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Analysis of Serum Creatinine Levels, Blood Pressure and Grade of Hypertension of Chronic Disease Management Program Participants

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Abstract: Indonesia is one of the countries with the highest number of cases of hypertension in the world; the predominant patient is the elderly. In some patients with hypertension, increased blood pressure causes impaired salt and creatinine excretion, resulting in poor kidney function. A chronic disease management program is a health care system with a proactive-integrative approach to prevent further complications. The research objective is to analyze serum creatinine levels, blood pressure, and hypertension grade and determine the relationship between serum creatinine and blood pressure in chronic disease management program participants. The study subjects, 73 participants with hypertension, were obtained by purposive sampling. Patient data and hypertension grade were obtained from medical records; an auto chemistry analyzer analyzed serum creatinine. Data were analyzed using the Pearson correlation test using SPSS. Participants with hypertension fall into the elderly age (60-69 years), totalling 31 (42%); pre-elderly age (45–59 years) includes 28 (38%); and high-risk elderly age (>70 years) includes 14 (19%). Most of the participants (40 participants) fell into hypertension stage II, followed by hypertension stage I (25 participants), and only 8 participants fell into the elevated category. The mean serum creatinine of participants with Elevated blood pressure criteria was 0.89±0.178, Hypertension grade I 0.91±0.322, and hypertension grade II 0.99±0.269, illustrating a trend of increasing serum creatinine levels due to higher blood pressure criteria. Pearson correlation test shows a significant correlation between both systolic blood pressure with serum creatinine levels ($p<0.05$, $r=0.2$) and diastolic blood pressure with serum creatinine levels ($p=0.007$, $r=0.342$). There was a trend of increasing serum creatinine levels corresponding to the hypertension grade in participants. Blood pressure was significantly correlated with serum creatinine, clearly confirming that an increase in blood pressure may followed by an increase in serum creatinine.
Keywords: Creatinine levels; correlation; hypertension.

INTRODUCTION

Indonesia has the highest number of hypertension cases in the world. According to the 2018 National Basic Health Research (Riskesdas), the prevalence of hypertension was 34.1%, an increase from 27.8% in 2013. The majority of patients are elderly, with 45.32% in the 45-54 age group, 55.23% in the 55-64 age group, 63.22% in the 65-74 age group, and 69.53% in those over 75 years old (Kemenkes RI, 2018). Hypertension is when blood pressure rises above normal limits (systolic >140 mmHg & diastolic >90 mmHg). In hypertension, blood flow to the kidneys decreases due to vasoconstriction, where the blood vessels constrict, leading to kidney cell damage. Additionally, increased blood pressure can disrupt the excretion

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of salt and creatinine, potentially triggering kidney dysfunction (Rahayu & Indriyani, 2021). Clinical manifestations of kidney damage caused by hypertension can range from asymptomatic to end-stage renal disease. In the early stages of hypertension, renal blood flow decreases, but the average filtration rate entering the glomerulus is maintained. However, in some hypertensive patients, elevated blood pressure disrupts salt and creatinine excretion, impairing kidney function (Meti & Nurjanah, 2018). The effects of kidney damage due to hypertension range from asymptomatic stages to terminal kidney failure (Sulastomo et al., 2018). Multiple clinical trials and analyses have confirmed that vigorously managing high blood pressure in individuals with and without kidney disease decreases the chances of cardiovascular disease and death from any cause. Despite this, the effect of blood pressure reduction on kidney health is still debatable (Chang & Appel, 2018) (Duni et al., 2019).

The chronic disease management program is a healthcare service system with a proactive and integrative approach that involves participants, healthcare facilities, and social health insurance administration bodies to maintain the health of patients with chronic diseases (Ghufron Mukti, 2021). This program focuses on two chronic diseases, namely hypertension and type II diabetes mellitus. Its efforts to maintain and improve health and promote a healthy lifestyle include medical consultations, participants clubs, home visits, periodic general health check-ups, and other measures to prevent complications, followed continuously by each participant (Meiriana et al., 2019).

Several studies on the same population (Chronic disease management program participants) have been conducted, such as the study by Nuswantoro et al. (2022) at the Pontianak Health Laboratory Center on diabetic patients and hypertensive patients who were examined for serum urea and serum creatinine levels, this study showed that increased urea and creatinine levels were associated with the development of diabetes mellitus and hypertension. Not many other studies link serum urea or creatinine levels with hypertension, and more complete data are needed regarding this case, so this study aims to analyze the relationship between hypertension and serum creatinine levels in participants in the chronic disease management program at Primary Healthcare Facilities Bekasi.

MATERIALS AND METHODS

This research was conducted at Prodia Laboratory Harapan Indah, Bekasi, from March to July 2022. The study population consisted of hypertensive chronic disease management program participants who regularly underwent creatinine examinations. The sample collected using purposive sampling with inclusion criteria: hypertensive, were pre-elderly age (45–59 years), elderly age (56-69 years), high-risk elderly age (>70 years) and provided informed consent to participate in this study. Exclusion criteria: hypertensive participants with another chronic disease, namely chronic kidney disease (CKD), congestive heart failure (CHF), and diabetes mellitus (DM).

Blood pressure, hypertension status and demographic of participants were observed by medical staff upon routinely visiting control in Primary Healthcare Facilities Bekasi. These data were then well documented in medical records, while serum creatinine was examined in Prodia Laboratory Harapan Indah, Bekasi, using an auto chemistry analyzer Cobas Integra 400 Plus (Roche®, Swiss). Serum creatinine examination procedure: Instrument calibration was conducted, followed by a quality control check until calibration and quality control were confirmed to be within control. Samples labelled with barcodes underwent centrifugation and were placed in

designated sample racks. Sample information was recorded into the device interface, and the racks were loaded into the Cobas Integra 400 Plus analyzer. Upon pressing the "Start" button, the analyzer autonomously commenced the creatinine testing process. The Laboratory Information System (LIS) automatically captured and recorded test outcomes. During the post-analytical phase, the obtained results were meticulously documented and disseminated. Prior to finalizing the results, a rigorous verification process was conducted to ensure the accuracy of the data recorded on LIS (Roche Diagnostics, 2019). Final reports will be released after internal validation is considered.

The data were analyzed using SPSS software, with descriptive statistical tests performed to describe the variables under study and inferential statistical tests, specifically the Pearson correlation test, to examine the relationship between blood pressure and serum creatinine levels in hypertensive participants. The Health Research Ethics Committee (KEPK) of STIKes Prima Indonesia approved all protocols in this study, with ethical clearance number 143/EC/KEPK/STIKES-PI/VI/2022.

RESULTS AND DISCUSSION

Characteristics of Elderly Participants

A chronic disease management program is a healthcare service system that takes a proactive and integrative approach. It involves participants, healthcare facilities, and Badan Penyelenggara Jaminan Kesehatan, Indonesia's national health insurance program, to maintain the health of patients with chronic diseases. This study was conducted on 73 hypertensive participants. The gender and age group distribution of the participants are summarized in Table 1.

Table 1. Characteristics of Participants

Variable	n	%
Gender		
Male	36	49
Female	37	51
Age Group		
Pre-elderly (45 – 59 Yrs)	28	38
Elderly (60 – 69 Yrs)	31	42
Hight risk elderly (>70 Yrs)	14	19

The male participants were 36 (49%), and the female participants were 37 (51%). Aged groups distribution revealed that the majority of participants were elderly aged (60-69 years, n=31, 42%), followed by pre-elderly aged (45-59 years, n=28, 38%) and high-risk elderly aged (>70 years, n=14, 19%). This study aligns with the 2018 Riskesdas data, which shows that hypertension in both the elderly age group and the elderly was in high prevalence(Vinet & Zhedanov, 2011). Furthermore, this study is consistent with research conducted by Azwaldi et al. (2023), including 106 elderly participants who reported 65.1% (69 participants) were suffering from hypertension and 34.9% (37 participants) with controlled blood pressure of 69 hypertension participants the majority were elderly aged (60-69 years, 29 participants) followed br pre-elderly aged (45-59 years, 26 participants) and high risk elderly aged (>70 years, 14 participants) (Azwaldi et al., 2023).

Blood Pressure and Hypertension

Hypertension is when blood pressure increases beyond the normal limits (systolic >140 mmHg and diastolic >90 mmHg). The American Heart Association

classifies hypertension based on systolic and diastolic blood pressure values as follows: Normal (<120 mmHg, <80 mmHg), Elevated blood pressure (120–129 mmHg, <80 mmHg), Hypertension Grade I (130–139 mmHg, 80–89 mmHg), Hypertension Grade II (≥140 mmHg, ≥90 mmHg), and Hypertensive crisis (>180 mmHg, >120 mmHg)(Garfinkle, 2017). Blood pressure examination and category are summarised in Table 2 and Figure 1.

Table 2 Blood pressure

Variable	n	Median (Min – Max)	Mean±SD
Systolic blood pressure (mmHg)	73	140 (120 – 180)	143±15
Diastolic blood pressure (mmHg)	73	84 (63 – 114)	85±10

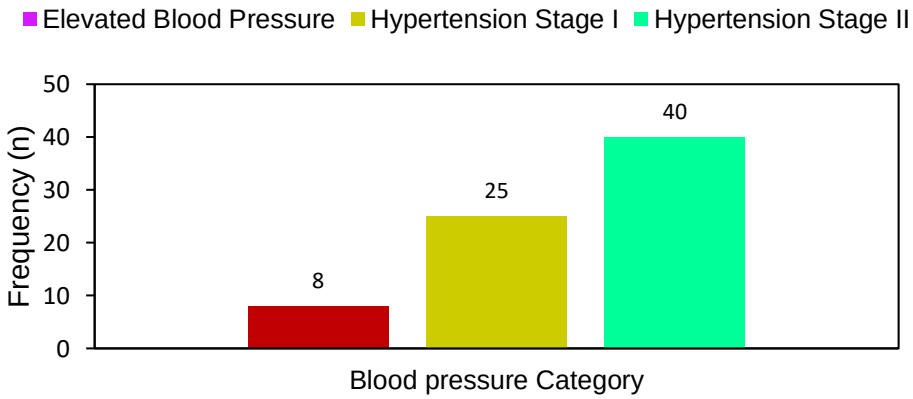

Figure 1. Frequency of Blood Pressure Category

The mean systolic blood pressure of the 73 chronic disease management program participants was 138 mmHg, with the lowest systolic pressure being 110 mmHg and the highest 180 mmHg. In contrast, the average diastolic blood pressure is 60 mmHg, with the lowest diastolic pressure being 63 mmHg and the highest 114 mmHg (Table 2). The majority of participants, 40 (50.79%), were classified as Stage II hypertension, followed by 25 (34.25%) in Stage I hypertension and only 8 participants (10.96%) were categorized as elevated blood pressure (figure 1). These data differ from the research conducted by Yuziani and Sofia (2023) in the same population (chronic disease management program participants with hypertension). The study by Yuziani & Sofia (2023) reported that among chronic disease management program participants among chronic disease management program, stage I hypertension was the most prevalent (n=14, 40%), followed by stage II hypertension (n=8, 22.9%), elevated blood pressure (n=9, 25.7%), and normal blood pressure (n=4, 11.4%) (Yuziani & Sofia, 2023). As chronic disease management program participants with hypertension received both lifestyle interventions and drug referrals, their hypertension stage may have been controlled and improvement in quality of life during their participation in the program (Qolbi et al., 2023; Yusransyah et al., 2020) (Purwati N & Indrawati, 2017).

Serum Creatinine

Serum creatinine examination among 73 elderly participants with hypertension is summarized in Table 3 and Figure 2.

Tabel 3. Serum Creatinine Examination

Variable	n	Median (Min – Max)	Mean±SD
Serum creatinine (mg/dL)	73	0.93 (0.51 – 1.94)	0.93±0.24

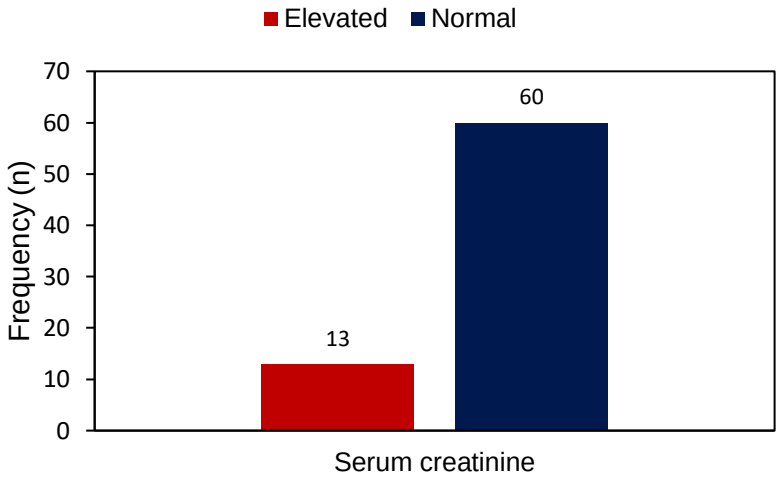

Figure 2. Frequency of Serum Creatinine Category

Creatinine is the end product of creatine and creatine phosphate metabolism. Creatinine is released into circulation and excreted by the kidneys in urine. Under physiological conditions, urinary creatinine excretion is equal to creatinine production. Kidney damage will result in an increase in serum creatinine levels. Serum creatinine is the most commonly used biomarker for kidney function, estimating the Glomerular Filtration Rate (GFR) using the Modification of Diet in Renal Disease (MDRD) formula or the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula (Kashani et al., 2020) (Barreto et al., 2019).

The mean serum creatinine level of the 73 elderly Participants was 0.93 mg/dL, ranging from a minimum of 0.51 mg/dL to a maximum of 1.94 mg/dL, spanning both normal and elevated criteria (Table 3). Most Participants (60 participants) exhibited normal creatinine levels (Men: 0.7 - 1.3 mg/dL & women: 0.6 - 1.1 mg/dL), suggesting kidney function is in an optimal state. In comparison, 13 participants had elevated serum creatinine levels (Men: >1.3 mg/dL & women: >1.1 mg/dL) (Figure 2). This study indicates that various activities in the program, such as lifestyle education, support independent health maintenance, particularly in promoting kidney health (Nappoe et al., 2023).

Blood pressure and Serum Creatinine Levels

The distribution of blood pressure criteria due to creatinine level of 73 participants is plotted in Table 4.

Tabel 4. Distribution of Blood Pressure Criteria Due to Creatinine Level

Blood Pressure Criteria	Creatinin Serum (n)	
	Normal	Elevated
Elevated blood pressure(n=8)	7	1
Hypertension grade I (n=25)	22	3
Hypertension grade II (n=40)	31	9
Total	**60**	**13**

Hypertension results from many interacting factors that increase blood pressure beyond normal limits (systolic >140 mmHg and diastolic >90 mmHg). During hypertension, blood flow to the kidneys decreases due to vasoconstriction, where blood vessels constrict, leading to kidney cell damage. Additionally, high blood pressure can disrupt the excretion of salt and creatinine, potentially triggering kidney function impairment(Harrison et al., 2021) (Rahayu & Indriyani, 2021) (Bozkurt et al., 2016).

The plotted blood pressure criteria against creatinine level in Table 4 show that most of the participants who exhibit elevated serum creatinine are suffering from hypertension grade II (9 participants), followed by hypertension grade I (3 participants), and only 1 participant of elevated blood pressure participant exhibit an elevated serum creatinine. These data revealed a trend of increasing serum creatinine levels due to higher blood pressure criteria. As well as serum creatinine as a parameter of kidney function, this study was in line with a study conducted by Ameer (2022) that found that blood pressure potentially triggers kidney function impairment (Ameer, 2022). According to Harrison et al. (2021), increased blood pressure in hypertension disrupts salt excretion and worsens kidney function. Additionally, hyperperfusion of the kidneys during increased blood pressure can lead to glomerular hemodynamic changes (Harrison et al., 2021).

Meanwhile, according to Huan et al. (2015), sodium and fluid retention, salt sensitivity, sympathetic dysfunction, and endothelial function abnormalities are key features that contribute to hypertension and exacerbate its effects (Huan et al., 2015). Furthermore, according to Angeli et al. (2028), clinical manifestations of kidney damage due to hypertension can range from asymptomatic to terminal kidney damage (Angeli et al., 2018). Poorly controlled hypertension can accelerate the progression to end-stage kidney disease (Haad et al., 2023).

Correlation of Blood Pressure and Serum Creatinine Levels

The Pearson correlation test between systolic and diastolic blood pressure and serum creatinine levels is presented in Table 5.

Table 5 Correlation of Blood Pressure and Serum Creatinine Levels

		Serum Creatinine
Systolic Blood Pressure (mmHg)	Correlation coefficient (r)	0.320
	p-value*	0.013
	Sample size (n)	73
Diastolic Blood Pressure (mmHg)	Correlation coefficient (r)	0.342
	p-value*	0.007
	Sample size (n)	73

**Pearson correlation*

Blood pressure is a crucial vital sign that reflects the force exerted by the blood against the arterial walls, measured in millimetres of mercury (mmHg) and expressed as systolic blood pressure. It represents the peak pressure during ventricular contraction, and diastolic blood pressure reflects the minimum pressure between heartbeats(Samartkit & Pullteap, 2024). Serum creatinine is a byproduct of muscle metabolism that is filtered by the kidneys and excreted in urine. It is a common biomarker used to assess kidney function. Elevated serum creatinine levels often indicate impaired kidney function (Luft, 2021).

Table 5 presents the results of the Pearson correlation analysis between blood pressure and serum creatinine levels. A significant correlation was found between systolic blood pressure with serum creatinine level (p=0.013, r=0.32) and diastolic blood pressure with serum creatinine levels (p=0.007, r=0.342). These findings suggest a significant relationship between systolic and diastolic blood pressure and serum creatinine levels. The R-values for both systolic and diastolic blood pressure with serum creatinine levels show a positive correlation with a weak correlation strength.

This study suggests that elevated blood pressure may contribute to impaired kidney function. Regular monitoring and management of both blood pressure and kidney function, especially in hypertensive individuals, is crucial for early detection of kidney damage and timely intervention (Luft, 2021). According to Pugh et al. (2019), Effective blood pressure control through medication and lifestyle modifications can help reduce the risk of kidney disease progression (Pugh et al., 2019).

The study's limitations included a relatively small sample size and a cross-sectional design that limited the generalizability of the findings. Additionally, this study focused on hypertension participants and did not account for other potential confounding factors, such as diabetes mellitus and cardiovascular diseases.

CONCLUSION

Aged groups distribution revealed that the majority of chronic disease management program participants were elderly aged (60-69 years, n=31, 42%), followed by pre-elderly aged (45-59 years, n=28, 38%) and high-risk elderly aged (>70 years, n=14, 19%). Most of them (40 participants) fell into hypertension stage II, followed by hypertension stage I (25 participants), and only 8 participants fell into the elevated blood pressure category. Most of the participants who exhibited elevated serum creatinine are suffering from hypertension grade II (9 participants) followed by hypertension grade I (3 participants), and only 1 participant with elevated blood pressure participant exhibited an elevated serum creatinine, revealing a trend of increasing serum creatinine level due to higher blood pressure criteria. The Pearson correlation test results indicated a significant relationship between systolic and diastolic blood pressure and serum creatinine levels ($p<0.05$). The R-values for both systolic and diastolic blood pressure showed a positive correlation with serum creatinine levels, though with weak correlation strength. This study suggests that increased serum creatinine levels may accompany elevated blood pressure.

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CONFLICT OF INTEREST

There is no conflict of interest in this research.

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