangrove meat	128.7	23.1	0	4	288	0	-	-	
Fish salmon atlantic farmed, raw	208	20.4	0	13.4	-	3.90	3.5	0.36	24.0
Finfish roe mixed species	143	22.3	1.5	6.42	90	16	7	1	40.3
Hen egg, whole	133.11	13.1	1.2	8.4	235	0	1	0.9	30.3
Fruits									
Strawberry	34	0.8	7.6	0.5	0.68	53	0.27	0.18	-
Cantaloupe	24	0.6	5.1	0.1	107.08	34	-	0.1	-
Rose apple, green	31	0.5	7.3	0.1	0.42	13	-	-	-
Longan	76	1.2	17.5	0.1	0	23.1	-	0.1	0.1
Guava common	52	0.7	12.1	0.1	1.26	154.4	0.22	0.11	-
Kiwi fruit	47	0.9	9.5	0.6	4.92	93	-	0.1	-
Tangelo / Tangerine / Mandarin	45	1	9.9	0.2	11.86	19.7	0.41	0.08	0.1
Papaya, ripe	41	0.5	9.5	0.1	40.37	36	-	0.1	1.2
Pomelo	46	0.7	9.9	0.4	2.21	52	0.2	0.1	
Mango (Kiewsaweya variety), unripe	85	0.8	19.9	0.2	2.93	29.9	1.45	0.1	-
Durian (Monthong variety / golden pillow variety)	163	2.2	30.1	3.7	4.36	53.5	0.89	0.25	-
Litchi	65	1	14.9	0.2	0	22.0	0.42	0.17	0.1
Cherries eating, raw	59	0.9	14.1	0.3	2.17	20	-	0.1	
Kalanchoe	63	1.2	14.2	0.1	0	32.2	-	0.13	0.1
Longkong	67	0.9	15.6	0.1	0	24	-	0.18	-
Mango (Thongdum variety),	82	0.6	19.9	0	-	25	-	-	-

Some dietary antioxidant profiles of Thai fruits and vegetables per 100 grams of ready to eat food which contain at least one of five micronutrients ≥ 15% of Thai DRI

Food name	ENERGY	PRO	CHO	FAT	VIT A	VIT C	VIT E	ZN	SE
ripe									
Rambutan	77	1	17.9	0.1	0	37.5	0	0.1	0.6
Persimmon, dried	225	3.4	57.6	0.7	138	0	-	0.3	-
Banana (Namwa variety), unripe	110	1.4	28.7	0.2	24	31	-	-	-
Jujube apple	50	1	11.3	0.1	5.08	32	-	0	-
Santol	57	0.4	13.9	0.2	4	14	-	-	-
Vegetables									
Horse tamarind, tender tips	85	9.2	11.4	0.4	254.7	7	-	-	-
Okra, young pods	23	1.5	3.7	0.2	66.4	44	-	0.4	-
Garlic flowers	39	1.4	9.4	0.2	5	44	-	-	-
Cassia leaves	115	6.3	20.9	0.71	20	56	-	-	-
Sesbania flowers	40	1.7	7.9	0.2	0.58	27	-	-	-
Acacia pennata	54.94	8.61	4.182	0.41	88.6	38.54	-	0.41	-
Wing bean pods	26	1.9	4.3	0.1	11.5	27	-	0.3	-
Crawdaisy leaves	19	1.8	3.3	0.3	263.5	27	-	-	-
Indian penny wort leaves	44	1.8	7.1	0.9	103	4	-	-	-
Tiliacora triandra Diels	95	5.6	16.1	0.9	329.1	141	-	-	-
Gourd sponge round	26	1	5.1	0.1	-	14	-	0.2	-
Mint leaves	47	3.2	6.7	0.8	263.6	88	-	-	-
Sweet basil leaves	40	2.9	6.7	0.1	226.6	21	-	0.8	-
Water mimosa	48	4.2	6.9	0.4	294.7	29	-	0.4	-
Mustard green stem and leaves	23	2.5	2.4	0.4	138.4	118	-	0.2	-
Kale Chinese	27	2.4	3.7	0.3	96.8	76	-	0.6	-
Ivygourd	31.04	3.492	3.783	0.19	326.2	12.61	-	0.485	-
Thai water morning glory red stem	27	1.8	4.6	0.2	57.5	58	-	0.2	-
Chilli pepper	31	1.4	5.9	0.2	4.42	52	-	0.2	-
Gourd wax	21.42	0.408	4.59	0.20		31.62	-	0.102	-
Gourd bitter young leaves	78.21	5.742	13.16	0.29	466.5	108.9	-	-	-
Shallot spring	30	2	4.7	0.3	38.1	22	-	0.1	-
Horseradish leaves and tender tips	72	7.4	11.6	1.5	307.4	167	-	0.6	-
Mashroom jew's ear, dried	345	7.6	76.9	0.7	0.92	0	-	5.7	-
Corn baby	30	1.9	5.1	0.2	-	24	-	0.6	-
Spinach	22	2.4	2	0.6	-	17	-	0.8	-
Holy basil leaves	50	3.3	8.1	0.5	458.4	24	-	0.5	-
Lettuce red leaf, raw	16	1.33	2.26	0.22	375	3.7	0.15	0.2	1.5
Broccoli	32.96	2.781	5.15	0.10	24.5	132.8	-	0.515	-

Some dietary antioxidant profiles of Thai fruits and vegetables per 100 grams of ready to eat food which contain at least one of five micronutrients ≥ 15% of Thai DRI

Food name	ENERGY	PRO	CHO	FAT	VIT A	VIT C	VIT E	ZN	SE
Brussels sprouts	37	3.2	5.6	0.2	-	115	-	0.4	-
Yard long bean green, boiled	37	2.9	8.1	0.1	5.5	19	-	0.3	-
Lemon juice 100%	24	0.5	8.3	0	0.5	25	-	0.1	-
Asparagus	25.296	2.55	3.672	0.1	7.14	19.38	-	0.51	-
Cauliflower	33	2.5	5.3	0.2	2.67	72	-	0.3	-
Cabbage	26	1.5	4.7	0.2	7.5	25	-	0.2	-
Onion	29	1.4	5.6	0.1	0	22	-	0.2	-
Celery	26	1.6	4.5	0.2	115.1	37	-	0.5	-
Tomato	28.34	1.09	5.232	0.32	36.9	29.43	-	0.218	-
Mungbean sprout	39	3.4	6.1	0.1	1.5	13	-	0.4	-
Carrot	40	1.6	7.9	0.2	101.3	19	-	0.2	-
Garden peas pods	47	3	8.5	0.1	5.92	48	-	0.6	-
Egg plant	76.96	2.91	14.4	0.83	8.92	18.7	-	0.20	-
Roselle	57.00	1.70	12.4	0.10	66.4	44.00	-	-	-
Cereals/ Legume/ starchy vegetables									
Macaroni, cooked, unenrich	158.0	5.8	30.9	0.9	0.0	0.0	0.1	0.5	26.4
Bread whole wheat	285.0	11.9	47.2	5.4	0.0	0.0	0.3	2.1	39.1
Cereal soy based supplementary food (NesVita brand)	400.0	10.0	76.7	6.7	0.0	50.0	11.7	-	-
Corn flakes (Kellogg's Frosties supercharged)	388.9	2.8	88.9	0.0	555.6	25.0	-	-	-
Job's tear whole seeds	365.0	14.8	70.4	2.7	2.0	17.0	-	-	-
Rice whole grain milled by machine, steamed	142.0	2.8	29.6	1.4	0.0	0.0	18.6	1.0	-
Lotus root, raw	65.0	1.0	15.2	0.0	0.0	25.0			-
Cassava	129.0	0.8	30.9	0.2	1.0	60.0	-	0.3	-
Potato	71.0	2.5	14.9	0.2	13.0	41.0	-	0.7	-
Arrow roots, white	81.0	1.7	17.9	0.3		16.0	-	0.7	-
Sesame seeds, black	553.0	21.9	12.1	46.3	2.0		-	3.2	-
Lotus seeds, dried	325.0	12.3	66.3	1.2	0.0	14.5	-	1.0	-
Peanut, boiled	316.0	14.4	11.4	26.3	1.0	5.0	-	1.7	-
Pigeonpea immature seeds, fresh	119.0	7.5	21.6	0.6	4.2	26.0	-	0.9	-
Sunflower seeds, dry, roasted without salt	582.0	19.3	24.1	49.8	0.0	1.4	26.1	5.3	79.3
Almonds dry roasted with salt added	597.0	22.1	19.3	52.8	0.0	0.0	26.0	3.5	2.8
Mungbean	351.0	21.7	62.7	1.5	-	-	-	2.7	-
Cowpea seeds, black color, dried	332.0	23.8	58.5	0.3	15.5	-	-	2.9	-
Chinese chestnut	223.0	6.6	46.1	1.5	10.0	36.0	-	0.9	-

Some dietary antioxidant profiles of Thai fruits and vegetables per 100 grams of ready to eat food which contain at least one of five micronutrients ≥ 15% of Thai DRI

Food name	ENERGY	PRO	CHO	FAT	VIT A	VIT C	VIT E	ZN	SE
Soybean seeds, dried	423.0	34.2	33.9	16.7	1.0	8.0	-	2.9	-
Rice bean seeds, dried	356.0	22.5	61.7	2.1		7.0	-	2.4	-
Cashew nut, fried	543.0	18.3	16.4	49.3	2.0	0.0	-	4.9	-
Ginkgo seeds, whole	185.0	4.8	38.1	1.6	15.0	25.0	-	0.3	-
Milk and products									
Cheese, Cheddar	347.0	21.4	0.8	28.7	148.0	0.0	-	-	-
Milk powder reduced fat	406.0	30.4	45.0	11.6	1450.0	121.0	-	-	-
Milk powdered, full cream	504.0	24.6	39.3	27.6	983.0	37.0	-	-	-
Milk condensed sweetened	339.0	7.7	57.0	8.9	221.0	2.7	0.2	1.0	15.4
Milk tablet, sweet	461.0	14.8	61.4	17.4	203.0	-	-	-	-
Milk powdered, Bear brand (yellow)	495.0	14.5	55.3	24.0	447.0	40.0	6.0	3.7	-
Milk powdered, Bear brand (plain)	506.0	25.7	37.4	28.2	540.0	30.0	5.0	4.5	-
Milk powder defatted, high calcium (Anlene)	355.0	38.6	48.0	0.9	1000.0	13.0	-	5.6	-
Fat and oils							-		
Peanut oil	884.0	0.0	0.0	99.9	0.0	0.0	-	0.0	0.0
Olive oil salad or cooking	884.0	0.0	0.0	100.0	0.0	0.0	14.4	0.0	0.0
Rice bran oil	897.8	0.0	0.0	99.8	-	0.0	7.6	-	-
Shortening bread soybean (hydrogenated) and cottonseed	884.0	0.0	0.0	100.0	-	0.0	8.0	0.0	0.0
Butter, salted	758.0	0.4	0.0	84.0	-	0.0	-	-	-
Seasoning & condiments									
Roselle / Red sorrel leaves	57.0	1.7	12.4	0.1	66.4	44.0	-	-	-
Tomato ketchup	83.0	1.4	21.8	0.2	6.0	13.0	-	-	-
Curry powder	380.0	9.5	47.4	16.9	377.3	0.0	-	-	-
Bitter orange peels	106.0	2.8	21.3	1.1		115.0	-	-	-
Garlic, dried bulbs	129.0	6.1	25.8	0.1		14.0	-	1.0	-
Bitter orange; leech leaves, semidried	138.0	6.8	20.8	3.1	110.1	20.0	-	-	-
Cumin / Yeera, seeds	354.0	16.9	54.2	7.7	7.3	7.0	-	-	-
Chilli bird ground	465.0	14.2	54.0	21.4	717.8	11.0	-	-	-
Coriander seeds	325.0	13.6	66.4	0.6	6.2	0.0	-	4.5	-
Coriander root	57.0	1.7	12.2	0.2	-	30.0	-	-	-
Curry paste, red	114.0	5.3	18.1	2.2	-	22.0	-	-	-
Shrimp paste, fermented, first class quality / Kapi (Thai)	120.0	8.6	6.8	1.0	-	0.0	-	2.0	-
Beverages									
Orange juice	33.0	0.7	7.4	0.1	-	13.0	-	-	-
Soymilk, no sugar hi calcium (Vsoy brand)	47.8	3.9	3.5	2.0	-	5.2	3.5	-	-

Some dietary antioxidant profiles of Thai fruits and vegetables per 100 grams of ready to eat food which contain at least one of five micronutrients ≥ 15% of Thai DRI

Food name	ENERGY	PRO	CHO	FAT	VIT A	VIT C	VIT E	ZN	SE
Soymilk, low sugar hi folate plus corn milk (VITAMILK brand)	60.9	3.0	6.1	2.6	-	2.6	1.5	-	-
Pomegranate Juice 100% (Tipco brand)	30.0	0.0	8.0	0.0	200.0	0.0	1.8	-	-
Carrot with mixed fruit juice 100% (Unif brand)	45.0	0.0	11.0	0.0	60.4	15.0	0.4	-	-
Soymilk, Cereal Flavour (Foremost brand)	104.4	3.5	14.4	3.5	121.7	-	-	-	-
Strawberry Juice 100% UHT (DoiKhum brand)	55.0	0.5	13.0	0.0	119.5	-	-	-	-
Pineapple Juice 100% (Malee brand)	50.0	0.0	11.5	0.0	120.0	-	-	-	-
Grape red Juice 100% (Tesco brand)	50.0	0.0	12.5	0.0	0.0	16.7	-	-	-
Orange Juice 100% (UFC brand)	55.0	0.0	13.0	0.0	0.0	95.0	-	-	-
Red Apple red Juice 100% (Tesco brand)	55.0	0.0	13.5	0.0	0.0	18.0	-	-	-
Tomato Juice with Mixed Fruit Juice 60% (Malee brand)	55.0	0.0	13.5	0.0	120.0	6.0	1.5	-	-
Guava Juice 100% UHT	65.0	0.0	16.5	0.0	0.0	76.3		-	-
Chocolate flavoured drink 3 in 1 instant powder mix (Milo brand)	428.6	11.4	68.6	11.4	228.6	-	-	-	-
Passion fruit juice	60.0	0.9	12.4	0.8	20.4	30.0	-	-	-
Appetizer and local dishes									
Noodle sheets soup with meat and tofu / Guayjub (Thai)	83.2	4.6	8.6	3.4	119.6	0.2	0.1	0.3	3.9
Crab and ground pork wrapped with tofu skin fried / HoyJortod (Thai)	335.8	17.7	13.8	23.5	60.1	0.0	0.3	0.7	9.0
Bun steamed, red pork filled	242.8	10.3	35.5	6.4	0.9	0.0	0.7	0.6	10.2
Southern style rice salad : rice with assorted vegetables served with southern fish sauce (nam boodoo) / Khaoyumpaktai (Thai)	151.3	3.8	24.4	4.3	8.2	14.7	0.2	0.4	2.2
Meat salad, Northeastern style / Laabnhua (Thai)	118.3	12.8	7.3	4.1	1864.1	8.5	0.0	2.0	4.4
Mashed fresh chilli mixed with condiments /Jaewpriksod (Thai)	57.0	4.7	8.3	0.7	22.5	18.8	-	0.2	-
Saute mungbean noodle and hen egg / Padwunsensaikhaikai (Thai)	212.4	5.9	25.7	9.5	62.1	2.6	0.3	0.4	10.7
Green papaya salad / Tummalakor (Thai)	32.6	1.4	6.3	0.2	5.6	31.5	-	0.0	-
Unripe mango salad / Tummamoungdib (Thai)	82.8	0.7	19.5	0.3	10.5	31.6	-	0.0	0.5
Medical foods									
Nutren Optimum (powder)	454.0	20.0	58.0	16.0	539.9	65.0	9.0	6.5	18.0
Nutren Balance (powder)	447.0	17.1	50.1	19.8	539.9	63.0	13.0	6.8	18.0

Some dietary antioxidant profiles of Thai fruits and vegetables per 100 grams of ready to eat food which contain at least one of five micronutrients ≥ 15% of Thai DRI

Food name	ENERGY	PRO	CHO	FAT	VIT A	VIT C	VIT E	ZN	SE
Nutren Fibre (powder)	430.0	17.2	55.0	16.3	509.9	60.0	12.0	6.0	17.0
Peptamen (powder)	478.0	20.4	63.1	16.0	742.4	90.0	16.5	6.5	19.0
GenDM (powder)	452.1	17.0	61.6	15.3	339.3	33.9	6.8	3.6	15.0
Blendera (powder)	450.0	17.2	62.8	15.2	296.2	134.3	14.9	7.6	-
Glucerna SR (powder)	425.0	21.2	55.8	15.4	318.6	41.4	14.2	4.6	20.5
Ensure FOS (powder)	428.0	15.9	57.4	14.0	450.5	54.0	11.0	4.7	22.0
Nepro (liquid per 100 ml)	200.4	7.0	22.2	9.6	31.8	10.6	0.0	2.4	10.1

APPENDIX II

The Content validity index form for PART III Food frequency in the past 3 months

Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
Frequency of **Meat/ Fish and Aquatic/ Egg and products** intake during past 3 months	**Question 1:** Did you eat **Meat/ Fish and Aquatic/ Egg and products**?		**ท่านรับประทานอาหารจำพวกเนื้อสัตว์/ ปลาและอาหารทะเล/ ไข่หรือไม่?**					
	Table 1: Asking frequency of food intake in **Meat/ Fish and Aquatic/ Egg and products** group							
	06040	Beef meat medium fat	เนื้อวัวติดมัน					
	06042	Beef meat lean	เนื้อวัวไม่ติดมัน					
	06053	Pork spare ribs (Fat 14.7%)	ซี่โครงหมู					
	06068	Pork loin (Fat 7.7%)	เนื้อหมูสันนอก (ไขมัน 7.7%)					
	06069	Pork tenderloin (Fat 3.2%)	เนื้อหมูสันใน /หมูเนื้อแดง (ไขมัน 3.2%)					
	06095	Chicken wing, fried	ปีกไก่ทอด					
	06165	Beef meat sundried, fried	เนื้อวัวทอดแดดเดียว (ฮาลาล)					
	07001	Shrimp sea	กุ้งทะเล เปลือกขาว หัวแข็ง					
	07003	Shrimp common	กุ้งน้ำจืด (ตัวเล็ก)					
	07041	Squid splendid	ปลาหมึกกล้วย / หมึกหลอด					
	07060	Cockle / Ark shell, blanched	หอยแครงลวก					
	07062	Mussel green, dried	หอยแมลงภู่แห้ง					
	07073	Black pomfret	ปลาจะละเม็ดดำ					
	07083	Jellyfish, dried, salted	แมงกระพรุน แห้งเค็ม					
	07116	Crab mud/mangrove meat	เนื้อปูทะเล					
	07200	Fish salmon atlantic farmed, raw	ปลาแซลมอน					
	08023	Finfish roe mixed species	ไข่ปลา (เฉลี่ย)					
	08004	Duck egg, whole	ไข่เป็ด ทั้งฟอง					
	08006	Duck egg, salted	ไข่เป็ด เค็ม					
	08011	Hen egg, whole	ไข่ไก่ ทั้งฟอง					
Frequency of **Fruits** intake during past 3 months	**Question 2:** Did you eat **Fruits**?		**ท่านรับประทานผลไม้หรือไม่?**					
	Table 2: Asking frequency of food intake in **Fruit** group							
	05002	Banana (Namwa variety), unripe	กล้วยน้ำว้า ดิบ					
	05008	Rambutan	เงาะ					
	05009	Rose apple, green	ชมพู่ เขียว					
	05012	Durian	ทุเรียน หมอนทอง					
	05015	Guava common	ฝรั่ง					
	05016	Jujube apple	พุทรา					
	05042	Papaya, ripe	มะละกอ สุก					
	05049	Longan	ลำไย					

The Content validity index form for PART III Food frequency in the past 3 months

Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
	05050	Santol	กระท้อน					
	05056	Litchi	ลิ้นจี่					
	05059	Kalanchoe	ส้มจีน เช้ง					
	05061	Tangelo / Tangerine / Mandarin	ส้มเขียวหวาน					
	05062	Pomelo	ส้มโอ					
	05066	Cantaloupe	แคนตาลูป					
	05079	Persimmon, dried	ลูกพลับ แห้ง					
	05082	Strawberry	สตรอเบอรี่					
	05096	Mango, ripe	มะม่วงทองดำ สุก					
	05098	Mango, unripe	มะม่วงเขียว เสวย ดิบ					
	05107	Cherries eating, raw	เชอรี่					
	05123	Kiwi fruit	กีวี					
	05157	Longkong	ลองกอง					
Frequency of **Vegetable** intake during past 3 months	**Question 3:** Did you eat **Vegetables**?		**ท่านรับประทานผักหรือไม่?**					
	Table 3: Asking frequency of food intake in **Vegetable** group							
	04002	Horse tamarind, tender tips	กระถิน ยอดอ่อน					
	04005	Cauliflower	กะหล่ำดอก					
	04009	Cabbage	กะหล่ำปลี					
	04010	Okra (lady's finger), young pods	กระเจี๊ยบมอญ ฝัก อ่อน					
	04011	Garlic flowers	ดอกกระเทียม					
	04023	Cassia leaves	ขี้เหล็ก ใบ					
	04025	Sesbania flowers	ดอกแค					
	04027	Acacia pennata	ชะอม					
	04035	Mungbean sprout	ถั่วงอก					
	04040	Yard long bean green, boiled	ถั่วฝักยาว ต้ม					
	04042	Wing bean pods	ถั่วพู ฝัก					
	04044	Garden peas pods	ถั่วลันเตา ฝักอ่อน					
	04050	Holy basil leaves	ใบกะเพรา					
	04051	Crawdaisy leaves	ใบตังโอ๋					
	04052	Indian penny wort leaves	ใบบัวบก					
	04059	Tiliacora triandra Diels	ใบย่านาง					
	04061	Gourd sponge round	บวบหอม / บวบ กลม					
	04063	Mint leaves	ใบสะระแหน่					
	04065	Sweet basil leaves	ใบโหระพา					
	04070	Water mimosa	ผักกระเฉด					
	04077	Mustard green stem and leaves	ผักกาดเขียว					
	04081	Kale Chinese	ผักคะน้า					
	04082	Celery	ผักขึ้นฉ่าย /ซีจีน					
	04087	Ivygourd	ผักตำลึง					
	04092	Thai water morning	ผักบุ้งไทย ต้นแดง					

The Content validity index form for PART III Food frequency in the past 3 months

Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
		glory red stem						
	04106	Chilli pepper	พริกหยวก					
	04109	Gourd wax	ฟักเขียว					
	04114	Gourd bitter young leaves	มะระ ยอดอ่อน					
	04117	Egg plant	มะเขือพวง					
	04121	Tomato	มะเขือเทศ					
	04133	Shallot spring	ต้นหอม					
	04136	Onion	หอมหัวใหญ่					
	04155	Horseradish leaves and tender tips	ยอดใบมะรุม					
	04160	Mashroom jew's ear, dried	เห็ดหูหนูแห้ง					
	04166	Asparagus	หน่อไม้ฝรั่ง					
	04167	Carrot	แครอท					
	04168	Broccoli	บร็อคโคลี่					
	04180	Corn baby	ข้าวโพดอ่อน					
	04195	Lemon juice 100%	น้ำมะนาว 100%					
	04196	Brussels sprouts	แขนงกะหล่ำ					
	04225	Spinach	ผักปวยเล้ง					
	04248	Lettuce red leaf, raw	ผักกาดหอมม่วง					
	04245	Roselle / Red sorrel leaves	กระเจี๊ยบเปรี้ยว (แดง)					
Frequency of **Cereals and legumes/ starchy vegetable** intake during past 3 months	**Question 4:** Did you eat **Cereals and legumes/ starchy vegetable**?		**ท่านรับประทาน ข้าว/แป้ง/ธัญพืช หรือไม่?**					
	Table 4: Asking frequency of food intake in **Cereal and legume/ starchy vegetable** group							
	01007	Biscuits plain / Buttermilk commercially baked	ขนมปังบิสกิต ธรรมดา / ขนมปังกรอบ					
	01008	Bread white sliced	ขนมปัง ขาว แผ่น					
	01035	Job's tear whole seeds	ลูกเดือย					
	01043	Corn flakes (Kellogg's Frosties SUPERCHARGES)	ข้าวโพด แผ่นอบกรอบ / คอนเฟลก เคลือบน้ำตาล (ตรา เคลลอคส์ ฟรอสตีส์ ซุปเปอร์ชาร์จ)					
	01045	Macaroni, cooked, unenrich	มักกะโรนี ต้ม					
	01048	Bread whole wheat	ขนมปังโฮลวีท					
	01056	Rice whole grain milled by machine, steamed	ข้าวเจ้ากล้อง นึ่ง					
	01127	Cereal soy based supplementary food (NesVita brand)	ธัญญาหาร รสดั้งเดิม เครื่องดื่มสำเร็จ รูป ตรา เนสวิต้า					
	02005	Potato	มันฝรั่ง					
	02008	Cassava	มันสำปะหลัง					

The Content validity index form for PART III Food frequency in the past 3 months

Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
	02026	Arrow roots, white	สาคูขาว					
	02030	Lotus root, raw	รากบัว					
	03002	Chinese chestnut	เกาลัดจีน					
	03005	Sesame seeds, white and black	งาดำหรือขาว ดิบ					
	03016	Cowpea seeds, black color, dried	ถั่วดำ เมล็ด แห้ง					
	03021	Peanut, boiled	ถั่วลิสง ต้ม					
	03024	Mung bean	ถั่วเขียว เมล็ด แห้ง					
	03027	Soybean seeds, dried	ถั่วเหลือง เมล็ด แห้ง					
	03029	Rice bean seeds, dried	ถั่วแดง เมล็ด แห้ง					
	03030	Pigeonpea immature seeds, fresh	ถั่วแระ เมล็ดอ่อน สด					
	03033	Lotus seeds, dried	เมล็ดบัว แห้ง					
	03037	Cashew nut, fried	เมล็ดมะม่วง หิมพานต์ ทอด					
	03050	Ginkgo seeds, whole	แป๊ะก๊วย ดิบ					
	03053	Sunflower seeds, dry, roasted without salt	เมล็ดทานตะวัน แห้ง คั่วไม่ใส่เกลือ					
	03077	Almonds dry roasted with salt added	เมล็ดอัลมอนด์ คั่ว ใส่เกลือ					
Frequency of **Milk and dairy products** intake during past 3 months	**Question 5:** Did you eat **Milk and dairy products**?		**ท่านดื่มนมหรือรับประทานผลิตภัณฑ์จากนมหรือไม่?**					
	Table 5: Asking frequency of food intake in **Milk and dairy product** group							
	09002	Milk condensed sweetened	นมข้นหวาน					
	09009	Milk powdered, full cream	นมผง ฟูลครีม					
	09037	Cheese, Cheddar	เนยแข็ง เชดดาร์					
	09050	Milk powdered, Bear brand (yellow)	นมผงตราหมี (กระป๋องเหลือง)					
	09081	Milk powdered, Bear brand (plain)	นมผงตราหมี (ชนิดจืด กระป๋องขาว)					
	09082	Milk powder defatted, high calcium (Anlene)	นมผง ขาดมันเนย แคลเซียมสูง (แอนลีน)					
	09087	Milk powder reduced fat	นมผงพร่องมันเนย เสริมแคลเซียม					
	09096	Milk tablet, sweet	นมปรุงแต่ง รสหวาน ชนิดเม็ด					
Frequency of **Fat and oil** intake during past 3 months	**Question 6:** Did you eat **Fat and oil**?		**ท่านใช้น้ำมันหรือเนยในการประกอบอาหารหรือไม่?**					
	Table 6: Asking frequency of food intake in **Fat and oil** group							
	10003	Peanut oil	น้ำมันถั่วลิสง					
	10008	Butter, salted	เนยสด เค็ม					

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Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
	10021	Olive oil salad or cooking	น้ำมันมะกอก					
	10024	Rice bran oil	น้ำมันรำข้าว					
	10026	Shortening bread soybean (hydrogenated) and cottonseed	ชอทแทนนิ่ง ขนมปัง น้ำมันถั่วเหลืองและฝ้าย (ไฮโดจีแนท)					
	10029	Shortening confectionery fractionated palm	ชอทแทนนิ่ง คอนแฟกชั่นนารี แฟรกชั่นแนท น้ำมันปาล์ม					
	10032	Cream whipped, cream topping, pressurized	วิปปิ้งครีม					
Frequency of **Condiment and seasoning** intake during past 3 months	**Question 7:** Did you eat **Condiment and seasoning**?		**ท่านเติมเครื่องปรุงรส หรือใช้เครื่องแกงในการประกอบอาหารหรือไม่?**					
	Table 7: Asking frequency of food intake in **Condiment and seasoning** group							
	12003	Shrimp paste, fermented, first class quality / Kapi (Thai)	กะปิกุ้ง คุณภาพดี					
	12005	Tomato ketchup	ซอสมะเขือเทศ / แคทชับ					
	12013	Curry paste, red	น้ำพริกแกงแดง					
	12015	Curry powder	ผงกะหรี่					
	12030	Bitter orange peels	ผิวมะกรูด					
	12033	Garlic, dried bulbs	กระเทียม หัว					
	12036	Bitter orange; leech leaves, semidried	ใบมะกรูด ค่อนข้างแห้ง					
	12038	Cumin / Yeera, seeds	ยี่หร่า					
	12042	Chilli bird ground	พริกขี้หนู ป่น					
	12058	Coriander seeds	ผักชี เมล็ด					
	12059	Coriander root	ผักชี ราก					
	12073	Soup, chicken broth or bouillon, dry	ซุปผง รสไก่					
	12077	Garlic, deep fried	กระเทียมเจียวกรอบแห้ง					
	12082	Soup, beef broth or bouillon, powder, dry	ซุปผง รสเนื้อ					
	12083	Soup instant, pork / chicken broth, cube, dry (Knor brand)	ซุปก้อนปรุงรส หมู /ไก่					
Frequency of **Sweet/ Bakery/ Snacks/ Ice cream** intake during past 3 months	**Question 8:** Did you eat **Sweet**, **Bakery, Snacks or Ice cream**?		**ท่านรับประทาน ของหวาน เบเกอรี ไอศครีมหรืออาหารว่าง หรือไม่?**					
	Table 8: Asking frequency of food intake in **Sweet, Bakery, Snacks Ice cream** group							
	09100	Ice creams vanilla	ไอศกรีมวานิลา					
	18005	Karipubsaichem (Thai)	กะหรี่ปั๊ปไส้เค็ม					
	18017	Bread magarine, toast	ขนมปังทา มาการีน โรยน้ำตาล					

The Content validity index form for PART III Food frequency in the past 3 months

Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
	18025	KanomPia (black bean) (Thai)	ขนมเปี๊ยะ ไส้ถั่วดำ					
	18027	Peanut bake / Khokhea (Thai)	ถั่วอบโก๋แก่					
	18073	Kanombali (Thai)	ขนมสาลี่					
	18097	Egg yolk sheeted in heavy syrup cupped / Thongyip (Thai)	ทองหยิบ					
	18101	Gold threads egg yolk strained in heavy syrup / Foithong (Thai)	ฝอยทอง					
	18133	Roti with sweet condented milk and sugar	โรตีโรยนมข้นและน้ำตาล ไม่ใส่ไข่					
	18170	Cream puffs, prepared from recipe, shell, with custard filling	เอแคร์ ไส้ครีม					
	01129	Doughnuts yeastleavened with cream filling	โดนัท ไส้ครีม					
	18114	Egg custard, baked	ขนมหม้อแกงไข่					
	18121	Native melon in coconut milk	กะทิแตงไทย					
Frequency of **Beverage** intake during past 3 months	**Question 9:** Did you drink **Beverage**?		**ท่านดื่ม น้ำหวาน น้ำผลไม้หรือเครื่องดื่มหรือไม่?**					
	Table 9: Asking frequency of food intake in **Beverage** group							
	14002	Orange juice	น้ำส้มคั้น					
	14030	Passion fruit juice	น้ำเสาวรสคั้น					
	14055	Chocolate flavoured drink 3 in 1 instant powder mix (Milo brand)	เครื่องดื่มรสช็อกโกแลต ผง กึ่งสำเร็จรูป 3 in 1 (ตราไมโล(					
	14087	Guava Juice 100% UHT	น้ำฝรั่ง 100% แคลเซียมสูง UHT					
	14091	Strawberry Juice 100% UHT (DoiKhum brand)	น้ำสตรอเบอรี่ 100% UHT (ตราดอยคำ)					
	14095	Pineapple Juice 100% (Malee brand)	น้ำสับปะรด 100% (ตรามาลี)					
	14096	Tomato Juice with Mixed Fruit Juice 60% (Malee brand)	น้ำมะเขือเทศผสมน้ำผลไม้รวม 60% (ตรามาลี self plus)					
	14098	Red Apple red Juice 100% (Tesco brand)	น้ำแอปเปิ้ลแดง 100% (ตราTesco)					
	14099	Grape red Juice 100% (Tesco brand)	น้ำองุ่นแดง 100% (ตราTesco)					
	14101	Pomegranate Juice 100% (Tipco brand)	น้ำทับทิม 100% (ตราTipco)					
	14110	Carrot with mixed fruit juice 100%	น้ำแครอทผสมผลไม้รวม 100%					

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Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
		(Unif brand)	(ตราUnif)					
	14124	Soymilk, Cereal Flavour	นมถั่วเหลือง ผสม นมผง รสธัญญาหาร 5 ชนิด					
Frequency of **Appetizer/ Local dishes** intake during past 3 months	**Question 10:** Did you eat **Appetizer or local dishes**?		**ท่านรับประทานอาหารว่างหรือเมนูอาหารท้องถิ่นหรือไม่?**					
	Table 10: Asking frequency of food intake in **Appetizer and local dish** group							
	16004	Wide rice noodles with pork, egg and soysauce	ก๋วยเตี๋ยวเส้น ใหญ่ ผัดซีอิ๊วใส่ไข่					
	16009	Rice with shrimp paste	ข้าวคลุกกะปิ					
	16010	Rice fried with pork, vegetable and egg	ข้าวผัดหมูใส่ไข่					
	16043	Noodle sheets soup with meat and tofu	ก๋วยจั๊บ					
	16049	Southern style rice salad : rice with assorted vegetables served with southern fish sauce	ข้าวยำปักษ์ใต้					
	16073	Rice noodles, big size with pork and soup	เส้นใหญ่ หมู น้ำ					
	16076	Macaroni fried with pork	ผัดมักกะโรนี หมู					
	16082	Crab and ground pork wrapped with tofu skin fried	หอยจ้อทอด					
	16098	Bun steamed, red pork filled	ซาลาเปา ไส้หมูแดง					
	16123	Spring roll, deep fried	ปอเปี๊ยะทอด					
	17020	Mashed fresh chilli mixed with condiments	แจ่วพริกสด					
	17036	Unripe mango salad	ตำมะม่วงดิบ					
	17064	Saute Chinese water morning glory	ผัดผักบุ้งจีน					
	17065	Saute mungbean noodle and hen egg	ผัดวุ้นเส้นใส่ไข่ไก่					
	17076	Meat salad, Northeastern style	ลาบเนื้อ (อีสาน)					
	17079	Green papaya salad	ตำมะละกอ					
Frequency of **Fast food** intake during past 3 months	**Question 11:** Did you eat **Fast food**?		**ท่านรับประทานอาหารฟาส์ตฟู้ด (อาหารจานด่วน) หรือไม่?**					
	Table 11: Asking frequency of food intake in **Fast food** group							
	16023	Pizza, supreme (Pizza Hut)	พิซซ่าสุพรีม (พิซซ่าฮัท)					
	16040	Sandwich with tuna fish	แซนวิชทูน่า					
	16093	Sanwich, pork and ham shreede chinese style filled	แซนวิช ไส้หมูหยอง + แฮม					

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Objectives	Questions (English)		Questions (Thai)	Relavance scores				I-CVI
				Highly relevant 4	Quite relevant 3	Somewhat relevant 2	Not relevant 1	
	16107	Rice sausage pork mixed, grilled (Fat 19.3%)	ไส้กรอก ข้าว มีหมู สับ ย่าง (Fat 19.3%)					
	16110	Croissants butter	ครัวซอง เนย					
	16118	Chicken broilers, drumstick, fried flour	ไก่ น่อง เนื้อ หนัง ชุบแป้งทอด					
	16122	Chicken breaded and fried, boneless pieces plain	ไก่ ไม่มีกระดูก ชุบ แป้งขนมปัง ทอด					
	16183	WENDY'S Jr. Hamburger without cheese	แฮมเบอร์เกอร์ ไม่ มีเนยแข็ง					
Frequency of **Medical food** intake during past 3 months	**Question 12:** Did you eat **Medical food**?		**ท่านได้รับอาหารทางการแพทย์เพิ่มเติมหรือไม่?**					
	Table 12: Asking frequency of food intake in **Medical food** group							
	22001	Nutren Optimum (powder)	นิวเทรน ออฟติมัม					
	22002	Nutren Balance (powder)	นิวเทรน บาลานซ์					
	22003	Nutren Fibre (powder)	นิวเทรน ไฟเบอร์					
	22010	GenDM (powder)	เจ็นดีเอ็ม					
	22013	Blendera (powder)	เบลนเดอรา					
	22014	Glucerna SR (powder)	กลูเซอนา เอสอาร์					
	22015	Ensure FOS (powder)	เอนชัวร์ เอฟโอเอส รสวนิลา ฝาน้ำเงิน					
	22018	Nepro (liquid per 100 mL)	เนปโปร ชนิดน้ำ พร้อมดื่ม หน่วย มล.					

APPENDIX III

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
Frequency of **Meat/ Fish and Aquatic/ Egg and products** intake during past 3 months	**Question 1:** Did you eat **Meat/ Fish and Aquatic/ Egg and products**?		**ท่านรับประทานจำพวกเนื้อสัตว์ ปลาและอาหารทะเลไข่หรือไม่?**				
	Table 1: Asking frequency of food intake in **Meat/ Fish and Aquatic/ Egg and product** group						
	06040	Beef meat medium fat	เนื้อวัวติดมัน	2	3	3	0.7
	06042	Beef meat lean	เนื้อวัวไม่ติดมัน	3	3	3	1
	06053	Pork spare ribs (Fat 14.7%)	ซี่โครงหมู	3	3	3	1
	06068	Pork loin (Fat 7.7%)	เนื้อหมูสันนอก (ไขมัน 7.7%)	3	3	3	1
	06069	Pork tenderloin (Fat 3.2%)	เนื้อหมูสันใน / หมูเนื้อแดง (ไขมัน 3.2%)	3	3	3	1
	06095	Chicken wing, fried	ปีกไก่ทอด	3	3	3	1
	06165	Beef meat sundried, fried	เนื้อวัวทอดแดดเดียว (ฮาลาล)	3	3	3	1
	07001	Shrimp sea	กุ้งทะเล เปลือกขาว หัวแข็ง	3	3	3	1
	07003	Shrimp common	กุ้งน้ำจืด (ตัวเล็ก)	3	3	3	1
	07041	Squid splendid	ปลาหมึกกล้วย / หมึกหลอด	3	3	3	1
	07060	Cockle / Ark shell, blanched	หอยแครง ลวก	3	3	3	1
	07062	Mussel green, dried	หอยแมลงภู่แห้ง	3	3	3	1
	07073	Black pomfret	ปลาจะละเม็ดดำ	3	3	3	1
	07083	Jellyfish, dried, salted	แมงกระพรุนแห้ง เค็ม	3	3	3	1
	07116	Crab mud/mangrove meat	เนื้อปูทะเล	3	3	3	1
	07200	Fish salmon atlantic farmed, raw	ปลาแซลมอน	3	3	3	1
	08023	Finfish roe mixed species	ไข่ปลา (เฉลี่ย)	3	3	3	1
	08004	Duck egg, whole	ไข่เป็ด ทั้งฟอง	4	3	3	1
	08006	Duck egg, salted	ไข่เป็ด เค็ม	4	3	3	1
	08011	Hen egg, whole	ไข่ไก่ ทั้งฟอง	4	3	3	1
Frequency of **Fruits** intake during past 3 months	**Question 2:** Did you eat **Fruits**?		**ท่านรับประทานผลไม้หรือไม่?**				
	Table 2: Asking frequency of food intake in **Fruits** group						
	05002	Banana (Namwa variety), unripe	กล้วยน้ำว้า ดิบ	3	3	3	1
	05008	Rambutan	เงาะ	3	3	3	1
	05009	Rose apple, green	ชมพู่ เขียว	3	3	3	1
	05012	Durian	ทุเรียนหมอนทอง	3	3	3	1
	05015	Guava common	ฝรั่ง	3	3	3	1
	05016	Jujube apple	พุทรา	3	3	3	1
	05042	Papaya, ripe	มะละกอ สุก	3	3	3	1
	05049	Longan	ลำไย	3	3	3	1
	05050	Santol	กระท้อน	3	3	3	1
	05056	Litchi	ลิ้นจี่	3	3	3	1
	05059	Kalanchoe	ส้มจีน เช้ง	3	3	3	1
	05061	Tangelo / Tangerine / Mandarin	ส้มเขียวหวาน	3	3	3	1

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
	05062	Pomelo	ส้มโอ	3	3	3	1
	05066	Cantaloupe	แคนตาลูป	3	3	3	1
	05079	Persimmon, dried	ลูกพลับ แห้ง	3	3	3	1
	05082	Strawberry	สตรอเบอร์รี	3	3	3	1
	05096	Mango, ripe	มะม่วงทองดำสุก	3	3	3	1
	05098	Mango, unripe	มะม่วงเขียวเสวยดิบ	3	3	3	1
	05107	Cherries eating, raw	เชอรี่	3	3	3	1
	05123	Kiwi fruit	กีวี	3	3	3	1
	05157	Longkong	ลองกอง	3	3	3	1
Frequency of **Vegetable** intake during past 3 months	**Question 3:** Did you eat **Vegetables**?		**ท่านรับประทานผักหรือไม่?**				
	Table 3: Asking frequency of food intake in **Vegetable** group						
	04002	Horse tamarind, tender tips	กระถิน ยอดอ่อน	3	3	3	1
	04005	Cauliflower	กะหล่ำดอก	3	3	3	1
	04009	Cabbage	กะหล่ำปลี	3	3	3	1
	04010	Okra (lady's finger), young pods	กระเจี๊ยบมอญ ฝักอ่อน	3	3	3	1
	04011	Garlic flowers	ดอกกระเทียม	3	3	3	1
	04023	Cassia leaves	ขี้เหล็ก ใบ	3	3	3	1
	04025	Sesbania flowers	ดอกแค	3	3	3	1
	04027	Acacia pennata	ชะอม	3	3	3	1
	04035	Mungbean sprout	ถั่วงอก	3	3	3	1
	04040	Yard long bean green, boiled	ถั่วฝักยาว ต้ม	3	3	3	1
	04042	Wing bean pods	ถั่วพู ฝัก	3	3	3	1
	04044	Garden peas pods	ถั่วลันเตา ฝักอ่อน	3	3	3	1
	04050	Holy basil leaves	ใบกะเพรา	3	3	3	1
	04051	Crawdaisy leaves	ใบตังโอ้	3	3	3	1
	04052	Indian penny wort leaves	ใบบัวบก	3	3	3	1
	04059	Tiliacora triandra Diels	ใบย่านาง	3	3	3	1
	04061	Gourd sponge round	บวบหอม / บวบกลม	3	3	3	1
	04063	Mint leaves	ใบสะระแหน่	3	3	3	1
	04065	Sweet basil leaves	ใบโหระพา	3	3	3	1
	04070	Water mimosa	ผักกระเฉด	3	3	3	1
	04077	Mustard green stem and leaves	ผักกาดเขียว	3	3	3	1
	04081	Kale Chinese	ผักคะน้า	3	3	3	1
	04082	Celery	ผักขึ้นฉ่าย /ซีจีน	3	3	3	1
	04087	Ivygourd	ผักตำลึง	3	3	3	1
	04092	Thai water morning glory red stem	ผักบุ้งไทย ต้นแดง	3	3	3	1
	04106	Chilli pepper	พริกหยวก	3	3	3	1
	04109	Gourd wax	ฟักเขียว	3	3	3	1
	04114	Gourd bitter young leaves	มะระ ยอดอ่อน	3	3	3	1
	04117	Egg plant	มะเขือพวง	3	3	3	1

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
	04121	Tomato	มะเขือเทศ	3	3	3	1
	04133	Shallot spring	ต้นหอม	3	3	3	1
	04136	Onion	หอมหัวใหญ่	3	3	3	1
	04155	Horseradish leaves and tender tips	ยอดใบมะรุม	3	3	3	1
	04160	Mashroom jew's ear, dried	เห็ดหูหนูแห้ง	3	3	3	1
	04166	Asparagus	หน่อไม้ฝรั่ง	3	3	3	1
	04167	Carrot	แครอท	3	3	3	1
	04168	Broccoli	บร็อคโคลี่	3	3	3	1
	04180	Corn baby	ข้าวโพดอ่อน	3	3	3	1
	04195	Lemon juice 100%	น้ำมะนาว 100%	3	3	3	1
	04196	Brussels sprouts	แขนงกะหล่ำ	3	3	3	1
	04225	Spinach	ผักปวยเล้ง	3	3	3	1
	04248	Lettuce red leaf, raw	ผักกาดหอมม่วง	3	3	3	1
	04245	Roselle / Red sorrel leaves	กระเจี๊ยบเปรี้ยว (แดง)	3	3	3	1
Frequency of **Cereals and legumes/ starchy vegetable** intake during past 3 months	**Question 4:** Did you eat **Cereals and legumes/ starchy vegetable**?		**ท่านรับประทานข้าว/แป้ง/ธัญพืชหรือไม่?**				
	Table 4: Asking frequency of food intake in **Cereals and legumes/ starchy vegetable** group						
	01007	Biscuits plain / Buttermilk commercially baked	ขนมปังบิสกิต ธรรมดา / ขนมปังกรอบ	2	2	2	0
	01008	Bread white sliced	ขนมปัง ขาว แผ่น	3	3	3	1
	01035	Job's tear whole seeds	ลูกเดือย	3	3	3	1
	01043	Corn flakes (Kellogg's FROSTIES SUPERCHARGED)	ข้าวโพด แผ่นอบกรอบ / คอนเฟลก เคลือบน้ำตาล	3	3	3	1
	01045	Macaroni, cooked, unenrich	มักกะโรนี ต้ม	3	3	3	1
	01048	Bread whole wheat	ขนมปังโฮลวีท	3	3	3	1
	01056	Rice whole grain milled by machine, steamed	ข้าวเจ้ากล้อง นึ่ง	3	3	3	1
	01127	Cereal soy based supplementary food (NesVita brand)	ธัญญาหาร รสดั้งเดิม เครื่องดื่มสำเร็จรูป ตรา เนสวิต้า	3	3	3	1
	02005	Potato	มันฝรั่ง	3	3	3	1
	02008	Cassava	มันสำปะหลัง	3	3	3	1
	02026	Arrow roots, white	สาคูขาว	3	3	3	1
	02030	Lotus root, raw	รากบัว	3	3	3	1
	03002	Chinese chestnut	เกาลัดจีน	3	3	3	1
	03005	Sesame seeds, white and black	งา ดำ หรือ ขาว ดิบ	3	3	3	1
	03016	Cowpea seeds, black color, dried	ถั่วดำ เมล็ด แห้ง	3	3	3	1
	03021	Peanut, boiled	ถั่วลิสง ต้ม	3	3	3	1
	03024	Mung bean	ถั่วเขียว เมล็ด แห้ง	3	3	3	1
	03027	Soybean seeds, dried	ถั่วเหลือง เมล็ด	3	3	3	1

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
			แห้ง				
	03029	Rice bean seeds, dried	ถั่วแดง เมล็ด แห้ง	3	3	3	1
	03030	Pigeonpea immature seeds, fresh	ถั่วแระ เมล็ด อ่อน สด	3	3	3	1
	03033	Lotus seeds, dried	เมล็ดบัว แห้ง	3	3	3	1
	03037	Cashew nut, fried	เมล็ดมะม่วง หิม พานต์ ทอด	3	3	3	1
	03050	Ginkgo seeds, whole	แป๊ะก๊วย ดิบ	3	3	3	1
	03053	Sunflower seeds, dry, roasted without salt	เมล็ดทานตะวัน แห้ง คั่วไม่ใส่เกลือ	3	3	3	1
	03077	Almonds dry roasted with salt added	เมล็ดอัลมอนด์ คั่ว ใส่เกลือ	3	3	3	1
Frequency of **Milk and dairy products** intake during past 3 months	**Question 5:** Did you eat **Milk and dairy products**?		**ท่านดื่มนมหรือรับประทานผลิตภัณฑ์จากนมหรือไม่?**				
	Table 5: Asking frequency of food intake in **Milk and dairy product** group						
	09002	Milk condensed sweetened	นมข้นหวาน	3	3	3	1
	09009	Milk powdered, full cream	นมผง ฟูลครีม	3	3	3	1
	09037	Cheese, Cheddar	เนยแข็ง เชดดาร์	3	3	3	1
	09050	Milk powdered, Bear brand (yellow)	นมผงตราหมี	3	3	3	1
	09081	Milk powdered, Bear brand (plain)	นมผงตราหมี	3	3	3	1
	09082	Milk powder defatted, high calcium (Anlene)	นมผง ขาดมัน เนย แคลเซียมสูง	3	3	3	1
	09087	Milk powder reduced fat	นมผงพร่องมันเนย เสริมแคลเซียม	3	3	3	1
	09096	Milk tablet, sweet	นมปรุงแต่งรส หวาน ชนิดเม็ด	3	3	3	1
Frequency of **Fat and oil** intake during past3 months	**Question 6:** Did you eat **Fat and oils**?		**ท่านใช้น้ำมัน/เนยในการประกอบอาหารหรือไม่?**				
	Table 6: Asking frequency of food intake in **Fat and oil** group						
	10003	Peanut oil	น้ำมันถั่วลิสง	3	3	3	1
	10008	Butter, salted	เนยสด เค็ม	3	3	3	1
	10021	Olive oil salad or cooking	น้ำมันมะกอก	3	3	3	1
	10024	Rice bran oil	น้ำมันรำข้าว	3	3	3	1
	10026	Shortening bread soybean (hydrogenated) and cottonseed	ชอทแทนนิ่ง ขนมปัง น้ำมัน ถั่วเหลือง และฝ้า	3	3	3	1
	10029	Shortening confectionery fractionated palm	ชอทแทนนิ่ง คอนแฟกชั่นนารี แฟรกชั่นแนท น้ำมันปาล์ม	2	2	3	0.3
	10032	Cream whipped, cream topping, pressurized	วิปปิ้งครีม	2	2	3	0.7
Frequency of **Condiment and seasoning** intake during past 3 months	**Question 7:** Did you eat **Condiment and seasoning**?		**ท่านเติมเครื่องปรุงรสหรือใช้เครื่องแกงในการประกอบอาหารหรือไม่?**				
	Table 7: Asking frequency of food intake in **Condiment and seasoning** group						
	12003	Shrimp paste, fermented, first class quality / Kapi	กะปิกุ้ง คุณภาพ ดี	4	3	3	1

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
		(Thai)					
	12005	Tomato ketchup	ซอสมะเขือเทศ / แคทชับ	4	3	3	1
	12013	Curry paste, red	น้ำพริกแกงแดง	4	3	3	1
	12015	Curry powder	ผงกะหรี่	4	3	3	1
	12030	Bitter orange peels	ผิวมะกรูด	4	3	3	1
	12033	Garlic, dried bulbs	กระเทียม หัว	4	3	3	1
	12036	Bitter orange; leech leaves, semidried	ใบมะกรูด ค่อนข้างแห้ง	4	3	3	1
	12038	Cumin / Yeera, seeds	ยี่หร่า	4	3	3	1
	12042	Chilli bird ground	พริกขี้หนู ป่น	4	3	3	1
	12058	Coriander seeds	ผักชี เมล็ด	4	3	3	1
	12059	Coriander root	ผักชี ราก	4	3	3	1
	12073	Soup, chicken broth or bouillon, dry	ซุปผง รสไก่	2	3	3	0.7
	12077	Garlic, deep fried	กระเทียมเจียว กรอบแห้ง	2	2	3	0.3
	12082	Soup, beef broth or bouillon, powder, dry	ซุปผง รสเนื้อ	2	3	3	0.7
	12083	Soup instant, pork / chicken broth, cube, dry (Knor brand)	ซุปก้อนปรุง รส หมู / ไก่	2	3	3	0.7
Frequency of **Sweet/ Bakery/ Snacks/ Ice cream** intake during past 3 months	**Question 8:** Did you eat **Sweet/ Bakery/ Snacks/ Ice cream**?		**ท่านรับประทานของหวาน เบเกอรี่ อาหารว่างหรือไอศครีมหรือไม่?**				
	Table 8: Asking frequency of food intake in group **Sweet/ Bakery/ Snacks/ Ice cream**						
	09100	Ice creams vanilla	ไอศกรีมวานิลา	2	2	3	0.3
	18005	Karipubsaichem (Thai)	กะหรี่ปั๊ปไส้เค็ม	2	2	3	0.3
	18017	Bread magarine, toast	ขนมปังทามาการีน โรยน้ำตาล	2	2	3	0.3
	18025	KanomPia (black bean) (Thai)	ขนมเปี๊ยะไส้ถั่วดำ	2	2	3	0.3
	18027	Peanut bake / Khokhea (Thai)	ถั่วอบโก๋แก่	2	2	3	0.3
	18073	Kanombali (Thai)	ขนมสาลี่	3	2	3	0.7
	18097	Egg yolk sheeted in heavy syrup cupped / Thongyip (Thai)	ทองหยิบ	3	2	3	0.7
	18101	Gold threads egg yolk strained in heavy syrup / Foithong (Thai)	ฝอยทอง	2	3	3	0.7
	18133	Roti with sweet condented milk and sugar	โรตีโรยนมข้นและน้ำตาล ไม่ใส่ไข่	2	3	3	0.7
	18170	Cream puffs, prepared from recipe, shell, with custard filling	เอแคร์ ไส้ครีม	2	3	3	0.7
	01129	Doughnuts yeastleavened with cream filling	โดนัท ไส้ครีม	3	2	3	0.7
	18114	Egg custard, baked	ขนมหม้อแกงไข่	2	3	3	0.7
	18121	Native melon in coconut milk	กะทิแตงไทย	2	3	3	0.7

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
Frequency of **Beverage** intake during past 3 months	**Question 9:** Did you drink **Beverages**?		**ท่านดื่มน้ำหวาน น้ำผลไม้หรือเครื่องดื่มหรือไม่?**				
	Table 9: Asking frequency of foo dintake in **Beverage** group						
	14002	Orange juice	น้ำส้มคั้น	3	3	3	1
	14030	Passion fruit juice	น้ำเสาวรสคั้น	3	3	3	1
	14055	Chocolate flavoured drink 3 in 1 instant powder mix (Milo brand)	เครื่องดื่มรสช็อกโกแลต ผง กึ่งสำเร็จรูป 3 in 1 (ตราไมโล)	3	3	3	1
	14087	Guava Juice 100% UHT	น้ำฝรั่ง 100% แคลเซียมสูง UHT (ตราดอยคำ)	3	3	3	1
	14091	Strawberry Juice 100% UHT (DoiKhum brand)	น้ำสตรอเบอรี่ 100% UHT (ตราดอยคำ)	3	3	3	1
	14095	Pineapple Juice 100% (Malee brand)	น้ำสับปะรด 100% (ตรามาลี)	3	3	3	1
	14096	Tomato Juice with Mixed Fruit Juice 60% (Malee brand)	น้ำมะเขือเทศผสมน้ำผลไม้รวม 60% (ตรามาลี self plus)	3	3	3	1
	14098	Red Apple red Juice 100% (Tesco brand)	น้ำแอปเปิ้ลแดง 100% (ตรา Tesco)	3	3	3	1
	14099	Grape red Juice 100% (Tesco brand)	น้ำองุ่นแดง 100% (ตรา Tesco)	3	3	3	1
	14101	Pomegranate Juice 100% (Tipco brand)	น้ำทับทิม 100% (ตรา Tipco)	3	3	3	1
	14110	Carrot with mixed fruit juice 100% (Unif brand)	น้ำแครอทผสมผลไม้รวม 100% (ตรา Unif)	3	3	3	1
	14124	Soymilk, Cereal Flavour	นมถั่วเหลือง ผสมนมผง รสธัญญาหาร 5 ชนิด	3	3	3	1
Frequency of **Appetizer/ Local dishes** intake during past 3 months	**Question 10:** Did you eat **Appetizer or local dishes**?		**ท่านรับประทานอาหารว่างหรือเมนูอาหารท้องถิ่นหรือไม่?**				
	Table 10: Asking frequency of food intake in **Appetizer and local dish** group						
	16004	Wide rice noodles with pork, egg and soysauce	ก๋วยเตี๋ยวเส้นใหญ่ผัดซีอิ๊วใส่ไข่	2	3	3	0.7
	16009	Rice with shrimp paste	ข้าวคลุกกะปิ	2	3	3	0.7
	16010	Rice fried with pork, vegetable and egg	ข้าวผัดหมูใส่ไข่	2	3	3	0.7
	16043	Noodle sheets soup with meat and tofu	ก๋วยจั๊บ	3	3	3	1
	16049	Southern style rice salad : rice with assorted vegetables served with southern fish sauce	ข้าวยำปักษ์ใต้	3	3	3	1
	16073	Rice noodles, big size with pork and soup	เส้นใหญ่ หมู น้ำ	2	3	3	0.7
	16076	Macaroni fried with pork	ผัดมักกะโรนีหมู	2	3	3	0.7

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
	16082	Crab and ground pork wrapped with tofu skin fried	หอยจ้อทอด	3	3	3	1
	16098	Bun steamed, red pork filled	ซาลาเปา ไส้หมูแดง	3	3	3	1
	16123	Spring roll, deep fried	ปอเปี๊ยะทอด	3	3	3	1
	17020	Mashed fresh chilli mixed with condiments	แจ่วพริกสด	3	3	3	1
	17036	Unripe mango salad	ตำมะม่วงดิบ	3	3	3	1
	17064	Saute Chinese water morning glory	ผัดผักบุ้งจีน	2	2	3	0.3
	17065	Saute mungbean noodle and hen egg	ผัดวุ้นเส้นใส่ไข่ไก่	3	3	3	1
	17076	Meat salad, Northeastern style	ลาบเนื้อ	3	3	3	1
	17079	Green papaya salad	ตำมะละกอ	3	3	3	1
Frequency of **Fast food** intake during past 3 months	**Question 11:** Did you eat **Fast food**?		**ท่านรับประทานอาหารฟาส์ตฟู้ด (อาหารจานด่วน) หรือไม่?**				
	Table 11: Asking frequency of Food name in group **Fast food**						
	16023	Pizza, supreme (Pizza Hut)	พิซซ่าสุพรีม (พิซซ่าฮัท)	2	2	3	0.3
	16040	Sandwich with tuna fish	แซนวิชทูน่า	2	2	3	0.3
	16093	Sanwich, pork and ham shreede chinese style filled	แซนวิช ไส้หมูหยอง + แฮม	2	2	3	0.3
	16107	Rice sausage pork mixed, grilled (Fat 19.3%)	ไส้กรอก ข้าว มีหมูสับ ย่าง (Fat 19.3%)	2	2	3	0.3
	16110	Croissants butter	ครัวซอง เนย	2	2	3	0.3
	16118	Chicken broilers, drumstick, fried flour	ไก่ น่อง เนื้อ หนัง ชุบแป้งทอด	2	2	3	0.3
	16122	Chicken breaded and fried, boneless pieces plain	ไก่ ไม่มีกระดูก ชุบแป้งขนมปังทอด	2	2	3	0.3
	16183	WENDY'S Jr. Hamburger without cheese	แฮมเบอร์เกอร์ ไม่มีเนยแข็ง	2	2	3	0.3
Frequency of **Medical food** intake during past 3 months	**Question 12:** Did you eat **Medical food**?		**ท่านได้รับ อาหารทางการแพทย์ เพิ่มเติมหรือไม่?**				
	Table 12: Asking frequency of Food name in group **Medical food**						
	22001	Nutren Optimum (powder)	นิวเทรน ออฟติมัม	3	3	3	1
	22002	Nutren Balance (powder)	นิวเทรน บาลานซ์	3	3	3	1
	22003	Nutren Fibre (powder)	นิวเทรน ไฟเบอร์	3	3	3	1
	22010	GenDM (powder)	เจ็นดีเอ	3	3	3	1
	22013	Blendera (powder)	เบลนเดอรา (ชนิดผง)	3	3	3	1
	22014	Glucerna SR (powder)	กลูเซอนา เอสอาร์	3	3	3	1
	22015	Ensure FOS (powder)	เอนชัวร์ เอฟโอเอส รสวานิลา ฝา	3	3	3	1

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Objectives	Questions (English)		Question (Thai)	Relavance score			I-CVI
				Expert 1	Expert 2	Expert 3	
			น้ำเงิน				
	22018	Nepro (liquid per 100 mL)	เนปโปร ชนิดน้ำพร้อมดื่ม หน่วย มล.	3	3	3	1

APPENDIX IV

Food frequency questionnaire

Department of Nutrition and Dietetics
Faculty of Allied health science, Chulalongkorn University

This questionnaire is a part of thesis for Master degree program in Food and Nutrition. The purpose is to evaluate the background information of chronic kidney disease (CKD) patients. Also, the frequency of 12 food categories had been consumed which may affects to the level of plasma antioxidant. Please kindly provide information below by filling out this form based on your eating habit during last 3 months. The received information will not have any negative effect on you but it will be useful to investigate the relationship between food frequency and antioxidant level in predialysis CKD patients for further application.

<u>Indication</u> Please put a mark (√) in the box

Part I : General Information

1. Name-Surname..... HN……Phone number.....
2. Age……years old Gender: □ 1. Male □ 2. Female
3. Religion
   □ 1. Buddhism □ 2. Christianity □ 3. Islam □ 4. Others .....
4. Living Status
   □ 1. Stay alone □ 2. Stay with family, ……..... □ 3. Stay with others, please define……..
5. Education
   □ 1. Never study □ 2. Primary school □ 3. Secondary school □ 4. High school
   □ 5. College/ Bachelor degree □ 6. Master degree/ Doctoral degree
6. Occupation
   □ 1. Student□ 2. Housewife □ 3. Firm employee/Officer
   □ 4. Government officer □ 5. Private Business
   □ 6. General employee □ 7. Merchant □ 8. Others.....
7. Salary (average per month)
   □ 1. ≤ 9,000 Baht □ 2. > 9, 000 – 13,000 Baht □ 3. > 13,000 Baht

Part II : Patient's history

1. Diagnosed as CKD.....years.....months
2. Complication
   □ 1. Hypertension □ 2. Diabetes
   □ 3. Dislipidemia □ 4. Anemia
   □ 5. Osteoporosis □ 6. Hyperphosphatemia □ 7. Hyperkalemia
   □ 8. Gout □ 9. Edema □ 10. Others.....
3. Food restriction ……
   Food allergy.....

PART III: Food frequency in the past 3 months
Please mark the column to show how often you consume the following food items in 12 groups

Group 1: Meat/ Fish and Aquatic/ Egg and products			1. Did you eat **Meat/ Fish and Aquatic/ Egg and products**? ☐ No ➔ go to question 2 ☐ Yes for one and more than one of them ➔ go to table 1					
Table 1: Frequency of food intake during 3 months								
Code		**Food name**	Never or < 1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	06042	Beef meat lean						
2	06053	Pork spare ribs (Fat 14.7%)						
3	06068	Pork loin (Fat 7.7%)						
4	06069	Pork tenderloin (Fat 3.2%)						
5	06095	Chicken wing, fried						
6	06165	Beef meat sundried, fried						
7	07001	Shrimp sea						
8	07003	Shrimp common						
9	07041	Squid splendid						
10	07060	Cockle / Ark shell, blanched						
11	07062	Mussel green, dried						
12	07073	Black pomfret						
13	07083	Jellyfish, dried, salted						
14	07116	Crab mud/mangrove meat						
15	07200	Fish salmon atlantic farmed, raw						
16	08023	Finfish roe mixed species						
17	08011	Hen egg, whole						

Group 2: Fruits			2. Did you eat **Fruits**? ☐ No ➔ go to question 3 ☐ Yes ➔ go to table 2					
Table 2: Frequency of food intake during 3 months								
	Code	**Food name**	Never or < 1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	05002	Banana (Namwa variety), unripe						
2	05008	Rambutan						
3	05009	Rose apple, green						
4	05012	Durian (Monthong variety / golden pillow variety)						
5	05015	Guava common						
6	05016	Jujube apple						
7	05042	Papaya, ripe						
8	05049	Longan						
9	05050	Santol						
10	05056	Litchi						
11	05059	Kalanchoe						
12	05061	Tangelo / Tangerine / Mandarin						
13	05062	Pomelo						
14	05066	Cantaloupe						
15	05079	Persimmon, dried						
16	05082	Strawberry						
17	05096	Mango (Thongdum variety), ripe						
18	05098	Mango (Kiewsaweya variety), unripe						
19	05107	Cherries eating, raw						
20	05123	Kiwi fruit						
21	05157	Longkong						

Group 3: Vegetable	3. Did you eat **Vegetable**? ☐ No ➔ go to question 4 ☐ Yes ➔ go to table 3

Table 3: Frequency of food intake during 3 months

	Code	**Food name**	Never or < 1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	04002	Horse tamarind, tender tips						
2	04005	Cauliflower						
3	04009	Cabbage						
4	04010	Okra, young pods						
5	04011	Garlic flowers						
6	04023	Cassia leaves						
7	04025	Sesbania flowers						
8	04027	Acacia pennata						
9	04035	Mungbean sprout						
10	04040	Yard long bean green, boiled						
11	04042	Wing bean pods						
12	04044	Garden peas pods						
13	04050	Holy basil leaves						
14	04051	Crawdaisy leaves						
15	04052	Indian penny wort leaves						
16	04059	Tiliacora triandra Diels						
17	04061	Gourd sponge round						
18	04063	Mint leaves						
19	04065	Sweet basil leaves						
20	04070	Water mimosa						
21	04077	Mustard green, pickled						
22	04081	Kale Chinese						
23	04082	Celery						
24	04087	Ivygourd						
25	04092	Thai water morning glory red stem						
26	04106	Chilli pepper						
27	04109	Gourd wax						
28	04114	Gourd bitter young leaves						
29	04117	Egg plant						
30	04121	Tomato						
31	04133	Shallot spring						
32	04136	Onion						
33	04155	Horseradish leaves and tender tips						
34	04160	Mushroom jew's ear, dried						
35	04166	Asparagus						
36	04167	Carrot						
37	04168	Broccoli						
38	04180	Corn baby						
39	04195	Lemon juice 100%						
40	04196	Brussels sprouts						
41	04225	Spinach						
42	04248	Lettuce red leaf, raw						
43	04245	Roselle / Red sorrel leaves						

Group 4: Cereals and legumes/ starchy vegetable	4. Did you eat **Cereals and legumes/ starchy vegetable**? ☐ No ➔ go to question 5 ☐ Yes for one and more than one of them ➔ go to table 4

Table 4: Frequency of food intake during 3 months

	Code	**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Everyday
1	01008	Bread white sliced						
2	01035	Job's tear whole seeds						
3	01043	Corn flakes						
4	01045	Macaroni, cooked, unenrich						
5	01048	Bread whole wheat						
6	01056	Rice whole grain milled by machine, steamed						
7	01127	Cereal soy based supplementary food						
8	02005	Potato						
9	02008	Cassava						
10	02026	Arrow roots, white						
11	02030	Lotus root, raw						
12	03002	Chinese chestnut						
13	03006	Sesame seeds, white and black						
14	03016	Cowpea seeds, black color						
15	03021	Peanut, boiled						
16	03024	Mung bean						
17	03027	Soybean seeds, dried						
18	03029	Rice bean seeds, dried						
19	03030	Pigeonpea immature seeds						
20	03033	Lotus seeds, dried						
21	03037	Cashew nut, fried						
22	03050	Ginkgo seeds, whole						
23	03053	Sunflower seeds, dry, roasted without salt						
24	03077	Almonds dry roasted with salt added						

Group 5: Milk and dairy products	5. Did you eat **Milk and dairy products**? ☐ No ➔ go to question 6 ☐ Yes for one and more than one of them ➔ go to table 5

Table 5: Frequency of food intake during 3 months

Code		**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	09002	Milk condensed sweetened						
2	09009	Milk powdered, full cream						
3	09037	Cheese, Cheddar						
4	09050	Milk powdered, Bear brand (yellow)						
5	09081	Milk powdered, Bear brand (plain)						
6	09082	Milk powder defatted, high calcium (Anlene)						
7	09087	Milk powder reduced fat						
8	09096	Milk tablet, sweet						

Group 6: Fat and oil	6. Did you eat **Fat and oil**? ☐ No ➔ go to question 7 ☐ Yes for one and more than one of them ➔ go to table 6

Table 6: Frequency of food intake during 3 months

	Code	**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	10003	Peanut oil						
2	10008	Butter, salted						
3	10021	Olive oil salad or cooking						
4	10024	Rice bran oil						
5	10026	Shortening bread soybean (hydrogenated) and cottonseed						

Group 7: Condiment and seasoning	7. Did you eat **Condiment and seasoning**? ☐ No ➔ go to question 8 ☐ Yes for one and more than one of them ➔ go to table 7

Table 7: Frequency of food intake during 3 months

	Code	**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	12003	Shrimp paste, fermented						
2	12005	Tomato ketchup						
3	12013	Curry paste, red						
4	12015	Curry powder						
5	12030	Bitter orange peels						
6	12033	Garlic, dried bulbs						
7	12036	Bitter orange; leech leaves, semidried						
8	12038	Cumin / Yeera, seeds						
9	12042	Chilli bird ground						
10	12058	Coriander seeds						
11	12059	Coriander root						

Group 8: Beverage	8. Did you drink **Beverage**? ☐ No ➔ go to question 9 ☐ Yes ➔ go to table 8

Table 8: Frequency of food intake during 3 months

Code		**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	14002	Orange juice						
2	14030	Passion fruit juice						
3	14055	Chocolate flavoured drink 3 in 1 instant powder mix (Milo brand)						
4	14087	Guava Juice 100% UHT						
5	14091	Strawberry Juice 100% UHT (DoiKhum brand)						
6	14095	Pineapple Juice 100% (Malee brand)						
7	14096	Tomato Juice with Mixed Fruit Juice 60% (Malee brand)						
8	14098	Red Apple red Juice 100% (Tesco brand)						
9	14099	Grape red Juice 100% (Tesco brand)						
10	14101	Pomegranate Juice 100% (Tipco brand)						
11	14110	Carrot with mixed fruit juice 100% (Unif brand)						
12	14124	Soymilk, Cereal Flavour (Foremost brand)						

Group 9: Appetizer/ Local dishes	9. Did you eat **Appetizer/ Local dishes**? ☐ No ➔ go to question 10 ☐ Yes for one and more than one of them ➔ go to table 9

Table 9: Frequency of food intake during 3 months

Code		**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	16043	Noodle sheets soup with meat and tofu						
2	16049	Southern style rice salad : rice with assorted vegetables served with southern fish sauce						
3	16082	Crab and ground pork wrapped with tofu skin fried						
4	16098	Bun steamed, red pork filled						
5	16123	Spring roll, deep fried						
6	17020	Mashed fresh chilli mixed with condiments						
7	17036	Unripe mango salad						
8	17065	Saute mungbean noodle and hen egg						
9	17076	Meat salad, Northeastern style						
10	17079	Green papaya salad						

Group 10: Medical food	10. Did you eat **Medical food**? ☐ No ➔ go to question 11 ☐ Yes ➔ go to table 10

Table 10: Frequency of food intake during 3 months

	Code	**Food name**	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
1	22001	Nutren Optimum (powder)						
2	22002	Nutren Balance (powder)						
3	22003	Nutren Fibre (powder)						
4	22005	Peptamen (powder)						
5	22010	GenDM (powder)						
6	22013	Blendera (powder)						
7	22014	Glucerna SR (powder)						
8	22015	Ensure FOS (powder)						
9	22018	Nepro (liquid per 100 ml)						

Group 11: Sweet/ Bakery/ Snacks/ Ice cream	11. Did you eat **Sweet/ Bakery/ Snacks/ Ice cream**? ☐ No ➔ go to question 12 ☐ Yes					
Please define name of food	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
…….						
…….						
…….						
…….						
…….						
…….						
Group 12: Fast food	12. Did you eat **Fast food**? ☐ No ➔ end of the questionnaire ☐ Yes					
Please define name of food	Never or <1 per month	1 – 3 times/ month	Once per week	2 – 4 times/ week	5 – 6 times/ week	Every day
…….						
…….						
…….						
…….						
…….						
…….						
…….						
…….						

***** Thank you for your help*****

APPENDIX V

Preparation of solutions for MDA determination

1. **Preparation of potassium phosphate buffer**: 50 mM KH2PO4-KOH, pH 7

   - Weight 3.48 g K2HPO4 and 4.08 g KH2PO4, pour to a beaker
   - Add 100 mL distilled water into beaker, stir to dissolve
   - Adjust pH by pH meter using KOH until get pH = 7
   - Add distilled water and adjust to get 1L of buffer in volumetric flask
   - Degass buffer by water bath at 25^0C for 60 minutes
   - Filter buffer by solvent filtration with filter paper

2. **Preparation of solvent blank**: Ethanol (400 mL/L)

   - Dissolve 200 mL of absolute ethanol into distilled water and adjust to get 500 mL in a volumetric flask

3. **Preparation of stock TEP standard**:10 mM and 100 µM

   - 10 mM TEP: pipette 120 µL TEP, add distilled water to get 100 mL in a volumetric flask
   - 100 µM TEP: pipette 500 µL of 10 mM TEP, add distilled water to get 100 mL in a volumetric flask

4. **Preparation of working standard solutions:** 0.0, 0.25, 0.5, 0.75 and 1 µM TEP

   - TEP 0.0 µM: pipette 10 mL Ethanol into tube
   - TEP 0.25µM: pipette 25µL of 100µM TEP, adjust with Ethanol to get 10 mL in a volumetric flask
   - TEP 0.5 µM: pipette 50 µL of 100µM TEP, adjust with Ethanol to get 10 mL in a volumetric flask
   - TEP 0.75µM: pipette 75 µL of 100µM TEP, adjust with Ethanol to get 10mL in a volumetric flask
   - TEP 1 µM: pipette 100 µL of 100 µM TEP, adjust with Ethanol to get 10 mL in a volumetric flask

5. **Preparation of 0.2% BHT** (in absolute ethanol)

   - Weight 0.2 g of BHT, pour to a beaker

- Add absolute ethanol, dissolve and adjust to get 100 mL in a volumetric flask

6. **Preparation of 5% TCA** (aquenous)

   - Weight 5g of TCA, pour to a beaker

   - Add distilled water, dissolve and adjust to get 100 mL in a volumetric flask

7. **Preparation of 0.6% TBA** (aquenous)

   - Weight 0.6 g TBA, pour to a beaker

   - Add distilled water, dissolve and adjust to get 100 mL in a volumetric flask

-

APPENDIX VI

Preparation of solutions for Paraoxonase 1 assay

1. Preparation of 50 mM Tris buffer, pH 8.5
    - Weight 1.51 g Tris, dissolve with 100 mL distilled water.
    - Adjust pH to get pH = 8.5 by drop 1N HCl
    - Add distilled water until reach 250 mL
2. Preparation of assay buffer, including 0.132 M Tris – HCl, 1.32 mM $CaCl_2$, and 2.63 M NaCl, pH 8.5
    - Weight 8 g Tris, 73.25 mg $CaCl_2$ and 76.85 g NaCl
    - Dissolve all of them with distilled water
    - Measure pH to get pH = 8.5 by drop 1N HCl
    - Add distilled water until reach 500 ml of assay buffer
3. Preparation of stock paraoxon 120 mM
    - Pipette 13 μL paraoxon, dissolve with aceton to get 500 μL of stock paraoxon
4. Working solution 60 mM paraoxon
    - Dilute 100 μL of stock paraoxon 120 mM with 2000 μL Tris 50 mM, pH 8.5 to get 60 mM paraoxon

APPENDIX VII

Frequency of food intake per week (FFW_I) of CKD patients and control subjects

Food group	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Meat/fish/egg					
Beef meat lean	0.21 ± 0.08	0.56 ± 0.35	0.10 ± 0.07	0	NS
Pork spare ribs (Fat 14.7%)	0.53 ±0.21	0.75 ± 0.34	0.53 ± 0.19	0.3 ± 0.11	NS
Pork loin (Fat 7.7%)	0.71 ± 0.2	1.87 ± 0.43	1.80 ± 0.57	2.35 ± 0.95	NS
Pork tenderloin (Fat 3.2%)	0.89 ± 0.25	1.87 ± 0.43	1.63 ± 0.51	2.25 ± 0.94	NS
Chicken wing, fried	0.92 ± 0.31	0.43 ± 0.14	0.30 ± 0.20	0.75 ± 0.53	NS
Beef meat sundried, fried	0.07 ± 0.04	0.12 ± 0.08	0.03 ± 0.03	0	NS
Shrimp sea	0.32 ± 0.06	0.87 ± 0.47	1.06 ± 0.4	0.85 ± 0.68	NS
Shrimp common	0.39 ± 0.07	0.62 ± 0.36	0.66 ± 0.39	1.10 ± 0.56	NS
Squid splendid	0.53 ± 0.19	0.25 ± 0.13	0.10 ± 0.05	0.30 ± 0.11	NS
Cockle / Ark shell, blanched	0.10 ± 0.05	0.12 ± 0.08	0	0.40 ± 0.29	NS
Mussel green, dried	0.14 ± 0.06	0.12 ± 0.08	0	0.15 ± 0.07	NS
Black pomfret	0.03 ± 0.03	0.43 ± 0.37	0.23 ± 0.20	0.40 ± 0.29	NS
Jelly fish	0.03 ± 0.03	0	0	0	NS
Crab mud/mangrove meat	0.21 ± 0.06	0.31 ± 0.13	0.43 ± 0.20	0.35 ± 0.29	NS
Fish salmon atlantic farmed, raw	0.28 ± 0.08	0.50 ± 0.36	0.2 ± 0.06	0.25 ± 0.11	NS
Finfish roe mixed species	0.14 ± 0.06	0.06 ± 0.06	0.06 ± 0.06	0.30 ± 0.30	NS
Hen egg, whole	2.46 ± 0.59	0.30 ± 0.3	3.13 ± 0.59	2.45 ± 0.63	NS
Fruits					
Banana, unripe	0.82 ± 0.42	1.00 ± 0.73	1.56 ± 0.52	0.65 ± 0.28	NS
Rambutan	1.00 ± 0.30	0.68 ± 0.35	1.16 ± 0.54	1.10 ± 0.56	NS
Rose apple, green	0.17 ± 0.06	1.12 ± 0.08	0.06 ± 0.04	0.65 ± 0.39	NS
Durian	0.32 ± 0.09	0.18 ± 0.09	0.43 ± 0.19	0.15 ± 0.07	NS
Guava common	0.89 ± 0.26	1.12 ± 0.41	1.56 ± 0.49	0.7 ± 0.29	NS
Jujube apple	0.20 ± 0.07	0	0.10 ± 0.07	0.20 ± 0.13	NS
Papaya, ripe	0.85 ± 0.41	0.68 ± 0.35	1.33 ± 0.5	0.25 ± 0.11	NS
Longan	0.85 ± 0.51	0	0.26 ± 0.2	0.05 ± 0.05	NS
Santol	0.50 ± 0.21	0.06 ± 0.06	0.1 ± 0.07	0.40 ± 0.30	NS
Litchi	0.14 ± 0.06	0.06 ± 0.06	0.06 ± 0.04	0.65 ± 0.54	NS
Kalanchoe	0.32 ± 0.21	0.12 ± 0.08	0.03 ± 0.03	0.30 ± 0.30	NS
Tangelo	0.53 ± 0.39	0.56 ± 0.35	0.43 ± 0.27	0.55 ± 0.30	NS
Pomelo	0.67 ± 0.27	0.25 ± 0.13	0.70 ± 0.39	0.25 ± 0.11	NS
Cantaloupe	0.89 ± 0.26	1.00 ± 0.45	0.56 ± 0.36	0.10 ± 0.10	NS
Persimmon, dried	0.14 ± 0.06	0.06 ± 0.06	0.03 ± 0.03	0.05 ± 0.05	NS
Strawberry	0.14 ± 0.08	0.18 ± 0.09	0.13 ± 0.05	0.15 ± 0.10	NS
Mango, ripe	0.25 ± 0.21	0.56 ± 0.35	0.16 ± 0.07	0.25 ± 0.13	NS
Mango, unripe	0.46 ± 0.21	0.31 ± 0.13	0.33 ± 0.19	0.35 ± 0.10	NS
Cherries eating, raw	0.07 ± 0.04	0.18 ± 0.13	0.16 ± 0.07	0.05 ± 0.05	NS

Frequency of food intake per week (FFW_i) of CKD patients and control subjects

Food group	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Kiwi fruit	0.14 ± 0.06	0.18 ± 0.09	0.26 ± 0.2	0.10 ± 0.06	NS
Longkong	0.60 ± 0.21	0.37 ± 0.12	1.13 ± 0.49	0.85 ± 0.36	NS
Vegetables					
Horseradish leaves	0.25 ± 0.21	0.43 ± 0.37	0.06 ± 0.04	0.10 ± 0.06	NS
Tiliacora triandra diel	0.28 ± 0.10	0.25 ± 0.16	0.06 ± 0.04	0.45 ± 0.29	NS
Broccoli	0.89 ± 0.31	1.25 ± 0.62	0.50 ± 0.20	0.80 ± 0.37	NS
Mustard green	1.07 ± 0.43	0.5 ± 0.13	0.67 ± 0.25	0.90 ± 0.36	NS
Brussels sprouts	0.39 ± 0.10	0.37 ± 0.15	0.36 ± 0.20	0.15 ± 0.07	NS
Gourd bitter young leaves	0.10 ± 0.05	0.31 ± 0.09	0.33 ± 0.20	0.15 ± 0.07	NS
Mint leaves	0.42 ± 0.21	0.62 ± 0.35	0.50 ± 0.36	0.40 ± 0.10	NS
Kale Chinese	1.28 ± 0.31	1.18 ± 0.41	0.63 ± 0.19	1.25 ± 0.54	NS
Cauliflower	0.35 ± 0.08	0.62 ± 0.15	0.73 ± 0.39	0.60 ± 0.30	NS
Glory red stem	0.32 ± 0.11	1.12 ± 0.43	1.23 ± 0.42	0.70 ± 0.28	NS
Cassia leaves	0.28 ± 0.08	0.18 ± 0.09	0.30 ± 0.09	0.10 ± 0.06	NS
Chilli pepper	0.21 ± 0.08	0.62 ± 0.35	0.13 ± 0.05	0.50 ± 0.14	NS
Graden pea pod	0.42 ± 0.21	0.68 ± 0.36	0.23 ± 0.09	0.55 ± 0.29	NS
Okra	0.20 ± 0.07	0.18 ± 0.09	0.03 ± 0.03	1.15 ± 0.71	NS
Garlic flower	0.03 ± 0.03	0.06 ± 0.06	0.03 ± 0.03	0.05 ± 0.05	NS
Acacia pennata	0.39 ± 0.09	0.81 ± 0.32	0.13 ± 0.07	0.20 ± 0.08	NS
Celery	0.60 ± 0.21	0.87 ± 0.33	1.20 ± 0.61	0.85 ± 0.37	NS
Gourd wax	0.32 ± 0.06	0.37 ± 0.12	0.36 ± 0.11	0.85 ± 0.37	NS
Tomato	0.78 ± 0.27	1.62 ± 0.83	1.86 ± 0.56	1.85 ± 0.69	NS
Water mimosa	0.25 ± 0.06	0.25 ± 0.13	0.76 ± 0.39	0.15 ± 0.07	NS
Crawdaisy leaves	0.53 ± 0.28	0.25 ± 0.13	0.1 ± 0.05	0.45 ± 0.30	NS
Wing bean pod	0.32 ± 0.09	1.00 ± 0.45	0.46 ± 0.20	0.60 ± 0.28	NS
Sesbania flowers	0.50 ± 0.20	0.37 ± 0.15	0.13 ± 0.05	0.40 ± 0.12	NS
Cabbage	0.53 ± 0.08	2.10 ± 0.78	1.10 ± 0.40	0.85 ± 0.38	NS
Lemon juice	2.57 ± 0.65	2.06 ± 0.66	2.6 ± 0.69	2.65 ± 0.68	NS
Gourd bitter young leaves	0.11 ± 0.06	0.31 ± 0.09	0.33 ± 0.2	0.70 ± 0.54	NS
Holy basil leaves	1.00 ± 0.32	1.80 ± 0.67	1.30 ± 0.41	1.35 ± 0.52	NS
Lettuce red leaves	0.35 ± 0.23	0.88 ± 0.48	0.73 ± 0.49	0.20 ± 0.11	NS
Tiliacora triandra diel	0.31 ± 0.11	0.25 ± 0.16	0.67 ± 0.45	0.45 ± 0.29	NS
Ivy ground	0.46 ± 0.12	0.75 ± 0.34	0.40 ± 0.11	0.80 ± 0.53	NS
Horseradish leaves	0.27 ± 0.23	0.44 ± 0.37	0.07 ± 0.04	0.10 ± 0.07	NS
Water mimosa	0.27 ± 0.07	0.25 ± 0.13	0.77 ± 0.39	0.15 ± 0.08	NS
Mint leaves	0.46 ± 0.23	0.62 ± 0.35	0.5 ± 0.36	0.40 ± 0.10	NS
Crawdaisy leaves	0.58 ± 0.31	0.25 ± 0.13	0.10 ± 0.05	0.45 ± 0.30	NS
Horse tamarind	0.04 ± 0.04	0.06 ± 0.06	0.13 ± 0.08	0.15 ± 0.11	NS
Sweet basil leaves	0.88 ± 0.27	0.62 ± 0.35	1.20 ± 0.49	1.05 ± 0.50	NS
Cereals and legumes/ starchy vegetables					
Bread white sliced	1.27 ± 0.45	0.25 ± 0.13	2.17 ± 0.78	0.8 ± 0.37	NS
Job's tear whole seeds	0.5 ± 0.22	0.56 ± 0.36	0.50 ± 0.20	1.15 ± 0.56	NS

Frequency of food intake per week (FFW_i) of CKD patients and control subjects

Food group	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Corn flakes	0.19 ± 0.10	0.44 ± 0.37	0.37 ± 0.20	0.15 ± 0.10	NS
Macaroni, cooked, unenrich	0	0.25 ± 0.13	0.13 ± 0.08	0	NS
Bread whole wheat	0.85 ± 0.45	1.50 ± 0.86	1.90 ± 0.73	0.55 ± 0.28	NS
Rice whole grain milled by machine, steamed	1.15 ± 0.64	2.37 ± 0.97	2.56 ± 0.86	1.75 ± 0.92	NS
Cereal soy based supplementary food	0.11 ± 0.06	0.18 ± 0.13	0.03 ± 0.03	1.00 ± 0.73	NS
Potato	0.30 ± 0.09	0.62 ± 0.35	0.30 ± 0.09	0.40 ± 0.14	NS
Cassava	0.11 ± 0.06	0	0.23 ± 0.09	0.50 ± 0.29	NS
Arrow roots, white	0.19 ± 0.09	0.12 ± 0.08	0.10 ± 0.05	0.20 ± 0.08	NS
Lotus root, raw	0.15 ± 0.06	0.37 ± 0.37	0.06 ± 0.04	0.10 ± 0.06	NS
Chinese chestnut	0.11 ± 0.06	0.12 ± 0.08	0.10 ± 0.05	0.25 ± 0.11	NS
Sesame seeds, white and black	0.27 ± 0.11	1.4 ± 0.87	1.06 ± 0.49	0.90 ± 0.53	NS
Cowpea seeds, black color	0.04 ± 0.04	0.18 ± 0.13	0.23 ± 0.09	0.25 ± 0.11	NS
Peanut, boiled	0.34 ± 0.10	1.31 ± 0.68	0.67 ± 0.35	0.50 ± 0.28	NS
Mung bean	0.15 ± 0.06	1.18 ± 0.71	0.5 ± 0.36	0.55 ± 0.29	NS
Soybean seeds, dried	0.15 ± 0.06	0.37 ± 0.37	0.26 ± 0.2	0.05 ± 0.05	NS
Rice bean seeds, dried	0.03 ± 0.03	0.37 ± 0.37	0.33 ± 0.2	0.10 ± 0.06	NS
Pigeonpea immature seeds	0.03 ± 0.03	0.50 ± 0.36	0.06 ± 0.04	0.05 ± 0.05	NS
Lotus seeds, dried	0.11 ± 0.06	0.37 ± 0.37	0.26 ± 0.2	0.05 ± 0.05	NS
Cashew nut, fried	0.30 ± 0.10	0.31 ± 0.13	0.33 ± 0.2	0.30 ± 0.11	NS
Ginkgo seeds, whole	0.11 ± 0.06	0.25 ± 0.13	0.1 ± 0.05	0.15 ± 0.1	NS
Sunflower seeds, dry, roasted without salt	0.23 ± 0.09	0.18 ± 0.13	0.06 ± 0.04	0.20 ± 0.11	NS
Almonds dry roasted with salt added	0.42 ± 0.23	0.56 ± 0.35	0.10 ± 0.05	0.15 ± 0.10	NS
Milk and dairy products					
Milk condensed sweetened	1.60 ± 0.90	0.10 ± 0.10	1.90 ± 0.83	2.50 ± 1.65	NS
Milk powdered, full cream	1.15 ± 0.71	0.70 ± 0.58	0.04 ± 0.04	2.12 ± 1.63	NS
Cheese, Cheddar	0.05 ± 0.05	0.80 ± 0.56	0.36 ± 0.27	0.12 ± 0.12	NS
Milk powdered, plain	0.15 ± 0.07	0.40 ± 0.24	0.27 ± 0.27	0.75 ± 0.75	NS
Milk powdered defatted, high calcium	0.40 ± 0.29	1.10 ± 1.10	0	0.41 ± 0.22	NS
Milk powder reduced fat	0.25 ± 0.13	0.10 ± 0.10	0.45 ± 0.28	0	NS
Milk tablet sweet	0	0.04 ± 0.04	0	0.01 ± 0.01	NS

Frequency of food intake per week (FFW_i) of CKD patients and control subjects

Food group	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Fat and oil					
Peanut oil	0.46 ± 0.42	0.37 ± 0.37	0.46 ± 0.46	0.10 ± 0.06	NS
Butter, salted	0.07 ± 0.05	0.12 ± 0.08	0.03 ± 0.03	0.10 ± 0.10	NS
Olive oil salad or cooking	0.23 ± 0.23	0.31 ± 0.16	1.16 ± 0.57	0.15 ± 0.11	NS
Rice bran oil	1.03 ± 0.64	1.12 ± 0.85	2.96 ± 0.85	2.05 ± 0.91	NS
Shortening bread soybean and cottonseed	0	0.18 ± 0.13	0	0	NS
Condiment and seasoning					
Shrimp paste, fermented	1.38 ± 0.54	0.81 ± 0.33	0.56 ± 0.35	0.55 ± 0.29	NS
Tomato ketchup	0.53 ± 0.22	0.62 ± 0.37	0.73 ± 0.25	0.45 ± 0.29	NS
Curry paste, red	1.61 ± 0.70	1.18 ± 0.62	0.9 ± 0.37	0.55 ± 0.29	NS
Curry powder	0.11 ± 0.08	0.25 ± 0.13	0.16 ± 0.06	0.15 ± 0.07	NS
Bitter orange peels	0.42 ± 0.23	0.37 ± 0.15	1.13 ± 0.52	0.60 ± 0.28	NS
Garlic, dried bulbs	3.10 ± 0.73	3.90 ± 0.95	3.46 ± 0.72	3.90 ± 0.90	NS
Bitter orange; leech leaves, semidried	1.69 ± 0.57	1.18 ± 0.41	0.73 ± 0.49	1.40 ± 0.67	NS
Cumin / Yeera, seeds	0.11 ± 0.08	0.18 ± 0.13	0.30 ± 0.20	0.15 ± 0.07	NS
Chilli bird ground	1.88 ± 0.63	1.43 ± 0.75	1.96 ± 0.66	2.90 ± 0.77	NS
Coriander seeds	0.69 ± 0.52	0.62 ± 0.37	0.03 ± 0.03	0.70 ± 0.53	NS
Coriander root	1.80 ± 0.67	1.18 ± 0.42	0.80 ± 0.30	0.65 ± 0.54	NS
Beverage					
Orange juice	1.07 ± 0.47	0.75 ± 0.35	1.67 ± 0.07	0.30 ± 0.30	NS
Passion fruit juice	0.53 ± 0.30	0.06 ± 0.06	0	0.05 ± 0.05	NS
Chocolate flavoured drink 3 in 1 instant powder mix (Milo brand)	0.34 ± 0.23	0.37 ± 0.37	0.06 ± 0.04	0.65 ± 0.54	NS
Guava Juice 100% UHT	0.15 ± 0.08	0.12 ± 0.08	0	0.05 ± 0.05	NS
Strawberry Juice 100% UHT (DoiKhum brand)	0.15 ± 0.08	0	0	0.05 ± 0.05	NS
Pineapple Juice 100% (Malee brand)	0.15 ± 0.06	0.06 ± 0.06	0.03 ± 0.03	0.10 ± 0.10	NS
Tomato Juice with Mixed Fruit Juice 60% (Malee brand)	0.11 ± 0.06	0	0.06 ±0.06	0	NS
Red Apple red Juice 100% (Tesco brand)	0.07 ± 0.05	0	0.03 ± 0.03	0.05 ± 0.05	NS
Grape red Juice 100% (Tesco brand)	0.07 ± 0.05	0	0.03 ± 0.03	0.05 ± 0.05	NS
Pomegranate Juice 100% (Tipco brand)	0.11 ± 0.08	0	0.03 ± 0.03	0.05 ± 0.05	NS

Frequency of food intake per week (FFW_i) of CKD patients and control subjects

Food group	Control	Stage 1&2	Stage 3	Stage 4	*p-value*
Carrot with mixed fruit juice 100% (Unif brand)	0.15 ± 0.08	0	0.03 ± 0.03	0.05 ± 0.05	NS
Soymilk, Cereal Flavour (Foremost brand)	1.15 ± 0.58	0	0.23 ± 0.20	0	NS
Appetizer/ local dishes					
Noodle sheets soup with meat and tofu	0.38 ± 0.22	0.12 ± 0.08	0.46 ± 0.19	0.2 ± 0.11	NS
Southern style rice salad : rice with assorted vegetables served with southern fish sauce	0.07 ± 0.05	0.25 ± 0.09	0.1 ± 0.05	0.2 ± 0.11	NS
Crab and ground pork wrapped with tofu skin fried	0.15 ± 0.06	0.18 ± 0.09	0.26 ± 0.06	0.20 ± 0.11	NS
Bun steamed, red pork filled	0.19 ± 0.07	0.25 ± 0.13	0.36 ± 0.20	0.70 ± 0.38	NS
Spring roll, deep fried	0.50 ± 0.23	0.12 ± 0.08	0.13 ± 0.05	0.20 ± 0.08	NS
Mashed fresh chilli mixed with condiments	0.92 ± 0.43	0.25 ± 0.09	0.30 ± 0.20	0.15 ± 0.10	NS
Unripe mango salad	0.46 ± 0.22	0.12 ± 0.08	0.06 ± 0.04	0.10 ± 0.10	NS
Saute mungbean noodle and hen egg	0.30 ± 0.07	0.50 ± 0.13	0.50 ± 0.19	0.30 ± 0.11	NS
Meat salad, Northeastern style	0.11 ± 0.06	0.06 ± 0.06	0	0.05 ± 0.05	NS
Green papaya salad	1.88 ± 0.64	1.25 ± 0.38	0.73 ± 0.24	0.60 ± 0.28	NS

Results were expressed as mean ± SEM. Data were analyzed using Krussal Wallis to compare difference among groups

APPENDIX VIII

Ethical Approval

COA No. 208/2016

IRB No. 576/58

INSTITUTIONAL REVIEW BOARD

Faculty of Medicine, Chulalongkorn University

1873 Rama 4 Road, Patumwan, Bangkok 10330, Thailand, Tel 662-256-4493

Certificate of Approval

The Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand, has approved the following study in compliance with the International guidelines for human research protection as Declaration of Helsinki, The Belmont Report, CIOMS Guideline and International Conference on Harmonization in Good Clinical Practice (ICH-GCP)

Study Title : Investigation of total antioxidant status and antioxidant activity in pre - dialysis CKD patients

Study Code : -

Principal Investigator : Miss Lan Hoang Thi Bui

Affiliation of PI : Faculy of Allied Health Sciences, Chulalongkorn University.

Review Method : Full board

Continuing Report : At least once annually or submit the final report if finished.

Document Reviewed :

1. Research Proposal Version 2.0, 30 January 2016
2. Protocol Synopsis Version 2.0, 30 January 2016
3. Information sheet for research participant (the control group) Version 2.0 Dated February 24, 2016
4. Informed consent of research participants (the control group) Version 2.0, 30 January 2016
5. Information sheet for research participant (patients) Version 2.0 Dated February 24, 2016
6. Informed consent of research participants (patients) Version 2.0, 30 January 2016
7. Food frequency questionnaire Version 2.0, 30 January 2016

All approved investigators must comply with the following conditions:

1. Strictly conduct the research as required by the protocol;
2. Use only the information sheet, consent form (and recruitment materials, if any), interview outlines and/or questionnaires bearing the Institutional Review Board's seal of approval ; and return one copy of such documents of the first subject recruited to the Institutional Review Board (IRB) for the record;
3. Report to the Institutional Review Board any serious adverse event or any changes in the research activity within five working days;
4. Provide reports to the Institutional Review Board concerning the progress of the research upon the specified period of time or when requested;
5. If the study cannot be finished within the expire date of the approval certificate, the investigator is obliged to reapply for approval at least one month before the date of expiration.
6. If the research project is completed, the researcher must be form the Faculty of Medicine, Chulalongkorn University.

* A list of the Institutional Review Board members (names and positions) present at the meeting of Institutional Review Board on the date of approval of this study has been attached. All approved documents will be forwarded to the principal investigator.

8. Assessment frequency of dietary Version 2.0, 30 January 2016
9. A patient record Version 2.0, 30 January 2016
10. A record of food intake after 24 hours Version 2.0, 30 January 2016
11. Call for volunteers to join a study Version 2.0, 30 January 2016
12. CURRICULUM VITAE Version 1.0, 1 August 2015
13. GCP Training
14. Budget Version 1.0, 1 August 2015

Signature:..... Signature:.....

(Emeritus Professor Tada Sueblinvong MD) (Associate Professor Onanong Kulaputana MD, PhD)

Chairperson — Member and Assistant Secretary, Acting

The Institutional Review Board — Secretary The Institutional Review Board

Date of Approval : March 15, 2016

Approval Expire Date : March 14, 2017

Approval granted is subject to the following conditions: (see back of this Certificate)

คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย	AF 10-05/4.0 Version 2.0 30January2016 เอกสารแสดงความยินยอมเข้าร่วมในโครงการวิจัย (กลุ่มผู้ป่วย)

การวิจัย เรื่อง การวิเคราะห์สภาวะต้านออกซิเดชั่นและความสามารถในการต้านอนุมูลอิสระในผู้ป่วยโรคไตระยะก่อนล้างไต

วันให้คำยินยอม วันที่.....เดือน.....พ.ศ.....

ข้าพเจ้า นาย/นาง/นางสาว.....ที่อยู่ .....ได้อ่านรายละเอียดจากเอกสารข้อมูลสำหรับผู้เข้าร่วมโครงการวิจัยวิจัยที่แนบมาฉบับวันที่ ..... และข้าพเจ้ายินยอมเข้าร่วมโครงการวิจัยโดยสมัครใจ

ข้าพเจ้าได้รับสำเนาเอกสารแสดงความยินยอมเข้าร่วมในโครงการวิจัยที่ข้าพเจ้าได้ลงนาม และ วันที่ พร้อมด้วยเอกสารข้อมูลสำหรับผู้เข้าร่วมโครงการวิจัย ทั้งนี้ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย ระยะเวลาของการทำวิจัย วิธีการวิจัย อันตราย หรืออาการที่อาจเกิดขึ้นจากการวิจัย รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัย และแนวทางรักษาโดยวิธีอื่นอย่างละเอียด ข้าพเจ้ามีเวลาและโอกาสเพียงพอในการซักถามข้อสงสัยจนมีความเข้าใจอย่างดีแล้ว โดยผู้วิจัยได้ตอบคำถามต่าง ๆ ด้วยความเต็มใจไม่ปิดบังซ่อนเร้นจนข้าพเจ้าพอใจ

ข้าพเจ้ารับทราบจากผู้วิจัยว่าหากเกิดอันตรายใด ๆ จากการวิจัยดังกล่าว ข้าพเจ้าจะได้รับการรักษาพยาบาลโดยไม่เสียค่าใช้จ่าย

ข้าพเจ้ามีสิทธิที่จะบอกเลิกเข้าร่วมในโครงการวิจัยเมื่อใดก็ได้ โดยไม่จำเป็นต้องแจ้งเหตุผล และการบอกเลิกการเข้าร่วมการวิจัยนี้ จะไม่มีผลต่อการรักษาโรคหรือสิทธิอื่น ๆ ที่ข้าพเจ้าจะพึงได้รับต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูลส่วนตัวของข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะเมื่อได้รับการยินยอมจากข้าพเจ้าเท่านั้น บุคคลอื่นในนามของผู้สนับสนุนการวิจัยและคณะกรรมการพิจารณาจริยธรรมการวิจัยในคน อาจได้รับอนุญาตให้เข้ามาตรวจและประมวลข้อมูลของข้าพเจ้า ทั้งนี้จะต้องกระทำไปเพื่อวัตถุประสงค์เพื่อตรวจสอบความถูกต้องของข้อมูลเท่านั้น โดยถ้าตกลงที่จะเข้าร่วมการศึกษานี้ข้าพเจ้าได้ให้คำยินยอมที่จะให้มีการตรวจสอบข้อมูลประวัติทางการแพทย์ของข้าพเจ้าได้

ผู้วิจัยรับรองว่าจะไม่มีการเก็บข้อมูลใด ๆ เพิ่มเติม หลังจากที่ข้าพเจ้าขอยกเลิกการเข้าร่วมโครงการวิจัยและต้องการให้ทำลายเอกสารและภาพ ด้วยอย่างที่ใช้ตรวจสอบทั้งหมดที่สามารถสืบค้นถึงตัวข้าพเจ้าได้

ข้าพเจ้าเข้าใจว่า ข้าพเจ้ามีสิทธิ์ที่จะตรวจสอบหรือแก้ไขข้อมูลส่วนตัวของข้าพเจ้าและสามารถยกเลิกการให้สิทธิในการใช้ข้อมูลส่วนตัวของข้าพเจ้าได้ โดยต้องแจ้งให้ผู้วิจัยรับทราบ

ข้าพเจ้าได้ตระหนักว่าข้อมูลในการวิจัยรวมถึงข้อมูลทางการแพทย์ของข้าพเจ้าที่ไม่มีการเปิดเผยชื่อ จะผ่านกระบวนการต่าง ๆ เช่น การเก็บข้อมูล การบันทึกข้อมูลในแบบบันทึกและในคอมพิวเตอร์ การตรวจสอบ การวิเคราะห์ และการรายงานข้อมูลเพื่อวัตถุประสงค์ทางวิชาการ รวมทั้งการใช้ข้อมูลทางการแพทย์ในอนาคตหรือการวิจัยทางโภชนาการและการกำหนดอาหาร เท่านั้น

 คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย	AF 10-05\4.0 Version 2.0 30January2016 เอกสารแสดงความยินยอมเข้าร่วมในโครงการวิจัย (กลุ่มผู้ป่วย)

ข้าพเจ้าได้อ่านข้อความข้างต้นและมีความเข้าใจดีทุกประการแล้ว ยินดีเข้าร่วมในการวิจัยด้วยความเต็มใจ จึงได้ลงนามในเอกสารแสดงความยินยอมนี้

.....ลงนามผู้ให้ความยินยอม

(.....) ชื่อผู้ยินยอมตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

การจัดการกับตัวอย่างทางชีวภาพ

☐ ไม่มีตัวอย่างชีวภาพ

☐ มีแต่ไม่มีการขอเก็บ

☑ มีและขอเก็บตัวอย่างชีวภาพที่เหลือไว้เพื่อการวิจัยในอนาคต

ข้าพเจ้า ☐ ยินยอม

☐ ไม่ยินยอม

ให้เก็บตัวอย่างชีวภาพที่เหลือไว้เพื่อการวิจัยในอนาคต

.....ลงนามผู้ให้ความยินยอม

(.....) ชื่อผู้ยินยอมตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

ข้าพเจ้าได้อธิบายถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย อันตราย หรืออาการไม่พึงประสงค์หรือความเสี่ยงที่อาจเกิดขึ้นจากการวิจัย หรือจากยาที่ใช้ รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัยอย่างละเอียด ให้ผู้เข้าร่วมในโครงการวิจัยตามนามข้างต้นได้ทราบและมีความเข้าใจดีแล้ว พร้อมลงนามลงในเอกสารแสดงความยินยอมด้วยความเต็มใจ

.....ลงนามผู้ทำวิจัย

(นางสาวแสน ต้อง ที บุย) ชื่อผู้ทำวิจัย ตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

.....ลงนามพยาน

(ผศ.ดร.พิทยนคร อริยปิติพันธ์) ชื่อพยาน ตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย	เอกสารแสดงความยินยอมเข้าร่วมในโครงการวิจัย (กลุ่มควบคุม)

การวิจัยเรื่อง การวิเคราะห์สภาวะด้านออกซิเดชั่นและความสามารถในการต้านอนุมูลอิสระในผู้ป่วยโรคไตระยะก่อนล้างไต

วันให้คำยินยอม วันที่.....เดือน.....พ.ศ.....

ข้าพเจ้า นาย/นาง/นางสาว.....ที่อยู่ .....ได้อ่านรายละเอียดจากเอกสารข้อมูลสำหรับผู้เข้าร่วมโครงการวิจัยวิจัยที่แนบมาฉบับวันที่ ..... และข้าพเจ้ายินยอมเข้าร่วมโครงการวิจัยโดยสมัครใจ

ข้าพเจ้าได้รับสำเนาเอกสารแสดงความยินยอมเข้าร่วมในโครงการวิจัยที่ข้าพเจ้าได้ลงนาม และ วันที่ พร้อมด้วยเอกสารข้อมูลสำหรับผู้เข้าร่วมโครงการวิจัย ทั้งนี้ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย ระยะเวลาของการทำวิจัย วิธีการวิจัย อันตราย หรืออาการที่อาจเกิดขึ้นจากการวิจัย รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัย และแนวทางรักษาโดยวิธีอื่นอย่างละเอียด ข้าพเจ้ามีเวลาและโอกาสเพียงพอในการซักถามข้อสงสัยจนมีความเข้าใจอย่างดีแล้ว โดยผู้วิจัยได้ตอบคำถามต่าง ๆ ด้วยความเต็มใจไม่ปิดบังซ่อนเร้นจนข้าพเจ้าพอใจ

ข้าพเจ้ารับทราบจากผู้วิจัยว่าหากเกิดอันตรายใด ๆ จากการวิจัยดังกล่าว ข้าพเจ้าจะได้รับการรักษาพยาบาลโดยไม่เสียค่าใช้จ่าย

ข้าพเจ้ามีสิทธิที่จะบอกเลิกเข้าร่วมในโครงการวิจัยเมื่อใดก็ได้ โดยไม่จำเป็นต้องแจ้งเหตุผล และการบอกเลิกการเข้าร่วมการวิจัยนี้ จะไม่มีผลต่อการรักษาโรคหรือสิทธิอื่น ๆ ที่ข้าพเจ้าจะพึงได้รับต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูลส่วนตัวของข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะเมื่อได้รับการยินยอมจากข้าพเจ้าเท่านั้น บุคคลอื่นในนามของผู้สนับสนุนการวิจัยและคณะกรรมการพิจารณาจริยธรรมการวิจัยในคน อาจได้รับอนุญาตให้เข้ามาตรวจและประมวลข้อมูลของข้าพเจ้า ทั้งนี้จะต้องกระทำไปเพื่อวัตถุประสงค์เพื่อตรวจสอบความถูกต้องของข้อมูลเท่านั้น โดยการตกลงที่จะเข้าร่วมการศึกษานี้ข้าพเจ้าได้ให้คำยินยอมที่จะให้มีการตรวจสอบข้อมูลประวัติทางการแพทย์ของข้าพเจ้าได้

ผู้วิจัยรับรองว่าจะไม่มีการเก็บข้อมูลใด ๆ เพิ่มเติม หลังจากที่ข้าพเจ้าขอยกเลิกการเข้าร่วมโครงการวิจัยและต้องการให้ทำลายเอกสารและ/หรือ ตัวอย่างที่ใช้ตรวจสอบทั้งหมดที่สามารถสืบค้นถึงตัวข้าพเจ้าได้

ข้าพเจ้าเข้าใจว่า ข้าพเจ้ามีสิทธิ์ที่จะตรวจสอบหรือแก้ไขข้อมูลส่วนตัวของข้าพเจ้าและสามารถยกเลิกการให้สิทธิในการใช้ข้อมูลส่วนตัวของข้าพเจ้าได้ โดยต้องแจ้งให้ผู้วิจัยรับทราบ

ข้าพเจ้าได้ตระหนักว่าข้อมูลในการวิจัยรวมถึงข้อมูลทางการแพทย์ของข้าพเจ้าที่ไม่มีการเปิดเผยชื่อ จะผ่านกระบวนการต่าง ๆ เช่น การเก็บข้อมูล การบันทึกข้อมูลในแบบบันทึกและในคอมพิวเตอร์ การตรวจสอบ การวิเคราะห์และการรายงานข้อมูลเพื่อวัตถุประสงค์ทางวิชาการ รวมทั้งการใช้ข้อมูลทางการแพทย์ในอนาคตหรือการวิจัยทางโภชนาการและการกำหนดอาหาร เท่านั้น

INSTITUTIONAL REVIEW BOARD
Faculty of Medicine, Chulalongkorn University
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คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย	IRB No. 574/56 Version 1.0 Dated January 2016 เอกสารแสดงความยินยอมเข้าร่วมในโครงการวิจัย (กลุ่มควบคุม)

ข้าพเจ้าได้อ่านข้อความข้างต้นและมีความเข้าใจดีทุกประการแล้ว ยินดีเข้าร่วมในการวิจัยด้วยความเต็มใจ จึงได้ลงนามในเอกสารแสดงความยินยอมนี้

.....ลงนามผู้ให้ความยินยอม

(.....) ชื่อผู้ยินยอมตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

การจัดการกับตัวอย่างทางชีวภาพ

☐ ไม่มีตัวอย่างชีวภาพ

☑ มีแต่ไม่มีการขอเก็บ

☐ มีและขอเก็บตัวอย่างชีวภาพที่เหลือไว้เพื่อการวิจัยในอนาคต

ข้าพเจ้า ☐ ยินยอม

☐ ไม่ยินยอม

ให้เก็บตัวอย่างชีวภาพที่เหลือไว้เพื่อการวิจัยในอนาคต

.....ลงนามผู้ให้ความยินยอม

(.....) ชื่อผู้ยินยอมตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

ข้าพเจ้าได้อธิบายถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย อันตราย หรืออาการไม่พึงประสงค์หรือความเสี่ยงที่อาจเกิดขึ้นจากการวิจัย รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัยอย่างละเอียด ให้ผู้เข้าร่วมในโครงการวิจัยตามนามข้างต้นได้ทราบและมีความเข้าใจดีแล้ว พร้อมลงนามลงในเอกสารแสดงความยินยอมด้วยความเต็มใจ

.....ลงนามผู้ทำวิจัย

(นางสาวแสน ช้อง ที บุอ) ชื่อผู้ทำวิจัย ตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

.....ลงนามพยาน

(ผศ.พ.ท.พิทยนคร อริยปิติพันธ์) ชื่อพยาน ตัวบรรจง

วันที่ .....เดือน.....พ.ศ.....

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ชื่อโครงการวิจัย การวิเคราะห์ศักยภาวะต้านออกซิเดชั่นและความสามารถในการต้านอนุมูลอิสระในผู้ป่วยโรคไตระยะก่อนล้างไต (Investigation of total antioxidant status and antioxidant activity in pre-dialysis CKD patients)

ผู้สนับสนุนการวิจัย คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

ผู้ทำวิจัย

นางสาวแสน ฮ้อง ที บุย
อาคารจุฬาพัฒน์ 3 ชั้น 1 ภาควิชาโภชนาการและการกำหนดอาหาร
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เบอร์โทรศัพท์ 02-256-4251, 086-770-1059

เรียน ผู้เข้าร่วมโครงการวิจัยทุกท่าน

ท่านได้รับเชิญให้เข้าร่วมในโครงการวิจัยนี้เนื่องจากท่านเป็นผู้ป่วยโรคไตเรื้อรังระยะก่อนล้างไต ก่อนที่ท่านจะตัดสินใจเข้าร่วมในการศึกษาวิจัยดังกล่าว ขอให้ท่านอ่านเอกสารฉบับนี้อย่างถี่ถ้วน เพื่อให้ท่านได้ทราบถึงเหตุผลและรายละเอียดของการศึกษาวิจัยในครั้งนี้ หากท่านมีข้อสงสัยใดๆ เพิ่มเติม กรุณาซักถามจากทีมงานของผู้ทำวิจัยหรือผู้ร่วมทำวิจัยซึ่งจะเป็นผู้สามารถอธิบายคำถามและให้ความกระจ่างแก่ท่านได้

ท่านสามารถขอคำแนะนำในการเข้าร่วมโครงการวิจัยนี้จากครอบครัว เพื่อนหรือแพทย์ประจำตัวของท่านได้ ท่านมีเวลาอย่างเพียงพอในการตัดสินใจโดยอิสระ ถ้าท่านตัดสินใจแล้วว่าจะเข้าร่วมในโครงการวิจัยนี้ ขอให้ท่านลงนามในเอกสารแสดงความยินยอมของโครงการวิจัยนี้

เหตุผลความเป็นมา

ปัจจุบันผู้ป่วยโรคไตเรื้อรังเพิ่มขึ้นทุกปีและเป็นปัญหาทางสาธารณสุขหนึ่งของประเทศไทยและของโลก หากผู้ป่วยโรคไตเรื้อรังไม่ได้รับการดูแลรักษาตั้งแต่ระยะแรกๆ เพื่อชะลอการเสื่อมของไต ผู้ป่วยจะเข้าสู่โรคไตเรื้อรังระยะสุดท้ายได้เร็วขึ้น ในระยะที่ไตเสื่อมสภาพมากจะส่งผลให้เกิดการคั่งของของเสียในร่างกายและเกิดภาวะแทรกซ้อนจากโรคต่างๆ ร่วมมากขึ้น เช่น โปแตสเซียมหรือฟอสฟอรัสสูงในเลือด ไขมันในเลือดสูง โรคเก๊าท์ โลหิตจาง กระดูกพรุน เป็นต้น ผู้ป่วยจะมีชีวิตอยู่รอดต่อไปต้องได้รับการบำบัดทดแทนไต เช่น การล้างไตทางหน้าท้อง การฟอกเลือดด้วยเครื่องไตเทียม หรือการปลูกถ่ายไต อย่างไรก็ตาม สิ่งเหล่านี้ส่งผลกระทบต่อคุณภาพชีวิตของผู้ป่วย รวมทั้งกระทบต่อเศรษฐกิจของผู้ป่วยและของประเทศด้วยเช่นกัน อย่าง

การเกิดภาวะเครียดออกซิเดชั่นเป็นภาวะไม่สมดุลระหว่างอนุมูลอิสระและการลดลงของภาวะต้านอนุมูลอิสระภายในร่างกาย อนุมูลอิสระมีระดับเพิ่มมากขึ้นในผู้ป่วยเบาหวานชนิดที่ 2 ภาวะอักเสบและเนื้อตายมากขึ้น ซึ่งอาจทำให้เกิดการเสื่อมสภาพของเนื้อเยื่อไตและส่งผลกระทบต่อการทำงานของไต ดังนั้น ภาวะเครียดออกซิเดชันจึงเป็นกระบวนการที่สำคัญในการเกิดการเสื่อมสภาพของไต สารมาโลนไดอัลดีไฮด์ในเลือดเป็นตัวชี้วัดที่บ่งบอกภาวะออกซิเดชันของไขมันซึ่งจะพบมากขึ้นเมื่ออัตราการกรองของไตลดลงและสัมพันธ์กับของเสียที่ตั้งในเลือด ในร่างกายคนเรามีการสร้างเอนไซม์เพื่อต้านอนุมูลอิสระและปรับสมดุลของอนุมูลอิสระในร่างกาย เช่น คาตาเลส กลูธาไธโอนเปอร์ออกซิเดส ซุปเปอร์ออกไซด์ดิสมิวเตส และพาราออกโซเนส ภาวะทุพโภชนาการอาจเกิดขึ้นได้ในผู้ป่วยโรคไตเรื้อรังระยะที่ 3 – 5 เนื่องจากผู้ป่วยไตเรื้อรังระยะนี้มีภาวะเครียดออกซิเดชันมากกว่าคนปกติ จึงอาจทำให้มีการใช้สารต้านอนุมูลอิสระในร่างกาย เช่น วิตามิน เอ วิตามิน ซี กลูธาไธโอน เปอร์ออกซิเดส และเอนไซม์คาตาเลส หรือซุปเปอร์ออกไซด์ดิสมิวเตสมากกว่าปกติ

ดังนั้น อาหารที่ผู้ป่วยโรคไตเรื้อรังระยะก่อนล้างไตบริโภคจึงมีความสำคัญมากในการเพิ่มสารต้านอนุมูลอิสระให้เพียงพอกับที่ร่างกายต้องการเพื่อรักษาสมดุลในร่างกายไว้ อย่างไรก็ตาม ปัจจุบันยังมีข้อมูลไม่เพียงพอในการประมาณความต้องการปริมาณสารต้านอนุมูลอิสระในร่างกายของผู้ป่วยไตเรื้อรังระยะก่อนล้างไตและการประเมินภาวะโภชนาการจากอาหารที่ผู้ป่วยโรคไตเรื้อรังบริโภคในปัจจุบัน ยังไม่มีการประเมินสารอาหารที่เป็นแหล่งของสารต้านอนุมูลอิสระและหาความสัมพันธ์กับภาวะเครียดออกซิเดชันและสภาวะต้านอนุมูลอิสระในร่างกายเพื่อนำไปสู่การลดภาวะนี้โดยการปรับอาหารที่บริโภคให้สามารถลดตัวบ่งชี้ภาวะออกซิเดชันและตัวบ่งชี้การต้านอนุมูลอิสระได้

วัตถุประสงค์ของการศึกษา

วัตถุประสงค์หลักจากการศึกษาในครั้งนี้คือ ศึกษาและเปรียบเทียบระดับมาโลนไดอัลดีไฮด์ในเลือดซึ่งเป็นสารบ่งชี้ภาวะออกซิเดชัน สารบ่งชี้สภาวะการต้านอนุมูลอิสระโดยรวม และสารบ่งชี้การต้านอนุมูลอิสระ (กลูธาไธโอนเปอร์ออกซิเดส และพาราออกโซเนส) และประเมินการบริโภคสารต้านอนุมูลอิสระจากอาหารในผู้ป่วยโรคไตเรื้อรังระยะก่อนล้างไตและคนสุขภาพดี จำนวนผู้เข้าร่วมในโครงการวิจัย คือ 48 คน

วิธีการที่เกี่ยวข้องกับการวิจัย

หลังจากแพทย์ได้คัดกรองว่าท่านมีคุณสมบัติที่เหมาะสมที่จะเข้าร่วมในการวิจัยและท่านให้ความยินยอมที่จะเข้าร่วมในโครงการวิจัยนี้ ท่านจะได้รับเชิญให้มาพบผู้วิจัยเพื่อตามวันเวลาที่ผู้วิจัยนัดหมาย คือ วันที่ .....เดือน ..... พ.ศ.....เวลา ..... น. เพื่อให้สัมภาษณ์และประเมินความถี่ในการบริโภคอาหารในช่วง 3 เดือนที่ผ่านการศึกษานี้จะทำการเจาะเลือดเพียงครั้งเดียวซึ่งเป็นวันเดียวกับที่แพทย์ผู้ให้การรักษามีการสั่งเจาะเลือดเพื่อตรวจติดตามการรักษาอยู่แล้ว โดยท่านต้องงดอาหารก่อนมาเจาะเลือด ทั้งนี้ผู้วิจัยจะขอตรวจเลือดเพิ่ม ปริมาตร 8 มิลลิลิตร (1.6 ช้อนชา) เพื่อตรวจวิเคราะห์ตัวบ่งชี้ภาวะออกซิเดชัน ได้แก่ สารมาโลนไดอัลดีไฮด์ สารบ่งชี้สภาวะการต้านอนุมูลอิสระโดยรวม และสารบ่งชี้การต้านอนุมูลอิสระ (กลูธาไธโอนเปอร์ออกซิเดส และพาราออกโซเนส) ซึ่งมีผลต่อการเสื่อมของไต

ความรับผิดชอบของอาสาสมัครผู้เข้าร่วมในโครงการวิจัย

เพื่อให้งานวิจัยนี้ประสบความสำเร็จ ผู้ทำวิจัยใคร่ขอความความร่วมมือจากท่าน โดยจะขอให้ท่านปฏิบัติตามคำแนะนำของผู้ทำวิจัยอย่างเคร่งครัด รวมทั้งแจ้งอาการผิดปกติต่าง ๆ ที่เกิดขึ้นกับท่านระหว่างที่ท่านเข้าร่วมในโครงการวิจัยให้ผู้ทำวิจัยได้รับทราบ

เพื่อความปลอดภัย ท่านไม่ควรใช้วัคซีนหรือรับประทานยา สมุนไพร หรือผลิตภัณฑ์เสริมอาหารอื่น จากการซื้อยาโดยแพทย์อื่นหรือซื้อยาจากร้านขายยา หรือซื้อสมุนไพรและผลิตภัณฑ์เสริมอาหารรับประทานเอง ขอให้ท่านปรึกษาผู้ทำวิจัย ทั้งนี้เนื่องจากวัคซีน ยา สมุนไพรหรือผลิตภัณฑ์เสริมอาหารดังกล่าวอาจมีผลต่อการทำงานของไต ดังนั้นขอให้ท่านแจ้งผู้ทำวิจัยเกี่ยวกับยา สมุนไพรหรือผลิตภัณฑ์เสริมอาหารที่ท่านได้รับในระหว่างที่ท่านอยู่ในโครงการวิจัยด้วย

ความเสี่ยงที่อาจได้รับ

ในการเข้าร่วมโครงการวิจัยความเสี่ยงจากการรักษามีเล็กน้อยที่ไม่มากกว่าความเสี่ยงในชีวิตประจำวัน เช่น เสียเวลา สูญเสียรายได้เมื่อมาพบตามที่นัดหมาย (วันเดียวกับที่แพทย์นัดหมาย) ไม่สะดวก เป็นต้น

กรุณาแจ้งผู้ทำวิจัยในกรณีที่พบอาการอื่น ๆ ร่วมด้วย และระหว่างที่อยู่ในโครงการวิจัย ถ้ามีการเปลี่ยนแปลงเกี่ยวกับสุขภาพของท่าน ขอให้ท่านรายงานให้ผู้ทำวิจัยทราบโดยเร็ว

ความเสี่ยงที่ได้รับจากการเจาะเลือด

ท่านมีโอกาสที่จะเกิดอาการเจ็บ เลือดออก ช้ำจากการเจาะเลือด และอาการบวมบริเวณที่เจาะเลือดหรือหน้ามืดได้ และโอกาสที่จะเกิดการติดเชื้อบริเวณที่เจาะเลือดพบได้น้อยมาก

การพบแพทย์นอกตารางนัดหมายในกรณีที่เกิดอาการข้างเคียง

หากมีอาการข้างเคียงใด ๆ เกิดขึ้นกับท่าน ขอให้ท่านรีบมาพบแพทย์ที่สถานพยาบาลทันที ถึงแม้ว่าจะอยู่นอกตารางการนัดหมาย เพื่อแพทย์และผู้วิจัยจะได้ประเมินอาการข้างเคียงของท่าน และให้การรักษาหรือคำแนะนำด้านการบริโภคอาหารที่เหมาะสมทันที หากอาการดังกล่าวเป็นผลจากการเข้าร่วมในโครงการวิจัย ท่านจะไม่เสียค่าใช้จ่าย

ประโยชน์ที่อาจได้รับ

ท่านจะไม่ได้รับประโยชน์โดยตรงใดๆ จากการเข้าร่วมในการวิจัยนี้ แต่ผลของการศึกษาวิจัยในครั้งนี้จะได้ทราบภาวะโภชนาการและภาวะสมดุลของการต้านอนุมูลอิสระในร่างกายของท่าน ผลการศึกษาที่ได้จะมีประโยชน์อย่างยิ่งในการนำไปพัฒนารูปแบบการให้คำแนะนำด้านโภชนบำบัดแก่ผู้ป่วยโรคไตเรื้อรังระยะต่างๆ ร่วมกับการรักษาของแพทย์ในอนาคต และนำไปเป็นข้อมูลในการพัฒนาอาหารที่เหมาะสมสำหรับผู้ป่วยโรคไตเรื้อรังในการลดอนุมูลอิสระเพื่อชะลอการเสื่อมของไตต่อไปในอนาคต

วิธีการและรูปแบบการรักษาอื่น ๆ ซึ่งมีอยู่สำหรับอาสาสมัคร

ท่านไม่จำเป็นต้องเข้าร่วมโครงการวิจัยนี้เพื่อประโยชน์ในการรักษาโรคที่ท่านเป็นอยู่ เนื่องจากมีแนวทางการรักษาอื่น ๆ หลายแบบสำหรับรักษาโรคของท่านได้ ดังนั้น จึงควรปรึกษาแนวทางการรักษาวิธีอื่นๆ กับแพทย์ผู้ให้การรักษาท่านก่อนตัดสินใจเข้าร่วมในการวิจัย

ข้อปฏิบัติของท่านขณะที่ร่วมในโครงการวิจัย

ขอให้ท่านปฏิบัติดังนี้

- ขอให้ท่านให้ข้อมูลทางการแพทย์ของท่านทั้งในอดีตและปัจจุบันแก่ผู้ทำวิจัยด้วยความสัตย์จริง
- ขอให้ท่านแจ้งให้ผู้ทำวิจัยทราบความผิดปกติที่เกิดขึ้นระหว่างที่ท่านร่วมในโครงการวิจัย
- ขอให้ท่านงดการใช้ยาอื่นนอกเหนือจากที่แพทย์ผู้ให้การรักษาจัดให้ รวมถึงการรักษาอื่น ๆ เช่น การรักษาด้วยสมุนไพร การซื้อยาจากร้านขายยา การรับประทานผลิตภัณฑ์เสริมอาหาร

- ขอให้ท่านแจ้งให้ผู้ทำวิจัยทราบทันที หากท่านได้รับยาอื่นนอกเหนือจากยาที่แพทย์ผู้ให้การรักษาใช้ในการศึกษาตลอดระยะเวลาที่ท่านอยู่ในโครงการวิจัย

อันตรายที่อาจเกิดขึ้นจากการเข้าร่วมในโครงการวิจัยและความรับผิดชอบของผู้ทำวิจัย/ผู้สนับสนุนการวิจัย

หากพบอันตรายที่เกิดขึ้นจากการวิจัย ท่านจะได้รับการรักษาอย่างเหมาะสมทันที และเมื่อท่านปฏิบัติตามคำแนะนำของทีมผู้ทำวิจัยแล้ว ผู้ทำวิจัย/ผู้สนับสนุนการวิจัยยินดีจะรับผิดชอบค่าใช้จ่ายในการรักษาพยาบาลของท่าน และการลงนามในเอกสารให้ความยินยอม ไม่ได้หมายความว่าท่านได้สละสิทธิ์ทางกฎหมายตามปกติที่ท่านพึงมี

ในกรณีที่ท่านได้รับอันตรายใด ๆ หรือต้องการข้อมูลเพิ่มเติมที่เกี่ยวข้องกับโครงการวิจัย ท่านสามารถติดต่อกับผู้ร่วมวิจัย คือ ผศ.ดร.ทิพยเนตร อริยปิติพันธ์ ได้ตลอด 24 ชั่วโมง

ค่าใช้จ่ายของท่านในการเข้าร่วมการวิจัย

ท่านจะได้รับการตรวจองค์ประกอบของร่างกายและการตรวจเลือดวิเคราะห์หาสารบ่งชี้ภาวะออกซิเดชันในเลือด ได้แก่ สารมาโลนไดอัลดีไฮด์ สารบ่งชี้สภาวะการต้านอนุมูลอิสระโดยรวม และสารบ่งชี้การต้านอนุมูลอิสระ (กลูธาไธโอนเปอร์ออกซิเดส และพาราออกโซเนส) โดยไม่ต้องเสียค่าใช้จ่ายเพิ่มเติม <u>โดยผู้วิจัยจะมีเงินชดเชยค่าเดินทางและค่าเสียเวลาให้ท่านทุกครั้งที่ท่านมาพบผู้วิจัยตามเวลาที่นัดหมาย</u>

การเข้าร่วมและการสิ้นสุดการเข้าร่วมโครงการวิจัย

การเข้าร่วมในโครงการวิจัยครั้งนี้เป็นไปโดยความสมัครใจ หากท่านไม่สมัครใจจะเข้าร่วมการศึกษาแล้ว ท่านสามารถถอนตัวได้ตลอดเวลา การขอถอนตัวออกจากโครงการวิจัยจะไม่มีผลต่อการดูแลรักษาโรคของท่านแต่อย่างใด

ผู้ทำวิจัยอาจถอนท่านออกจากการเข้าร่วมการวิจัย เพื่อเหตุผลด้านความปลอดภัยของท่าน หรือเมื่อผู้สนับสนุนการวิจัยยุติการดำเนินงานวิจัย หรือ ในกรณีดังต่อไปนี้

- ท่านไม่สามารถปฏิบัติตามคำแนะนำของผู้ทำวิจัย
- ท่านต้องได้รับการบำบัดทดแทนไต เช่น การล้างไตผ่านทางช่องท้อง การฟอกเลือด และการปลูกถ่ายไต
- ท่านตั้งครรภ์ระหว่างที่เข้าร่วมโครงการวิจัย

การปกป้องรักษาข้อมูลความลับของอาสาสมัคร

ข้อมูลที่อาจนำไปสู่การเปิดเผยตัวท่านจะได้รับการปกปิดและจะไม่เปิดเผยแก่สาธารณชน ในกรณีที่ผลการวิจัยได้รับการตีพิมพ์ ชื่อและที่อยู่ของท่านจะต้องได้รับการปกปิดอยู่เสมอ โดยจะใช้เฉพาะรหัสประจำโครงการวิจัยของท่าน

จากการลงนามยินยอมของท่าน ผู้ทำวิจัยและผู้สนับสนุนการวิจัยสามารถเข้าไปตรวจสอบบันทึกข้อมูลทางการแพทย์ของท่านได้แม้จะสิ้นสุดโครงการวิจัยแล้วก็ตาม หากท่านต้องการยกเลิกการให้สิทธิ์ดังกล่าว ท่านสามารถแจ้งหรือเขียนบันทึกขอยกเลิกการให้คำยินยอม โดยส่งไปที่ ผศ.ดร.ทิพยเนตร อริยปิติพันธ์ ที่อยู่ อาคารจุฬาพัฒน์ 3 ชั้น 1 ภาควิชาโภชนาการและการกำหนดอาหาร คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ถนนพระราม 1 แขวงวังใหม่ เขตปทุมวัน กทม. 10330

หากท่านขอยกเลิกการให้คำยินยอมหลังจากที่ท่านได้เข้าร่วมโครงการวิจัยแล้ว ข้อมูลส่วนตัวของท่านจะไม่ถูกบันทึกเพิ่มเติม อย่างไรก็ตามข้อมูลอื่น ๆ ของท่านอาจถูกนำมาใช้เพื่อประเมินผลการวิจัย และท่านจะไม่สามารถกลับมาเข้าร่วมในโครงการนี้ได้อีก ทั้งนี้เนื่องจากข้อมูลของท่านที่จำเป็นสำหรับใช้เพื่อการวิจัยไม่ได้ถูกบันทึก

จากการลงนามยินยอมของท่าน ผู้ทำวิจัยสามารถบอกรายละเอียดของท่านที่เกี่ยวกับการเข้าร่วมโครงการวิจัยนี้ให้แก่แพทย์ผู้รักษาท่านได้

การจัดการกับตัวอย่างชีวภาพที่เหลือ

ตัวอย่างชีวภาพที่ได้จากอาสาสมัคร ได้แก่ เลือดที่เหลือจากการวิจัย ผู้วิจัยขอเก็บตัวอย่างไว้เพื่องานวิจัยในอนาคต เป็นระยะเวลา 5 ปี โดยจะเก็บหลอดนำในช่องแช่เยือกแข็ง – 70°C ณ ห้องปฏิบัติการของภาควิชาโภชนาการและการกำหนดอาหาร คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย จนกว่าจะนำมาตรวจวิเคราะห์ ซึ่งมีเฉพาะผู้วิจัยและผู้ร่วมวิจัยสามารถเข้าถึงตัวอย่างได้เท่านั้น และก่อนทำวิจัยจะต้องเสนอโครงร่างให้คณะกรรมการจริยธรรมการวิจัยรับรองจึงจะดำเนินการ

สิทธิ์ของผู้เข้าร่วมในโครงการวิจัย

ในฐานะที่ท่านเป็นผู้เข้าร่วมในโครงการวิจัย ท่านจะมีสิทธิ์ดังต่อไปนี้

1. ท่านจะได้รับทราบถึงลักษณะและวัตถุประสงค์ของการวิจัยในครั้งนี้
2. ท่านจะได้รับการอธิบายเกี่ยวกับระเบียบวิธีการของการวิจัยทางการแพทย์
3. ท่านจะได้รับการอธิบายถึงความเสี่ยงและความไม่สบายที่จะได้รับจากการวิจัย
4. ท่านจะได้รับการอธิบายถึงประโยชน์ที่ท่านอาจจะได้รับจากการวิจัย
5. ท่านจะได้รับการเปิดเผยถึงทางเลือกในการรักษาด้วยวิธีอื่น ยา หรืออุปกรณ์ซึ่งมีผลดีต่อท่านรวมทั้งประโยชน์และความเสี่ยงที่ท่านอาจได้รับ
6. ท่านจะได้รับทราบแนวทางในการรักษา ในกรณีที่พบโรคแทรกซ้อนภายหลังการเข้าร่วมในโครงการวิจัย
7. ท่านจะมีโอกาสได้ซักถามเกี่ยวกับงานวิจัยหรือขั้นตอนต่างๆที่เกี่ยวข้องกับงานวิจัย
8. ท่านจะได้รับทราบว่าการยินยอมเข้าร่วมในโครงการวิจัยนี้ ท่านสามารถขอถอนตัวจากโครงการเมื่อไรก็ได้ โดยผู้เข้าร่วมในโครงการวิจัยสามารถขอถอนตัวจากโครงการ โดยไม่ได้รับผลกระทบใด ๆ ทั้งสิ้น
9. ท่านจะได้รับเอกสารข้อมูลคำอธิบายสำหรับผู้เข้าร่วมในโครงการวิจัยและสำเนาเอกสารใบยินยอมที่มีทั้งลายเซ็นและวันที่
10. ท่านมีสิทธิ์ในการตัดสินใจว่าจะเข้าร่วมในโครงการวิจัยหรือไม่ก็ได้ โดยปราศจากการใช้อิทธิพลบังคับข่มขู่หรือการหลอกลวง

หากท่านไม่ได้รับการชดเชยอันควรต่อการบาดเจ็บหรือเจ็บป่วยที่เกิดขึ้นโดยตรงจากการวิจัย หรือท่านไม่ได้รับการปฏิบัติตามที่ปรากฏในเอกสารข้อมูลคำอธิบายสำหรับผู้เข้าร่วมในการวิจัย ท่านสามารถร้องเรียนได้ที่ คณะกรรมการจริยธรรมการวิจัย คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ตึกอานันทมหิดลชั้น 3 โรงพยาบาลจุฬาลงกรณ์ ถนนพระราม 4 เขตปทุมวัน กรุงเทพฯ 10330 โทร 0-2256-4493 ต่อ 14, 15 ในเวลาราชการ

ขอขอบคุณในการร่วมมือของท่านมา ณ ที่นี้

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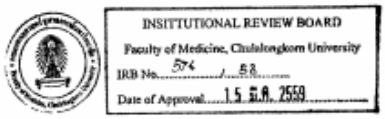
INSTITUTIONAL REVIEW BOARD
Faculty of Medicine, Chulalongkorn University
IRB No. 576/58
Date of Approval 15 มี.ค. 2559

ประกาศรับอาสาสมัครเข้าร่วมโครงการวิจัย

หากท่านสนใจจะเป็นส่วนหนึ่งของการพัฒนาคุณภาพชีวิตของผู้ป่วยโรคไตเรื้อรัง และมีคุณสมบัติต่อไปนี้

คุณสมบัติเบื้องต้นของอาสาสมัคร

- เพศชาย หรือ เพศหญิง อายุมากกว่า 18 ปี
- ได้รับการวินิจฉัยว่าเป็นโรคไตเรื้อรัง
- ไม่บริโภคผลิตภัณฑ์เสริมอาหาร วิตามิน หรือสมุนไพรทุกชนิด ในช่วง 1 เดือนที่ผ่านมา
- ไม่มีภาวะการอักเสบ แผลติดเชื้อ หรือกินยาต้านการอักเสบใน 1 สัปดาห์ที่ผ่านมา
- สามารถให้ความร่วมมือในการจดบันทึกอาหารที่บริโภคได้
- ยินยอมให้เจาะเลือดเพื่อโครงการนี้



ท่านที่สนใจเข้าร่วมโครงการ สามารถสอบถามรายละเอียดเพิ่มเติมได้ที่

นางสาวจีรนิจ ปองทอง (ผู้ประสานงานรับอาสาสมัคร) และนางสาวแสน ย้อง ทิ บุย

อาคารจุฬาพัฒน์ 3 ภาควิชาโภชนาการและการกำหนดอาหาร คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

โทรศัพท์มือถือ: 085-1078821 line ID: jingjojee

E-mail address: jingjo_jee@hotmail.com, hoanglan1010@gmail.com

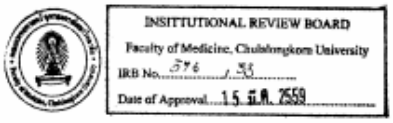
โครงการวิจัยเรื่อง การพัฒนารูปแบบการให้โภชนบำบัดเพื่อปรับปรุงพฤติกรรมการบริโภคอาหารและบรรเทาภาวะอักเสบในผู้ป่วยนอกโรคไตวายเรื้อรัง SD-CL-02 Version 2.0 30January20

ประกาศรับอาสาสมัครสุขภาพดีเข้าร่วมโครงการวิจัย

หากท่านสนใจจะเป็นส่วนหนึ่งของการพัฒนาคุณภาพชีวิตของผู้ป่วยโรคไตเรื้อรัง และมีคุณสมบัติต่อไปนี้

คุณสมบัติเบื้องต้นของอาสาสมัครสุขภาพดี

- เพศชาย หรือ เพศหญิง อายุมากกว่า 18 ปี
- สุขภาพดี ไม่มีโรคประจำตัว
- ไม่บริโภคผลิตภัณฑ์เสริมอาหาร วิตามิน หรือสมุนไพรทุกชนิด ในช่วง 1 เดือนที่ผ่านมา
- ไม่มีภาวะการอักเสบ แผลติดเชื้อ หรือกินยาต้านการอักเสบใน 1 สัปดาห์ที่ผ่านมา
- สามารถให้ความร่วมมือในการจดบันทึกอาหารที่บริโภคได้
- ยินยอมให้เจาะเลือดเพื่อโครงการนี้



ท่านที่สนใจเข้าร่วมโครงการ สามารถสอบถามรายละเอียดเพิ่มเติมได้ที่

นางสาวจีรนิจ ปองทอง (ผู้ประสานงานรับอาสาสมัคร) และนางสาวแสน ย้อง ทิ บุย

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VITA

Miss Thi Hoang Lan Bui was born on 10th October 1988 in Binh Dinh, Vietnam. She graduated with Bachelor degree of Public Health at Ho Chi Minh City University of Medical and Pharmacy in 2010. Then, she has worked at Department of Nutrition and Food at Ho Chi Minh City University of Medical and Pharmacy in Vietnam. In 2013 she pursued her Master of Science Degree in Food and Nutrition (major Applied Food and Nutrition) at Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Chulalongkorn University, Thailand. After graduation, she will return to her hometown and continue her job as a lecturer at Department of Nutrition and Food at Ho Chi Minh City University of Medical and Pharmacy in Vietnam.