Analysis of influencing factors in chronic kidney disease incidence in Indonesia

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Original Article

ABSTRACT

Background: The incidence of chronic kidney disease (CKD) continues to increase from year to year. There was an increase in CKD rates in the 2013 and 2018 basic health research or *Riset kesehatan dasar* (*Riskesdas*). Several provinces in Indonesia show a high incidence of CKD and require hemodialysis. As the incidence of CKD increases, it is important to investigate the influencing factors.

Objective: To identify the influencing factors of CKD incidence in Indonesia.

Methods: Data from 11 provinces with the highest incidence of CKD and hemodialysis were obtained from the Indonesian Ministry of Health through the *Riskesdas* 2018 survey. For comparison, the incidence of hemodialysis patients in 2020 at Immanuel Hospital Bandung was included in the investigation. All data were analysed using a Python software program, and a decision tree was determined. The results of the decision tree were analysed using Chi-square. Subject profiles were descriptively analysed for some *Riskesdas* 2018 data and medical records at Immanuel Hospital.

Results: The total data from *Riskesdas* was 130,787 subjects, among those, there were 610 people with CKD/hemodialysis, meanwhile data of 79 people with hemodialysis were obtained from Immanuel Hospital. The odds ratios of diabetes mellitus was 4.54 (p=0.000), hypertension was 3.00 (p=0.000), salty food was 2.26 (p=0.000), waist circumference (WC) was 1.35 (p=0.025), and body mass index (BMI) was 1.06 (p=0.605).

Conclusion: Diabetes, hypertension, salty foods, WC and BMI are the five most important factors influencing the incidence of CKD in Indonesia. These variables need to be managed properly to reduce the incidence of CKD.

Latar Belakang: *Angka kejadian penyakit ginjal kronik (PGK) terus meningkat dari tahun ke tahun. Terjadi peningkatan angka PGK pada Riskesdas tahun 2013 dan 2018. Beberapa provinsi di Indonesia menunjukkan angka kejadian PGK yang tinggi dan membutuhkan dialisis. Seiring meningkatnya insidensi PGK, penting untuk mengevaluasi faktor-faktor yang mempengaruhinya.*

Tujuan: *Mengidentifikasi faktor-faktor yang mempengaruhi kejadian PGK di Indonesia.*

Metode: *Data dari 11 provinsi dengan angka kejadian PGK dan dialisis tertinggi diperoleh dari Kementerian Kesehatan Republik Indonesia melalui survei Riskesdas 2018. Sebagai pembanding, data pasien dialisis pada tahun 2020 di RS Immanuel Bandung juga diikutsertakan dalam evaluasi. Semua data dianalisis menggunakan program perangkat lunak Python, dan pohon keputusan ditentukan. Hasil dari pohon keputusan dianalisis menggunakan Chi-square. Profil subjek dianalisis secara deskriptif untuk beberapa data Riskesdas dan rekam medis di Rumah Sakit Immanuel.*

Hasil*: Total data dari Riskesdas adalah 130,787 subjek, dari jumlah tersebut, terdapat 610 orang dengan PGK/dialisis, sedangkan data dari RS Immanuel Bandung adalah 79 orang dengan dialisis. Rasio odds diabetes*

mellitus adalah 4.54 (p=0.000), hipertensi 3.00 (p=0.000), makanan asin 2.26 (p=0.000), lingkar pinggang 1.35 (p=0.025), dan indeks massa tubuh 1.06 (p=0.605).

Kesimpulan: *Diabetes, hipertensi, makanan asin, lingkar pinggang, dan indeks massa tubuh merupakan lima faktor terpenting yang mempengaruhi kejadian PGK di Indonesia. Variabel-variabel tersebut perlu dikelola dengan baik untuk mengurangi kejadian PGK.*

INTRODUCTION

Chronic Kidney Disease represents a global health issue accompanied by substantial healthcare costs. The occurrence of CKD in Indonesia has demonstrated a rising trend yearly. As per the Basic health research or *Riskesdas* conducted by the Indonesian Ministry of Health in 2013, the average incidence of CKD stood at 2 per thousand. However, the latest *Riskesdas* data from 2018 indicates a near doubling of this rate to 3.8 per mile. The incidence in several Indonesian provinces significantly exceeds this average of 3.8 per mile. The six provinces bearing the highest burden of CKD are North Kalimantan, North Maluku, Southeast Sulawesi, Gorontalo, North Sulawesi, and West Nusa Tenggara. Often, CKD patients remain unaware of their disease status until it progresses to an advanced stage. The path that patients with advanced CKD, characterised by severe kidney damage, tend to follow leads to end-stage renal failure (ESRD), also known as terminal kidney failure. Under such circumstances, patients require hemodialysis treatment. The proportion of CKD patients with terminal kidney failure undergoing hemodialysis is considerably high, standing at 8.3%.[1,2]

Patients undergoing HD are typically those with severely compromised renal function, specifically at stage 5, with an estimated glomerular filtration rate (GFR) of less than 15. These patients exhibit a significantly higher mortality rate compared to the general population.[2] The six provinces in Indonesia with the highest prevalence of hemodialysis patients include DKI Jakarta, Bali, DI Yogyakarta, West Nusa Tenggara, Banten, and Bangka Belitung.[1]

Several factors may influence the development of CKD, including diabetes, hypertension, and central obesity. Other common causes of the majority of CKD are ageing, male gender, and lifestyle.[3] Health is closely related to living habits and eating patterns.[4] Lifestyles that can have a negative impact are less consumption of vegetables and fruit, the habit of drinking sugary drinks, excessive salt consumption, smoking, and lack of exercise.[5]

According to *Riskesdas* 2018, the smoking habit of the Indonesian people is increasing, while the consumption pattern of fruit and vegetables tends to decrease. Only 95% of Indonesia's population has sufficient consumption of fruits and vegetables.[1,6] Another thing that might affect people is a sedentary lifestyle due to busy work, resulting in a lack of time to exercise.[7]

The recent surge in the incidence of CKD in Indonesia may be attributable to the prevailing dietary habits and lifestyle choices within the society. Hence, it becomes imperative to investigate the fundamental causes of CKD and hemodialysis, with the objective of curtailing the disease's prevalence. This study aims to examine potential factors influencing the incidence of CKD, based on *Riskesdas* 2018.

METHODS
Study design

This study used a retrospective observational design. The prevalence of CKD patients in the 11 provinces in Indonesia with the highest CKD rates, as identified in the 2018 *Riskesdas* data, was compared with the same number of randomly selected healthy subjects. In addition, hemodialysis patient data from the 11 provinces mentioned before were compared with those in a selected city in Indonesia, specifically at Immanuel Bandung Hospital, covering the period from January to December 2020.

Data sources

The data for this study were sourced from the Labmandat database of the Indonesian Ministry of Health, specifically from the most recent *Riskesdas* 2018 data. Our study retrospectively registered data from six provinces with the highest incidence of CKD and six provinces with the highest incidence of hemodialysis in Indonesia. This resulted in a total of 11 provinces: North Kalimantan, North Maluku, North Sulawesi, Gorontalo, Central Sulawesi, West Nusa Tenggara, DKI Jakarta, Bali, DIY, Banten, and Bangka Belitung. The total number of provinces is 11, as West Nusa Tenggara Province is included in both categories. The study also compared data from

79 hemodialysis patients from a local hospital, Immanuel Bandung Hospital. The aim was to compare several main variables from national data, particularly those related to underlying diseases causing CKD. For data collection at Immanuel Hospital, a complete sampling method was employed. As a result, all medical records of CKD patients who underwent hemodialysis from January to December 2020 were utilised.

Variables

The independent variables in this study included age, urination disturbances, gender, diabetes, hypertension, systolic and diastolic measurements, consumption of sweet food and beverages, energy drinks, alcohol, salty food, fried food, preservatives, monosodium glutamate (MSG), soft drinks, instant food, fruits, vegetables, physical activity levels, stress and depression symptoms, height, weight, BMI and WC. The dependent variables were CKD and hemodialysis.

Specific cut-off points were established for the Chi-square test, each adhering to the guidelines applicable to the questions enlisted in the *Riskesdas* questionnaire. For instance, the cut-off for vegetable intake was set at 15 cups per week, reflecting the recommended fibre intake from consuming vegetables three times daily for five days. A limit of 90 cm was set for WC, in line with the Asia-Pacific obesity guidelines. Diabetes was determined based on whether the respondent had been medically diagnosed with diabetes mellitus. The diastolic and systolic limits were set at 90 mmHg and 140 mmHg, respectively, as per the JNC VIII guidelines. Hypertension was determined based on whether the respondent had been medically diagnosed with high blood pressure. The BMI was calculated using the formula weight/(height in m)^2, with a cut-off of 23 as per the Asia-Pacific obesity guidelines. The height limit was set at 160 cm, reflecting the average height of Indonesians. Consumption of salty food, fried food, and MSG were determined based on the respondent's answers to the questionnaire, specifically > 1 serving/day. Consumption of sweet drinks was also determined based on the respondent's answers to the questionnaire, specifically > 1 serving/day. Descriptive observations of the *Riskesdas* data revealed a high incidence of age, gender, BMI, WC (both male and female),

hypertension, diabetes, and smoking.

At Immanuel Hospital, the observed variables included the high incidence of age, gender, BMI, aetiology (hypertension, diabetes, smoking), education, payment methods, occupation, place of residence, and complications. As a large hospital with a significant number of hemodialysis patients, Immanuel Hospital served as a comparison to understand the influencing variables between the national data and data from one of Indonesia's major cities. However, only six data variables, namely age, gender, BMI, hypertension, diabetes, and smoking, were comparable.

Data analysis

The data from the 11 provinces were analysed using a decision tree from the random forests methodology in Python, utilising the scikit-learn machine learning library. Analysis based on entropy resulted in a tree depth of four stages, beyond which there was no significant change in entropy. The most influential variables were subsequently statistically analysed using a Chi-square test, adopting a case-control design and a confidence interval (CI) of 95%. For the Chi-square test, the data of CKD subjects were compared with an equal number of normal or non-CKD subjects, selected randomly. An odds ratio (OR) exceeding 1.00 was considered indicative of a positive influencing factor.

Ethical considerations

In accordance with the information provided by the Labmandat of the Indonesian Ministry of Health, written informed consent was obtained from all participants involved in this study. The trial was registered with the Labmandat Indonesian Ministry of Health under the registration ID IR.03.01/4/6932/2021 and the registry number 1365/FK-UKM/IX/2021. Furthermore, the study protocol implemented at Immanuel Hospital was reviewed and approved by the Ethical Review Board of Immanuel Hospital Bandung, with the approval number SK 28/A01/EC/VIII/2021.

RESULTS

The *Riskesdas* 2018 obtained data from 11 provinces comprising 130,787 entries, with 499 individuals identified as suffering from CKD and

an additional 111 CKD individuals undergoing hemodialysis therapy. This resulted in a total of 610 data entries for individuals with CKD or undergoing hemodialysis. The data from the six provinces with the highest CKD incidence, combined with those from the six provinces with the highest hemodialysis incidence, yielded 11 provinces in Indonesia. These provinces are presented in descending order of CKD and hemodialysis incidence percentages (Figure 1).
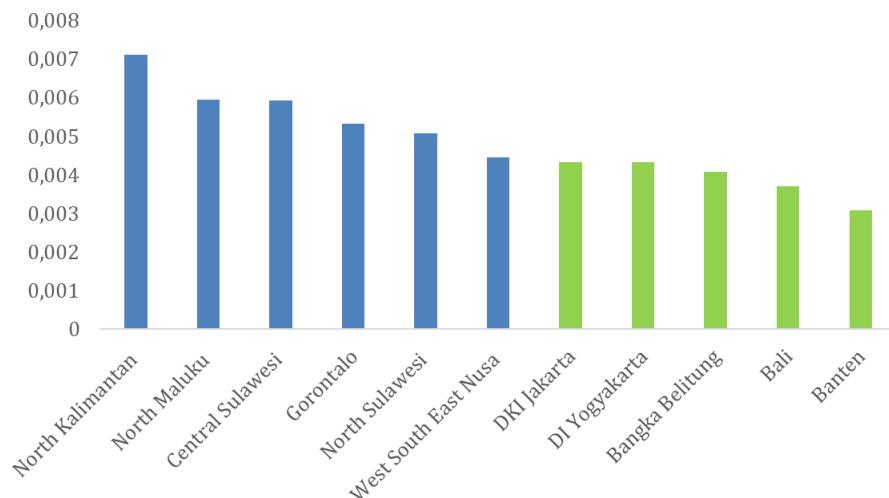

Figure 1. Percentage of CKD cases in 11 provinces (the highest case in Indonesia). The provinces with the highest CKD incidence (blue) and hemodialysis incidence (green).

The six provinces with the highest percentage of hemodialysis cases in Indonesia were DKI Jakarta, Bali, DI Yogyakarta, Banten, Bangka Belitung and West Nusa Tenggara. The percentages data of six provinces with the highest hemodialysis cases and six provinces with the highest CKD cases were obtained from 11 provinces in Indonesia. Percentages of the number of hemodialysis sufferers from 11 provinces in Indonesia in order from the largest to the smallest percentage (Figure 2).
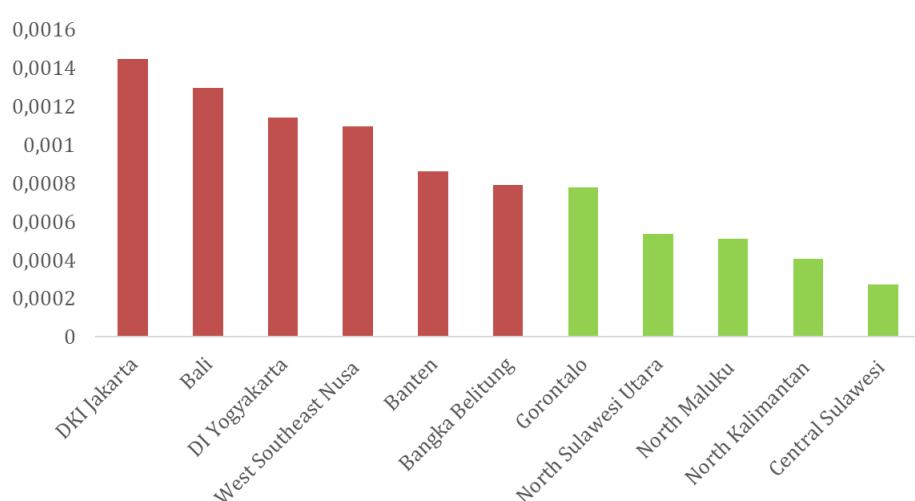

Figure 2. Percentage of hemodialysis cases in 11 provinces with the highest case in Indonesia. The province with highest hemodialysis incidence (red) and CKD incidence (green).

Upon inputting all 130,787 data entries into the Python software for entropy analysis via a decision tree, the analysis revealed ten factors that most significantly influenced the incidence of CKD/hemodialysis. These included diabetes, vegetable consumption, WC, diastolic and systolic blood pressure, hypertension, BMI, height, salty food consumption, and sweet drink intake.

Subsequently, a Chi-square test was conducted on a case-control design, with 610 CKD patients as the case subjects and a matched number of individuals from the general population as the control subjects. These control subjects were randomly selected from the complete *Riskesdas* data set, effectively undersampling the "normal" data.

The Chi-square statistical analysis revealed that only five variables significantly influenced the incidence of CKD, each demonstrating an OR greater than 1.00. These were diabetes, hypertension (both systolic and diastolic blood pressure), salty food intake, WC, and BMI (Table 1). Interestingly, while vegetable consumption demonstrated a statistically significant p-value ($p < 0.05$), its OR was less than 1.00. Conversely, BMI demonstrated a non-significant P-value ($P > 0.05$) but an OR greater than 1.00. Thus, the decision was made to consider only those variables with an OR greater than 1.00 as significant influencing factors.

Table 1. Data of CKD and non-CKD subjects with the interference variable factors

Variable	Parameters	CKD	Non-CKD	p-value	OR (95%CI)
Diabetes	Yes	85	21	0.000*	4.541[+] (1.021–2.005)
	No	525	589		
Vegetables	< 15 cups	462	535	0.000*	0.438 (-1.131– -0.522)
	> 15 cups	148	75		
Waist Circumference	> 90 cm	170	136	0.025*	1.347[+] (0.037–0.558)
	< 90 cm	440	474		
Diastolic	> 90 mmHg	172	153	0.219	1.173[+] (-0.095–0.414)
	< 90 mmHg	438	457		
Systolic	> 140 mmHg	229	158	0.000*	1.719[+] (0.298–0.786)
	< 140 mmHg	381	452		
Hypertension	Yes	194	82	0.000*	3.003[+] (0.811–1.388)
	No	416	528		
BMI	> 23	338	329	0.605	1.061[+] (-0.166–0.285)
	< 23	272	281		
Height	< 160 cm	406	393	0.434	1.099[+] (-0.142–0.330)
	> 160 cm	204	217		
Salty food	> 1 portion/day	222	123	0.000*	2.265[+] (0.560–1.075)
	< 1 portion/day	388	487		
Sweet drinks	> 1 portion/day	149	154	0.740	0.957 (-0.304–0.216)
	< 1 portion/day	461	456		

CKD: Chronic Kidney Disease, BMI: Body Mass Index, * for $p < 0.05$ and [+] for OR > 1.00

The comparison of age, gender, and BMI demonstrated that the majority of subjects were between the ages of 55-64, with males being more common than females. A high proportion of subjects were overweight (55.4% and 48.1%, respectively), and there were more subjects with hypertension than diabetes. The national rate of smoking was found to be higher than that at Immanuel Hospital (Table 2).

Based on Table 1, the OR for hypertension is 3.003, indicating that individuals with hypertension have three times the likelihood of developing CKD compared to those without hypertension. Descriptive analysis of the *Riskesdas* data revealed that out of the 610 CKD subjects, 201 individuals (32.9%) had hypertension (Table 2), a figure significantly higher than the number of subjects with diabetes, which stood at 85 individuals (13.9%). Similarly, descriptive data from Immanuel Hospital demonstrated that there were 45 CKD patients (57%) with hypertension, more than the 40 patients with diabetes (50.6%). However, the Chi-square test revealed that the OR for diabetes was greater than that for hypertension.

Table 2. Comparison of characteristics of 610 CKD or hemodialysis patient

Variable	Characteristics	Subject in 11 provinces n (%)	Subject in Immanuel Hospital n (%)
Age	Between 55–64 (15 to 90)	161(26.4)	26(32.9)
Gender	Male	316(51.8)	42(53.1)
	Female	294(48.2)	37(46.9)
BMI	> 23.00	338(55.4)	38(48.1)
WC Male	> 90 cm	87(27.5)	-
WC Female	> 80 cm	168(57.1)	-
Diabetes	Physician diagnosis	85(13.9)	40(50.6)
Hypertension	Systolic >140 mmHg	201(32.9)	45(57.0)
Smoking	> 1/day	234(38.4)	8(10.1)

CKD: Chronic Kidney Disease, BMI: Body Mass Index; WC: Waist Circumference; Data in 11 provinces in Indonesia and 79 hemodialysis patient data from Immanuel Hospital

DISCUSSION

It is widely recognised that diabetes plays a substantial role in the prevalence of CKD. The Centers for Disease Control and Prevention (CDC) states that diabetes mellitus is the primary cause of CKD. In fact, approximately one in three adults with diabetes also has CKD. Both type 1 and type 2 diabetes can lead to kidney disease. In the USA, diabetes and hypertension are the most common causes of CKD.[8] Our Chi-square case-control analysis further underscores the importance of diabetes in the onset of CKD. The OR was found to be 4.54, suggesting a significant influence of diabetes on the incidence of CKD. Diabetes induces a state of hyperglycaemia, which, if prolonged or chronic, can have detrimental effects on the kidneys. This condition, known as diabetic nephropathy, stimulates fibrosis and inflammation signalling pathways in the glomerulus and kidney tubules, resulting in kidney damage and decreased function.[9]

Hypertension is the second most significant factor in the development of CKD, with an OR of 3.00. This indicates that individuals with hypertension are three times more likely to develop CKD than those without hypertension. Although diabetes may pose a higher risk for CKD due to chronic hyperglycaemia causing more kidney damage than hypertension, the prevalence of hypertension in the general population is greater than that of diabetes. As recorded in the Indonesian renal registry, the most common cause of stage 5 CKD, based on etiological diagnosis in Indonesia, is hypertensive kidney disease (35%), followed by

diabetic nephropathy (29%).[10] Hypertension leads to an increase in intraglomerular pressure, which can subsequently cause structural and functional disorders in the glomerulus.[11] These two diseases, diabetes and hypertension, which are the primary causes of CKD, need to be properly managed from an early age to prevent the development of CKD.

In third place, the likelihood of causing CKD is linked to the consumption of salty food, with an OR of 2.27. It has been observed that salt intake tends to be high among individuals with CKD. Many CKD patients experience taste disorders, particularly for salty flavours, prompting an increase in salt intake. This, in turn, exacerbates the taste disorder and worsens the kidney condition. Manley and Haryono suggest that reducing salt intake could alleviate the heightened sensitivity to salty tastes. This taste disturbance is influenced by several factors, including salt intake, saliva, zinc status, and age.[15-17] The Chi-square test revealed a high salt intake OR of 2.27, indicating that individuals with high salt consumption are more than twice per day as likely to suffer from CKD compared to those with low salt consumption. According to the World Health Organization, one of the major risk factors for CKD is high salt intake. The recommended limit for salt intake for adults is 5 g of salt or less than 2 g of sodium per day.[17] It is suspected that since 2010, there has been an increase in daily salt intake from 9 g to 12 g, which is more than double the recommended daily intake. The average salt consumption of the Indonesian population is 3.5 g of sodium per day or 8.75 g of salt. The highest salt consumption was in the adult age

group of over 19 years, with an intake of 3.7 g/day or 9.25 g of salt per day, significantly exceeding the recommended limit.[18] The typical Indonesian diet often includes soy sauce, bottled chilli sauce and additional table salt, as well as preserved protein foods like salted fish or beef jerky. All of these foods contain high levels of sodium and contribute to the daily salt intake of the population. Limiting salt intake is crucial for both CKD patients and healthy individuals as a preventative measure against disease.

Age has been identified as a significant factor in taste disorders. As we age, the number and function of cells in our body, including taste cells or gustatory cells, decrease. This reduction typically begins in females in their 40s and males in their 50s. Alongside this, the remaining sense of taste also begins to atrophy, or shrink, and fails to function properly. Smoking has also been found to reduce the sense of taste.[19] Similar age-related changes occur in the kidneys. The normal range of GFR, a measure of kidney function, is 100 to 130 mL/min/1.73 m² in males and 90 to 120 mL/min/1.73 m² in females under 40. However, GFR progressively declines after the age of 40. The rate of GFR decline, which may be an inevitable part of normal ageing, usually begins after the age of 30-40 years and may increase after the age of 50-60.[20]

The highest age range in the *Riskesdas* 2018 was 55-64 years, accounting for 161 people (26.4%), while the data from Immanuel Hospital demonstrated 26 people (32.9%) in this age bracket, with an average patient age of 54.66. As individuals age, kidney function naturally declines, a process associated with a decrease in the GFR and a deterioration in tubular function for reabsorption.[21] Indeed, age is a significant, unchangeable factor contributing to CKD. However, through effective counselling and education, elderly patients can be encouraged to adopt healthier lifestyles. This includes adhering to a nutritious diet, ensuring salt consumption does not exceed recommended levels, and maintaining an active lifestyle.

In fourth place is systolic blood pressure. According to *Riskesdas* 2018, out of 610 CKD subjects, 201 people (32.9%) reported that they had been diagnosed with hypertension by doctors or medical personnel. All subjects had their first and second systolic and diastolic blood pressure measurements, with a third measurement rarely recorded. Upon analysis, it was found that systolic blood pressure significantly impacted the incidence of CKD, with an OR of 1.72. Individuals with a high trajectory of systolic blood pressure (ranging from 105 to 124 mmHg) were found to have higher rates of CKD compared to those with a stable trajectory. Therefore, even without reaching the threshold for hypertension, a sustained increase in systolic blood pressure significantly raises the risk of CKD.[22]

The BMI is considered a variable that may influence the incidence of CKD. However, according to the Chi-square test results, BMI did not significantly impact CKD, and the OR was not high (1.061). Despite this, out of 610 CKD subjects, there were 338 subjects (55.4%) with a high BMI, which is a considerable number. Data from Immanuel Hospital shows that there are 38 people (48.1%) in the obesity category (BMI > 23.0). Obesity carries a high risk of causing CKD. A high BMI contributes to the development of CKD, particularly in advanced stages.[23] Excessive body fat affects the kidneys; they must work harder to maximise their function, leading to changes in kidney haemodynamics.[24]

The WC is a crucial part of evaluating obesity and plays a significant role in the incidence of CKD, greatly influencing patient morbidity. In this study, WC demonstrated an OR of 1.35, suggesting that an increase in WC correlates with an increased likelihood of developing CKD. The WC is strongly associated with the amount of visceral fat in CKD patients. An increase in WC indicates the accumulation of adipose tissue in the abdominal area, leading to the release of pro-inflammatory cytokines that harm body organs. The relationship between WC and risk factors for CKD is comparable to that observed for cardiovascular disease, especially in males.[25] This could explain why the incidence of CKD is higher in males. The study found that in males, the number of individuals with WC greater than 90 cm was only 87 (27.5%), which is significantly less than the 168 females (57.1%) with WC greater than 80 cm. Unfortunately, WC data from Immanuel Hospital's medical records was unavailable for comparison. However, the incidence of CKD at Immanuel Hospital was higher in males. Obesity and a large WC must be properly managed through a healthy diet, balanced nutrition, regular exercise, or an active lifestyle.

The gender risk proportion at Immanuel Hospital shows that males (53.1%) have a higher risk of developing CKD than females (46.9%).[26] This is supported by *Riskesdas* 2018 data, which also reveals a higher number of male CKD patients (316 individuals, or 51.8%) compared to female CKD patients (294 individuals, or 48.2%). This differential can be attributed to lifestyle factors that are more prevalent in males, such as smoking and high-stress levels, which can put additional strain on the kidneys, causing them to work harder.

Another influential variable is smoking. CKD patients who smoke are likely to see their kidney function deteriorate. Inhaling cigarette smoke increases sympathetic activity, leading to the constriction of several blood vessels, including the coronary blood vessels. This results in an increase in renal peripheral resistance, which in turn leads to a decline in kidney function.[27] Many people, when facing problems, stress, or depression, resort to smoking or other unhealthy habits as a coping mechanism. The incidence of smoking, according to the 2018 *Riskesdas* data, has increased compared to the 2013 data. A concerning trend is the increasing number of female smokers in Indonesia (specific data not provided). Managing stress well is very important. They should consult a healthcare professional if they find it difficult to cope.

This study has some limitations. The most recent data available is from the *Riskesdas* 2018. The research is conducted every five years, and the latest *Riskesdas* 2023 have not yet been published. The CKD data obtained from the *Riskesdas* 2018 is quite limited, with much of it being incomplete, such as CKD stages, salt consumption limits, high blood pressure limits, and its stages. Despite these limitations, we aim to provide information on the variables that influence CKD in Indonesia, hoping that these findings will benefit the knowledge and health of the Indonesian population.

CONCLUSION

This study revealed that factors influencing CKD incidence in Indonesia were diabetes, hypertension, consumption of salty food, WC, and BMI. Other important variables that affect the incidence of CKD include age, vegetable consumption, gender, and smoking. To prevent CKD, these variables need to be effectively managed. Underlying conditions such as diabetes and hypertension should always be managed and monitored by healthcare professionals. Regular check-ups and adherence to prescribed medications are essential for controlling these conditions and mitigating the risk of developing CKD.

CONFLICT OF INTEREST

All of the authors stated that there was no conflict of interest.

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AUTHOR CONTRIBUTIONS

MH was responsible for the overall data collection and article preparation; FM: data collection at Immanuel Hospital, Bandung; SC: data collection at Immanuel Hospital, Bandung; SA: data analysis; JS: data analysis and Python software; RL: data compilation and article writing.

LIST OF ABBREVIATIONS

BMI: Body mass index CKD: Chronic kidney disease; LP; Lingkar pinggang, IMT: Indeks masa tubuh, DM: Diabetes melitus; ESRD: End stage renal disease; Riskesdas: Riset kesehatan dasar; WC: Waist circumference. GFR: Glomerular filtration rate, CDC: Centers for Disease Control and Prevention, Labmandat: Laboratory management data, PGK: Penyakit ginjal kronis, HD: Hemodialysis, MSG: Monosodium glutamate.

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