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Early detection of the risk of chronic kidney disease based on eating and drinking behaviors in Kendari City Indonesia

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Key words: early detection, chronic kidney disease, drink, calorie.

Abstract

The main purpose of this study is to analyze eating and drinking behavior that can be used for early detection of chronic kidney disease in Kendari City, Southeast Sulawesi. The research question is How do eating behavior and drinking water consumption affect protein urine, creatinine, and health status? This quantitative research used a cross-sectional study approach and recruited 136 respondents in Kendari City, Southeast Sulawesi, Indonesia from June to August 2023. The sampling technique is by accidental sampling technique. Eating behavior in calories and drinking water consumption are independent variables. Creatinine, protein urine levels, and health status are dependent variables. Data analysis using the chi-square, Kruskal Wallis H, linear regression, and ordinal regression of statistical tests. The daily drinking water consumption of less than 666 ml a day had a significant effect on protein urine levels by 19.6% and health status by 32.2%. However, it did not significantly affect urine creatinine levels. Total daily caloric intake did not significantly affect urine creatinine levels and protein urine, but it has a significant effect on health status by 8.2% especially total calorie intake which is less than 699 calories a day. Drinking water consumption of less than 666 ml a day and intake of calories less than 699 calories can be used as a basis for early detection of people at risk of developing chronic kidney disease.

Introduction

Early detection of chronic kidney disease (CKD) is defined as an effort to recognize the symptoms of chronic kidney disease through screening and education.[1] The early detection of high-risk people with CKD is important. This is because the kidney processes blood to excrete wastes and extra water and concert into the urine.[2] Then the urine produced by the kidney is carried by the ureter to the bladder outside. Furthermore, healthy, functioning kidneys are important because they eliminate waste products, drugs, and toxins from the blood. They regulate electrolyte concentrations, the amount of fluid within the body, and blood pressure. Also, they help maintain acid-base balance and produce hormones that affect blood and bones.

Disruption of the Glomerular Structure Leads to Nephrotic Syndrome. Nephrotic syndrome is caused by failure of the filtration barrier in Nephrotic syndrome.[3] Signs and Symptoms of Nephrotic Syndrome Chronic Kidney Disease such as edema, proteinuria, hypoalbuminemia, hyperlipidemia, and lapidia. The CKD patient needs to be treated including hemodialysis. The hemodialysis treatment must be done 2 times a week until recovery or for the rest of life. Therefore, the CKD patient will lose their time, money, and psychological stress or die.

This chronic kidney disease is a "silent killer" that occurs due to hypertension or diabetes mellitus which is not treated properly.[4] The prevalence of chronic kidney disease in Indonesia appears to be very small compared to hypertension and diabetes mellitus, but the trend is increasing in Indonesia, including in Kendari City. In 2018, the prevalence of CKD was 0.38%. This prevalence increased compared to 0.2% in 2013.[5,6] Compared to hypertension and DM, the prevalence of those diseases was 34.1% of hypertension and 1.5% of DM in Indonesia in 2018.[6] Hypertension and DM are the biggest risk factors for chronic kidney disease, if you do not take regular treatment, and unhealthy eating and drinking behavior. Thus, chronic kidney disease is called the iceberg phenomenon. There are 34% of provinces in Indonesia that are above the national prevalence in 2018 (0.38%), including the Sulawesi Island region. The impact of the high Prevalence of Chronic Kidney Disease includes the cost of treatment such as hemodialysis which is very expensive. Furthermore, the Indonesian government, including the Kendari city government must cover CKD patients' Health Insurance. The individuals and the families also must pay for transportation, food, and accommodation during hemodialysis treatment. The mortality rate will also be high in Kendari City.

Therefore, it is important to carry out prevention, namely starting with early detection of risk groups, such as those who have unhealthy habits in eating and drinking. However, whether eating and drinking behavior can be used as a sign of chronic kidney disease or not is still questionable. Several studies have found early signs for early detection of chronic kidney disease only through chemical aspects, namely through PT injury biomarkers including kidney injury molecule-1, neutrophil gelatinase-associated lipocalin, and liver fatty acid binding protein.[7] Early detection using signs that require laboratory tests will take quite a long time. As explained above, CKD sufferers are difficult to find in health centers in Kendari City, in particular. Therefore, this study will analyze daily eating and drinking behavior factors that are associated with the incidence of chronic kidney disease. As reported in several studies eating and drinking behavioral factors greatly influence human health. However, whether eating and drinking behavior can be used as a sign in implementing early detection for chronic kidney sufferers is still questionable. That is why, this

research made discoveries regarding the early detection of chronic kidney disease through identifying calorie intake and drinking water a day.

Materials and Methods

Study area

The research was carried out In Kendari City, Southeast Sulawesi Province Indonesia. Data collection was taken in 5 Health Centers and 3 Hospitals from June to August 2023. The five health centers include Lepo-Lepo, Mata, Abeli, and Kandai Health Centres. The 3 hospitals include Bahteramas, Santa Anna, and Kendari City Hospitals. The selection of research locations was based on geographical representation in the Kendari City area, namely the coast, city, and hills.

Study design

This quantitative research used a cross-sectional study design. The target population is healthy people, single-disease, multiple diseases, and acute/chronic kidney patients. Sample selection used an accidental sampling technique with inclusion criteria, namely aged between 17-65 years, willing to be a respondent, and able to communicate well. The sample size was 136 people. Dependent variables include urine protein levels, creatinine, and health status. Health status includes healthy groups, single disease, multiple diseases, and acute/chronic kidney patients. Independent variables include water consumption in milliliters per day and calorie intake in calories per day.

Data collection

There are three techniques for collecting data, namely interviews with questionnaires, health checks including blood pressure tests, and taking urine samples from respondents. The questionnaire includes data on eating patterns with 24-hour recall, daily drinking water consumption, and health status. Determining health status using a blood pressure monitor, and the results of a doctor's examination or health records from the health service unit. Urine samples are used to measure protein and creatinine levels as parameters for kidney function and organ disorders.

Data analysis

Data was statistically analyzed with SPSS version 25.0 and used Kruskal-Wallis H and ordinal regression tests. The Kruskal-Wallis H test is used to see the difference in average ranking between the number of calories intake and the amount of drinking water consumed per day which is associated with urine protein levels, creatinine, and health status. Ordinal regression test to see the

influence of eating and drinking behavior on levels of proteinuria, creatinine, and health status of respondents.

Results

Respondents characteristic

The healthy group is dominated by the age group < 35 years (Table 1). The single disease and CKD groups are dominated by those aged 41-50 years. The Multiple Diseases group is dominated by the age group >60 years, but those aged 41-50 years are also almost the same. The Healthy, Multiple Disease, and CKD groups are dominated by "Senior High School of educational degree of the subjects. The Single disease group is dominated by "Bachelors". The healthy, single-disease, multiple diseases and CKD groups were predominantly unemployed. Quite a lot of civil servants suffer from CKD.

The effect of drinking water on chronic kidney disease

Drinking water consumption is stated to have a significant effect on urine protein levels and health status (Figure 1). However, drinking water consumption did not affect the subject's creatinine levels. The contribution of drinking water consumption per day to protein urine levels is 19.6%. The contribution of drinking water consumption per day to the subject's health status was the greatest compared to protein urine and creatinine, namely 32.2%. Meanwhile, the contribution to creatinine levels is only 1%. The highest average creatinine level for subjects whose drinking water consumption was good was between 1333-2000 million liters per day. Meanwhile, the highest urea protein levels were in subjects whose drinking water consumption was less than <666 million liters per day. Meanwhile, if we look at health status, the highest ranking is drinking water consumption of less than <666 million liters per liver.

Healthy subjects drink mostly water per day, namely between 1333-2000 ml or good (Figure 2). Subjects with a single disease mostly consumed more than > 2001 ml of drinking water per day. Likewise, for subjects with multiple diseases, the consumption of drinking water per day can be said to be good, namely between 1333-2000 mL. Meanwhile, for chronic kidney sufferers, drinking water consumption is mostly less than <666 million liters per day.

The effect of daily calorie intake on chronic kidney disease

Subjects whose creatinine levels are very high are dominated by subjects whose calorie intake is more than > 2101 calories per day (Figure 3). Meanwhile, subjects with high protein urine levels

were dominated by subjects whose calorie intake was less than <699 calories per day. Meanwhile, if we look at the health status of the majority, the calorie intake is less than <699 calories per day, which is the same as the proteinuria variable. Daily calorie intake did not have a significant effect on the subjects' urine creatinine levels or proteinuria levels. The influence of daily calorie intake only contributed 2.6% to urine creatinine levels and 6.1% to the subject's proteinuria levels. However, calorie intake has a significant effect on the subject's health status. Subjects who were healthy and single disease mostly had a calorie intake of more than >2101 cal. a day. Meanwhile, subjects with multiple diseases and CKD, mostly ate with a calorie intake of less than <699 Cal a day.

Early detection of chronic kidney disease related to eating and drinking behaviors

The behavioral parameters of daily water consumption can be used as parameters for early detection of chronic kidney disease either through urine sample tests with urine protein parameters, and also by looking at the subject's health condition (Figure 4). The proteinuria parameter is effective for looking at the behavioral factors of water consumption, compared with eating patterns (calorie intake) per day. Meanwhile, daily calorie intake can only be used by looking at its relationship with the individual's health status.

Discussion

Early detection of chronic kidney disease through drinking water behavior

Individuals whose drinking water consumption is less than <666 ml per day have triggered high levels of proteinuria. High levels of proteinuria indicate that kidney function has been impaired.[8,9] High levels of proteinuria cause individuals to experience mineral deficiencies including iron, calcium, zinc, and copper, and disrupt the body's metabolic function.[10-12] Lack of drinking water consumption in the body causes the distribution of the main nutrients to the body's organs to be delayed, due to the lack of water that carries the blood.[13] Blood performance is very important in distributing nutrients to the body's organs, including the kidneys. Ultimately, this condition results in a buildup of substances in the body. Besides that, with a lack of fluids, the body also experiences dehydration, and inhibits circulation in the body.[13,14] Mild dehydration only results in fatigue. However, if the body is severely dehydrated, damage to the kidneys will occur due to the buildup of waste and acid.[15] Ultimately there is an increase in muscle protein or myoglobin. Therefore, for someone who is undergoing mandatory fasting in the month of Ramadan, it is recommended to rehydrate by drinking enough water at dawn and breaking the fast.[16] In addition, individuals who

fast are advised to stop taking medications, including non-steroidal anti-inflammatory drugs, for people with gouty arthritis because the work of the kidneys will increase.[16]

The initial symptoms that are a sign of a lack of fluid in the body are abnormalities in the body, such as hypertension, urinary tract disorders, and the formation of kidney stones.[17,18] The need for drinking water is not the same for all individuals, because it depends on age, physical activity, climate, and the individual's health status.[19] That is why chronic kidney sufferers on hemodialysis are recommended to consume little drinking water or fluids.[20] However, healthy individuals are advised to drink approximately 2 liters of water a day or according to their needs. In this study, the proportion of chronic kidney sufferers on hemodialysis was quite large, so their drinking water consumption could be said to be very little. Meanwhile, healthy individuals, individuals with single and multiple diseases consume more drinking water than chronic kidney sufferers on hemodialysis. Remember that fluid needs are replaced when carrying out hemodialysis treatment.

The explanation above shows that early detection of the course of chronic kidney disease can be learned from the behavior of drinking water. The measurement that can be used for early detection of water-drinking behavior is less than 666 mL per day. This size, when converted to mineral water bottles on the market, is approximately the same as 1 medium bottle of mineral water. Usually, the size of 1 medium bottle of mineral water on the market only contains 600 mL. Thus, 666 ml per day can be said to be the same when the behavior of consuming drinking water is less than 1.1 medium-sized bottles a day. Medium bottle sizes on the market are the easiest conversion measure for early detection of drinking water consumption which is a risk for chronic kidney disease. Drinking water consumption of less than 666 mL per day has been proven to trigger high levels of proteinuria. Where high levels of proteinuria are a parameter of impaired kidney function. Individuals who experience impaired kidney function with early symptoms such as weight loss, decreased appetite, nausea, weakness, and nocturia.[1,21]

Early detection of chronic kidney disease through calorie intake

Individuals whose calorie intake is less than <699 calories per day have caused health problems leading to chronic kidney function disorders. Calories obtained from food that enters the body are converted into energy through the metabolic process.[22] This energy is then used to support the performance and function of various body organs, including the kidneys. Therefore, if the body experiences a calorie deficiency for a long time, the body experiences malnutrition.[23,24] Many studies have stated that malnutrition is the main cause of inhibiting kidney function and ultimately damage.[25] Chronic malnutrition which results in hypokalemia, hypovolemia is a risk factor for

chronic kidney disease.[26] Lack of calorie intake in the body has caused disturbances in the balance of cell metabolism and/or abnormalities in cytokine pathways, including the expression of IL-6, TNF-α, and TGF-β. Abnormalities in the cytokine pathway indicate changes in the tissue that greatly affect human kidney function. In this study, a tendency for high levels of proteinuria in subjects with low-calorie intake has been shown.

When a body experiences a lack of energy, immunological function will decrease and as a result, the body becomes vulnerable to infectious diseases. The relationship between the biological mechanisms of infection and nutritional deficiencies has been widely studied.[27,28] Where nutrition is an important modulator in the immune response and determines the risk and prognosis of human body disorders.[25] Body temperature decreases with limited calories in the body.[29-31] Limited calorie intake itself can affect sirtuin-1 which modulates adiponectin gene expression and nitric oxide bioavailability.[32]

The low-calorie intake of the subjects in this study was because of these individuals' reduced carbohydrate and protein intake in their daily diet menu. Many of them don't eat breakfast or dinner. The breakfast menu is not complete in terms of nutritional elements. Most of their breakfast only consists of snacks such as fried bananas, cakes, or bread. There are no vegetables and fruit on their breakfast menu. Individuals also limit their dinner, including those suffering from complications and chronic kidney disease. Rice is the main food in the daily diet of people in Kendari City. Meanwhile, the food ingredients for the side dishes are sea fish such as tuna and a few people eat freshwater fish such as tilapia. Local vegetables such as Moringa leaves are a favorite in his daily diet. However, fruit is rarely a complement to the daily menu of the subjects in this study.

Restrictions on eating at night are often done by subjects who already have multiple diseases or complications, as well as chronic kidney sufferers on hemodialysis. Food restrictions are known to cause metabolic disorders in the body, including chronic hypokalemia.[33] As stated by several researchers, hypokalemia is a risk factor for chronic kidney disease.[26] However, the degree to which food disturbance results in hypokalemia is determined by the individual's body condition as well.[33] Individual conditions that are declared vulnerable to chronic kidney disease include middle age, frequent exposure to outdoor heat, as well as people with diabetes mellitus and hypertension.[34,35]

Conclusions

This study has proven that drinking water consumption of less than 666 mL a day can be used as a basis for early detection of people at risk of developing chronic kidney disease without laboratory

tests. Consumption of less drinking water (<666 mL) and calorie intake of less than 699 calories can also interfere with individual health status.

Improving the quality of life for CKD patients is important to reduce morbidity and mortality, slow the progression of kidney disease, minimize uremic toxicity, as well prevent malnutrition. The principles of nutritional therapy are providing sufficient calories, high protein intake, and limiting sugar.[36] Strict restriction of sodium intake is important due to sodium sieving fluid loss through the peritoneal membrane. Another recommendation is health promotion for healthy community groups, and those with single illnesses, including people with hypertension and diabetes mellitus, to continue to improve their health. Furthermore, maintaining kidney health means drinking the amount of water and calorie intake according to individual needs is necessary.

Research implications

Early detection of chronic kidney disease is important to prevent the high prevalence of chronic kidney disease in the world. Where human life in the world has changed a lot and influenced their behavior, including drinking and eating behavior which has an impact on their health status. Under certain conditions, a person experiences a lack of fluid intake and calorie intake. For example, workers outside buildings in high heat cause their bodies to become dehydrated. Lack of fluids causes the kidneys to work hard in the process of removing toxins and waste produced by the body and as a result, the kidneys experience damage.[35] Likewise, women's performance must be maintained with a strict diet, including reducing their food intake. Lack of food or calorie intake causes the body to become malnourished and results in hypokalemia, or hypovolemia. These two events are risk factors for chronic kidney disease.[26]

Early detection through drinking and eating behavior is something that can be done directly. Many water measurements can be used as a basis for calculating daily water intake. For example, bottled water on the market, a medium bottle contains 1 liter of water and a large bottle contains 2 liters of water. When using glass measurements, usually 1 standard glass contains 200 mL of water. Thus, if you drink less than 1 medium bottle a day or drink less than 3 glasses, this could be a measure for early detection. Likewise with food portions, where 1 plate of rice converts to 700 calories.[37] If you only have 1 plate a day for a long time, you will experience malnutrition and metabolic system disorders and ultimately disrupt kidney function. Furthermore, not only the quantity, but the quality of water, including the mineral content in the water you drink, also affects kidney health. Several studies state that drinking from poor-quality water sources causes increased creatinine levels or

kidney damage.[38,39] Therefore, to maintain kidney health, it is necessary to drink enough water accompanied by a calorie intake that is adjusted to the body's needs.

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Table 1. Demographic and health status characteristics of the study subjects.

Demographic characteristics	Healthy	%	Single Diseases	%	Multiple Diseases	%	Chronic Kidney Diseases	%
Age (Years)	**16**	**11.8**	**40**	**29.4**	**27**	**19.9**	**53**	**39.0**
< 35	6	4.4	4	2.9	3	2.2	11	8.1
36-40	2	1.5	3	2.2	1	0.7	7	5.1
41-50	3	2.2	12	8.8	6	4.4	16	11.8
51-60	4	2.9	15	11.0	10	7.4	12	8.8
>60	1	0.7	6	4.4	7	5.1	7	5.1

Demographic characteristics	Healthy	%	Single Diseases	%	Multiple Diseases	%	Chronic Kidney Diseases	%
Education								
Not completed on primary school	0	0.0	2	1.5	0	0.0	1	0.7
Primary school	2	1.5	7	5.1	6	4.4	3	2.2
Yunior High school	2	1.5	4	2.9	5	3.7	7	5.1
Senior HS	5	3.7	10	7.4	11	8.1	20	14.7
diploma	1	0.7	0	0.0	0	0.0	3	2.2
Bachelor	4	2.9	13	9.6	5	3.7	17	12.5
Master	2	1.5	3	2.2	0	0.0	2	1.5
Doctor	0	0.0	1	0.7	0	0.0	0	0.0
Occupation								
No Job	9	6.6	20	14.7	17	12.5	22	16.2
Laborer	1	0.7	1	0.7	1	0.7	0	0.0
Farmer	0	0.0	0	0.0	1	0.7	4	2.9
Self-employed	0	0.0	5	3.7	1	0.7	7	5.1
Private/ BUMN	3	2.2	5	3.7	3	2.2	7	5.1
Civil Servants	3	2.2	9	6.6	4	2.9	13	9.6
Total	**16**	**11.8**	**40**	**29.4**	**27**	**19.9**	**53**	**39.0**
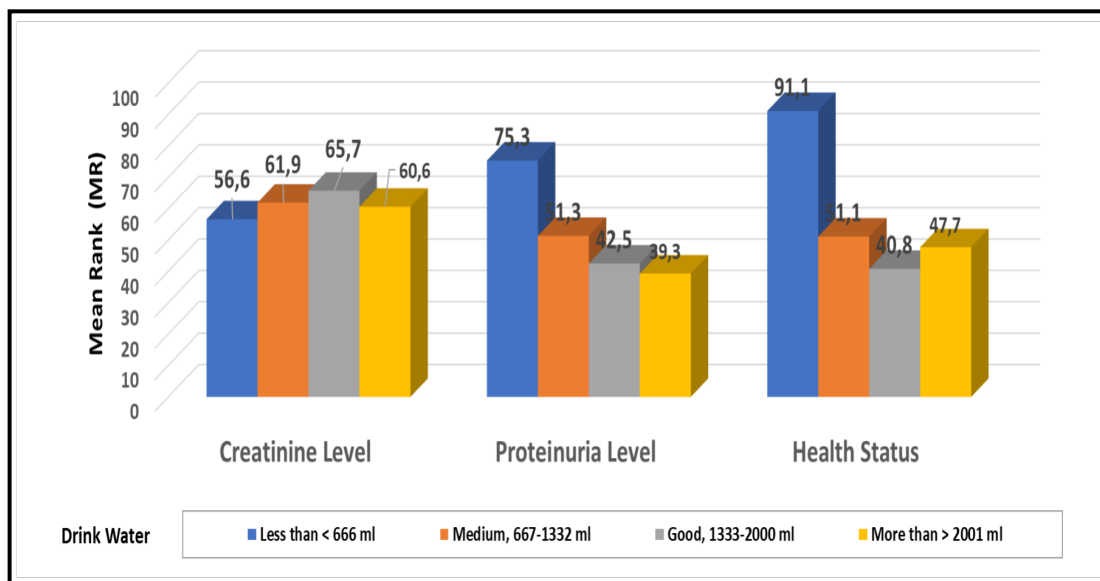
Note: Kruskal-Wallis H and Ordinal Regression tests

- Drink water – Proteinuria: $p < 0.0001$, R-Square= 0.196;

- Drink water – Health Status: $p < 0.0001$, R-Square= 0.322;

- Drink water – Creatinine Uria: $p=0.775$, R-Square = 0.010.

Figure 1. The effect of drinking water a day on creatinine levels, proteinuria and health status.
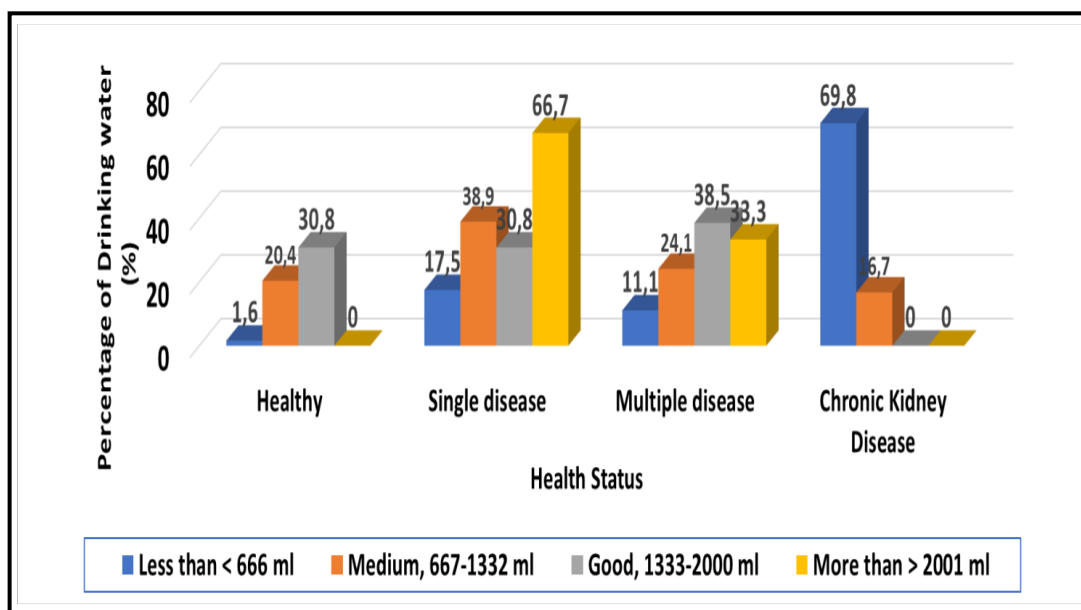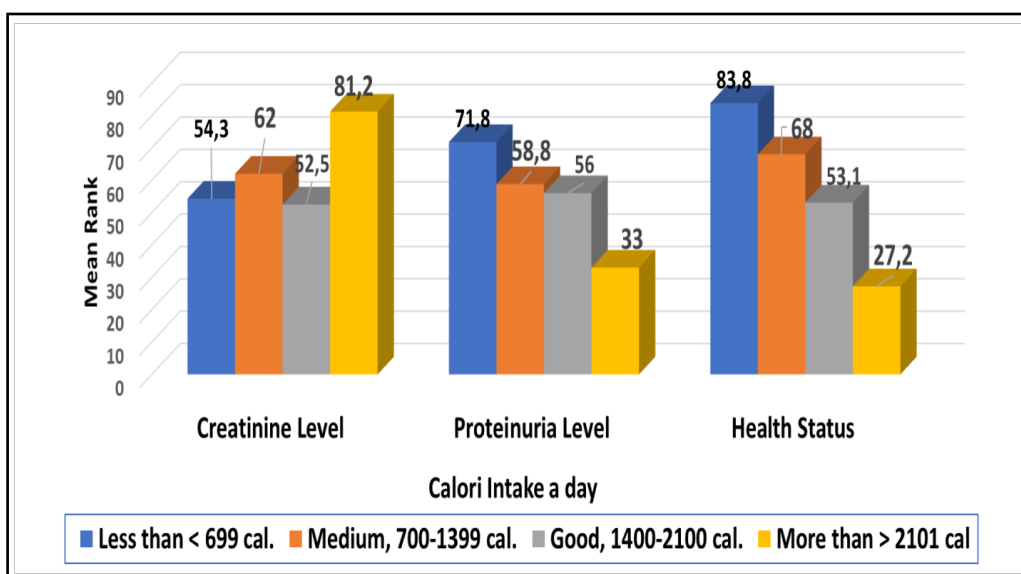
Figure 2. Drinking water consumption per day in different Health status.

Note: Kruskal-Wallis H and Ordinal Regression Tests:

Calori intake vs. Creatinine: $p = 0.404$, R-Square= 0.026;

Calori intake vs. Proteinuria: $p = 0.075$, R-Square= 0.061;

Calori intake vs. Health Status: $p < 0.05$, R-Square= 0.082.

Figure 3. The effect of calorie intake on Creatinine, Proteinuria and health status.
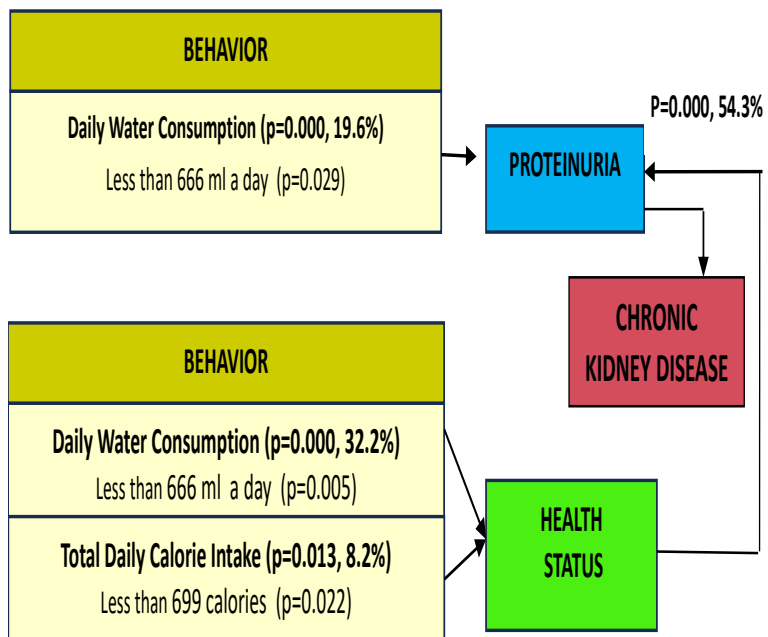
Figure 4. Early detection for chronic kidney disease with indicators of drinking water consumption behaviour and daily calorie intake.