



PROPORTION OF PULMONARY HYPERTENSION IN CHRONIC KIDNEY DISEASE PATIENTS AT ESIC MODEL HOSPITAL AND OCCUPATIONAL DISEASE CENTRE, INDORE, MADHYA PRADESH

Dr. Umang Brahmbhatt*

DNB, M.B.B.S., Department of General Medicine, ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh, India.
*Corresponding Author

Dr. Vidushi Verma

DNB, M.B.B.S., Department of General Medicine, ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh, India.

Dr. Kapil Kumar Verma

MD, M.B.B.S., Department of General Medicine, ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh, India.

Dr. Rajeev Shukla

DNB, M.B.B.S., Department of General Medicine, ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh, India.

ABSTRACT

Background: Chronic kidney disease (CKD) is a global health burden associated with systemic complications, including pulmonary hypertension (PH), which increases morbidity and mortality. Limited data exist on PH prevalence in CKD patients in Central India. **Objective:** To determine the proportion of PH in CKD patients at ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh, and assess associated socio-demographic and clinical factors. **Methods:** A cross-sectional study was conducted from September 2022 to August 2023, enrolling 123 CKD patients. PH was defined as pulmonary artery systolic pressure (PASP) ≥ 35 mmHg via transthoracic Doppler echocardiography. Socio-demographic, clinical, and laboratory data were collected. Statistical analysis included descriptive statistics, Pearson Chi-square tests, and unpaired t-tests. **Results:** PH was present in 18.7% of patients, with prevalence increasing with CKD stage (9.1% in stage III, 28.6% in stage V; $P=0.016$). Patients with PH had higher mean serum creatinine (7.59 ± 3.63 vs. 5.09 ± 3.39 mg/dL, $P=0.002$), higher serum urea (73.84 ± 19.46 vs. 62.91 ± 19.38 mg/dL, $P=0.016$), lower serum calcium (7.45 ± 1.59 vs. 8.54 ± 1.69 mg/dL, $P=0.006$), and lower hemoglobin (8.87 ± 1.93 vs. 9.99 ± 1.88 g/dL, $P=0.011$) compared to those without PH. No significant association was found between CKD duration and PH ($P=0.186$). **Conclusion:** PH affects nearly one-fifth of CKD patients, with higher prevalence in advanced stages. Routine PH screening and comprehensive management of renal and cardiovascular complications are crucial for improving outcomes.

KEYWORDS : Chronic Kidney Disease, Pulmonary Hypertension, Echocardiography, Prevalence, Esic Model Hospital, Indore.

INTRODUCTION

Chronic kidney disease (CKD) represents a significant global health challenge, imposing substantial economic costs on healthcare systems and serving as an independent risk factor for cardiovascular disease [1]. All stages of CKD are associated with increased risks of cardiovascular morbidity, premature mortality, and diminished quality of life [1]. Among CKD complications, pulmonary hypertension (PH), defined as mean pulmonary artery pressure (mPAP) ≥ 25 mmHg [8], is particularly concerning due to its direct association with mortality, especially in end-stage renal disease (ESRD) [2–7]. PH in ESRD is linked to poor outcomes, and its presence in early CKD stages may not be reversed even by interventions such as kidney transplantation, which also carries high mortality risk in affected patients [16].

PH encompasses a spectrum of clinical and pathophysiological entities with diverse etiologies, including cardiac, pulmonary, and systemic disorders [9]. Its prevalence in CKD varies across studies, ranging from 25.6% [10] to 50% [11]. PH involves vasoconstriction and obliteration of small pulmonary vessels by plexiform lesions, leading to increased resistance to pulmonary blood flow [12]. Proposed mechanisms include dysregulated endothelial growth and aberrant angiogenic responses to legal triggers [13]. In ESRD, hormonal and metabolic derangements, high cardiac output from anemia or fluid overload, and subclinical left ventricular dysfunction (primarily diastolic) contribute to elevated pulmonary artery pressure (PAP) [14]. Endothelial dysfunction, marked by defective nitric oxide activity, persists despite hemodialysis [15]. Elevated brain natriuretic peptide (BNP) and N-terminal pro-BNP are associated with PH and worse outcomes in CKD [7].

Given the limited data on PH prevalence in CKD patients in Central India, this study aimed to address this gap. Aim: To

determine the proportion of pulmonary hypertension in patients with chronic kidney disease at ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh. Objectives: (1) To measure PH parameters, including pulmonary artery systolic pressure (PASP), in CKD patients using echocardiography; (2) To evaluate medical details (medical history, physical examination, laboratory results) of CKD patients at ESIC Model Hospital and Occupational Disease Centre; (3) To assess the socio-demographic profile (age, sex, socioeconomic status) of CKD patients at ESIC Model Hospital and Occupational Disease Centre.

Materials and Methods

Place of Study

The study was conducted in the Department of General Medicine at ESIC Model Hospital and Occupational Disease Centre, Indore, Madhya Pradesh, India.

Study Design

This was a cross-sectional observational study.

Study Duration

The study was conducted from September 2022 to August 2023.

Study Population

The study population included all patients diagnosed with CKD presenting to ESIC Model Hospital and Occupational Disease Centre during the study period, meeting inclusion criteria and none of the exclusion criteria.

Sample Size

A total of 123 CKD patients were enrolled using a convenient sampling technique, including all eligible patients visiting the institution during the study period.

Inclusion Criteria

- Age ≥ 18 years.
- Confirmed CKD diagnosis (eGFR < 60 mL/min/1.73 m²) on

hemodialysis or conservative treatment.

- Voluntary written informed consent from the patient or their legally acceptable representative.

Exclusion Criteria

- Age < 18 years.
- Diagnosed with chronic obstructive pulmonary disease, interstitial lung disease, or chronic respiratory failure.
- HIV infection.
- Known smoking history.
- Collagen vascular disease.
- Left ventricular ejection fraction (LVEF) < 50%.
- Significant mitral or aortic valve disease.
- Unwillingness to provide voluntary written informed consent.

Methodology

Eligible patients were informed about the study in their native language, including study type, risks, benefits, and compliance requirements. After verbal consent, voluntary written informed consent was obtained before initiating study procedures.

Patients underwent comprehensive clinical and physical examinations, including:

- Demographic and Clinical Data: Age, sex, smoking history, comorbidities (e.g., diabetes mellitus, hypertension), age at CKD diagnosis, etiology of renal failure, dialysis duration, and arteriovenous fistula (AVF) access location (brachial or radial).
- Laboratory Investigations: Serum urea, creatinine, hemoglobin, calcium, and albumin levels.

Diagnostic Procedures:

- Electrocardiogram (ECG) and chest radiograph were performed.
- Transthoracic Doppler Echocardiography: Conducted using a Philips EPIQ 7 ultrasound machine to assess PH. PASP was calculated using the tricuspid regurgitation (TR) jet velocity and the modified Bernoulli equation: $PASP = 4 \times (TR \text{ jet velocity})^2 + 10 \text{ mmHg}$ (estimated right atrial pressure). PH was defined as $PASP \geq 35 \text{ mmHg}$ at rest. Echocardiography assessed left ventricular hypertrophy, chamber size, systolic and diastolic function, LVEF, regional wall motion abnormalities, and pericardial effusion. Stroke volume and cardiac output were calculated per American Society of Echocardiography guidelines.

Data Collection

Data were recorded using a customized proforma (Annexure-III), capturing socio-demographic, clinical, laboratory, and echocardiographic data.

Outcome Measures

- Proportion of CKD patients with PH ($PASP \geq 35 \text{ mmHg}$).
- PASP values.
- AVF access location.
- Dialysis duration.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 22. Descriptive statistics were reported as numbers and percentages. Associations between categorical variables were assessed using the Pearson Chi-square test, and mean comparisons were performed using the unpaired t-test. A P-value < 0.05 was considered statistically significant.

Financial Inputs and Funding The study was conducted under the Employees' State Insurance Corporation (ESIC) scheme, providing free medical services to employees and dependents. No additional tests or procedures were performed, ensuring no financial burden on patients or the

institution. Study-related expenses were borne by the investigator.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of ESIC Model Hospital. Voluntary written informed consent was obtained from each patient or their legally acceptable representative, in addition to consents for CKD management. Patient confidentiality was maintained, and only study-relevant data were used.

RESULTS

A total of 123 CKD patients were enrolled. Below are the key findings, with five critical tables embedded to highlight socio-demographic characteristics, CKD stage distribution, PH prevalence, and its association with CKD stage.

Socio-Demographic Characteristics

Table 1: Distribution of CKD Patients According to Age (N = 123)

Age Group	Frequency (No.)	Percentage (%)
18–20 years	2	1.6
21–30 years	3	2.4
31–40 years	22	17.9
41–50 years	39	31.7
51–60 years	32	26.0
61–70 years	22	17.9
>70 years	3	2.4
Total	123	100

The mean age was 49.62 ± 11.51 years (range: 18–72 years), with most patients in the 41–50 (31.7%) and 51–60 (26.0%) age groups.

Table 2: Distribution of CKD Patients According to Sex (N = 123)

Sex	Frequency (No.)	Percentage (%)
Female	41	33.3
Male	82	66.7
Total	123	100.0

Males comprised 66.7% (n=82), and females 33.3% (n=41), with a male-to-female ratio of 2:1.

Clinical Characteristics

Hypertension was present in 65.2% (n=80) and diabetes mellitus in 30.1% (n=37) of patients. The mean CKD duration was 42.46 ± 33.49 months (range: 3–180 months), with most patients having a duration of 24–36 months (26.8%, n=33). (Figure 1)

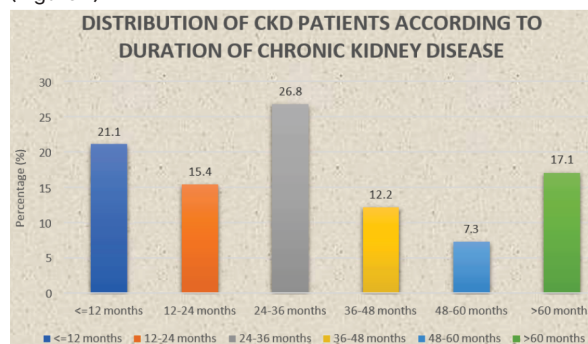


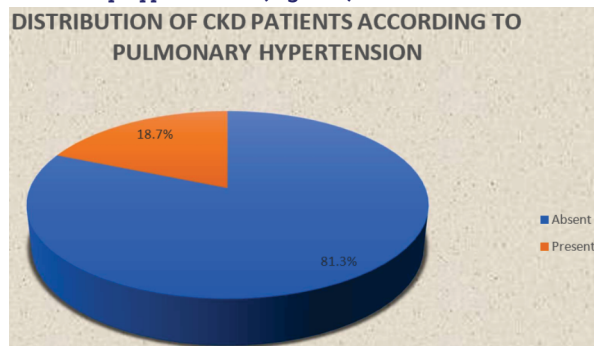
Table 3: Distribution of CKD Patients According to CKD Stage (N = 123)

CKD Stage	Frequency (No.)	Percentage (%)
Stage I	0	0.0
Stage II	0	0.0
Stage III	27	22.0
Stage IV	33	26.8
Stage V	63	51.2
Total	123	100.0

The majority had stage V CKD (51.2%), followed by stage IV (26.8%) and stage III (22.0%).

Dialysis was ongoing in 46.3% (n=57) of patients, and AVF was present in 39.8% (n=49). All patients had above-normal serum creatinine (mean: 5.57 ± 3.56 mg/dL). Serum urea was above normal in 91.1% (mean: 64.96 ± 19.78 mg/dL). Serum calcium was below normal in 46.3%, normal in 46.3%, and above normal in 7.3% (mean: 8.34 ± 1.72 mg/dL). Serum hemoglobin was below normal in 95.9% (mean: 9.78 ± 1.93 g/dL). Serum albumin was below normal in 33.3%, normal in 65.9%, and above normal in 0.8% (mean: 3.61 ± 0.58 g/L).

Pulmonary Hypertension (Figure 2)



Pulmonary hypertension was present in 18.7% (n=23) of patients.

Table 4: Association Between Chronic Kidney Disease and Pulmonary Hypertension (N=123)

CKD Stage	PH Absent (No.,%)	PH Present (No.,%)	Total (No.,%)
Stage I	0 (0.0%)	0 (0.0%)	0 (0.0%)
Stage II	0 (0.0%)	0 (0.0%)	0 (0.0%)
Stage III	25 (92.6%)	2 (9.1%)	27 (100.0%)
Stage IV	30 (90.9%)	3 (9.1%)	33 (100.0%)
Stage V	45 (71.4%)	18 (28.6%)	63 (100.0%)
Total	100 (81.3%)	23 (18.7%)	123 (100.0%)

Pearson Chi-square: $\chi^2=8.307$, $df=2$, $P=0.016$, Significant

PH prevalence increased with CKD stage: 9.1% in stage III, 9.1% in stage IV, and 28.6% in stage V ($P=0.016$). No significant association was found between CKD duration and PH ($P=0.186$). Patients with PH had significantly higher mean serum creatinine (7.59 ± 3.63 vs. 5.09 ± 3.39 mg/dL, $P=0.002$, higher serum urea (73.84 ± 19.46 vs. 62.91 ± 19.38 mg/dL, $P=0.016$, lower serum calcium (7.45 ± 1.59 vs. 8.54 ± 1.69 mg/dL, $P=0.006$, and lower hemoglobin (8.87 ± 1.93 vs. 9.99 ± 1.88 g/dL, $P=0.011$, compared to those without PH. Mean serum albumin was comparable (3.49 ± 0.56 vs. 3.63 ± 0.58 g/L, $P=0.284$).

DISCUSSION

Chronic kidney disease (CKD) is a global health challenge with significant systemic complications, including pulmonary hypertension (PH), which amplifies morbidity and mortality risks [1–7]. This study, conducted at ESIC Model Hospital and Occupational Disease Centre, Indore, investigated the prevalence of PH in 123 CKD patients and its associations with socio-demographic and clinical factors.

The mean age of 49.62 ± 11.51 years aligns with Bapat et al. (49.27 ± 16.7 years) [18] but is lower than Telles et al. (53.52 years) [22] and Piccin et al. (58.9 years) [29]. The male preponderance (66.7%, male-to-female ratio 2:1) is consistent with studies by Kanyari et al. [33], Telles et al. [22], and Piccin et al. [29]. Hypertension (65.2%) and diabetes mellitus (30.1%) were common comorbidities, comparable to findings by Kanyari et al. (74.2% hypertension, 41.2% diabetes) [33],

Kumar et al. (87% hypertension, 37% diabetes) [35], and Meremo et al. (96.7% hypertension, 38.7% diabetes) [37].

The majority of patients had stage V CKD (51.2%), unlike studies by O'Leary et al. (3% stage V) [26], Reque et al. (31.7% stage V) [24], and Navaneethan et al. (4% stage IV) [21], where earlier stages predominated. This discrepancy may reflect selection bias due to the tertiary care setting of ESIC Model Hospital. Dialysis was ongoing in 46.3% of patients, similar to Havlucu et al. (52.1%) [3], Pabst et al. (50%) [19], and Emara et al. (65.6%) [20].

PH prevalence was 18.7%, lower than reported by Sonkar et al. (25.6%) [10], Reque et al. (26.6%) [24], and Amal et al. (50%) [11]. The lower prevalence may reflect differences in patient populations or diagnostic criteria. PH prevalence increased with CKD stage (9.1% in stage III to 28.6% in stage V, $P=0.016$), consistent with Reque et al. [24] and Mehta et al. [31]. No significant association was found between CKD duration and PH ($P=0.186$), suggesting stage-specific factors drive PH development.

Patients with PH had higher serum creatinine and urea, and lower calcium and hemoglobin levels, aligning with findings by Amal et al. [11], Mehta et al. [31], and Patel et al. [17]. These associations highlight the role of metabolic derangements and anemia in PH pathogenesis. Serum albumin levels were comparable between groups, possibly due to nutritional or inflammatory factors not assessed in this study.

Limitations

The single-center design may introduce selection bias, limiting generalizability. The sample size, while adequate, may not capture the full spectrum of CKD patients. Hematological parameter differences were not significant in some comparisons, possibly due to limited statistical power.

CONCLUSION

CKD poses a significant global health burden, with PH affecting 18.7% of the 123 patients studied at ESIC Model Hospital, Indore. PH prevalence increased with CKD stage, reaching 28.6% in stage V ($P=0.016$). Patients with PH had higher serum creatinine and urea, and lower calcium and hemoglobin levels, underscoring the interplay between renal dysfunction and cardiovascular complications. Routine PH screening and integrated management of renal and cardiovascular issues are critical for improving outcomes. Further research is warranted to elucidate PH mechanisms and optimize therapeutic strategies in CKD patients.

REFERENCES

- Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, et al. Global prevalence of chronic kidney disease - A systematic review and meta-analysis. *PLoS One*. 2016;11(7):e0158765. doi:10.1371/journal.pone.0158765
- Agarwal R. Prevalence, determinants and prognosis of pulmonary hypertension among hemodialysis patients. *Nephrol Dial Transplant*. 2012;27(10):3908–14. doi:10.1093/ndt/gfs288
- Havlucu Y, Kursat S, Ekmekci C, Celik P, Serter S, Bayturan O, et al. Pulmonary hypertension in patients with chronic renal failure. *Respiration*. 2007;74(5):503–10. doi:10.1159/000102954
- Abdelwhab S, Elshinnawy S. Pulmonary hypertension in chronic renal failure patients. *Am J Nephrol*. 2008;28(6):990–7. doi:10.1159/000141933
- Yigla M, Fruchter O, Aharonson D, Yanay N, Reisner SA, Lewin M, et al. Pulmonary hypertension is an independent predictor of mortality in hemodialysis patients. *Kidney Int*. 2009;75(9):969–75. doi:10.1038/ki.2009.10
- Nickel N, Golpon H, Greer M, Knudsen L, Olsson K, Westerkamp V, et al. The prognostic impact of follow-up assessments in patients with idiopathic pulmonary arterial hypertension. *Eur Respir J*. 2012;39(3):589–96. doi:10.1183/09031936.00092311
- Fritz JS, Blair C, Oudiz RJ, Dufton C, Olschewski H, Despain D, et al. Baseline and follow-up 6-min walk distance and brain natriuretic peptide predict 2-year mortality in pulmonary arterial hypertension. *Chest*. 2013;143(2):315–23. doi:10.1378/chest.12-0270
- Sarnak MJ, Roberts KE. Pulmonary hypertension in CKD: Some answers, yet more questions. *J Am Soc Nephrol*. 2016;27(3):661–3. doi:10.1681/ASN.2015050555
- Simonneau G, Gatzoulis MA, Adatia I, Celermajer D, Denton C, Ghofrani A, et al. Updated clinical classification of pulmonary hypertension. *J Am Coll Cardiol*. 2013;62(25):D34–41. doi:10.1016/j.jacc.2013.10.029

10. Sonkar SK, Alam M, Chandra S, Sonkar GK, Gaikwad A, Bhosale V. Association of pulmonary hypertension with inflammatory markers and volume status in hemodialysis patients of end-stage renal disease. *Cureus*. 2021;13(3):e13635. doi:10.7759/cureus.13635
11. Amal M, Abdulaal M, Abdo MK, Riad HM. Pulmonary hypertension in predialysis chronic kidney disease: Frequency and potential mechanisms. *Med J Cairo Univ*. 2018;86(March):145–51.
12. Rubin LJ. Pathology and pathophysiology of primary pulmonary hypertension. *Am J Cardiol*. 1995;75(3):51A–54A. doi:10.1016/S0002-9149(99)80381-0
13. Jeffery TK, Morrell NW. Molecular and cellular basis of pulmonary vascular remodeling in pulmonary hypertension. *Prog Cardiovasc Dis*. 2002;45(3):173–202. doi:10.1053/pcad.2002.129990
14. Fathi R, Isabel N, Haluska B, Case C, Johnson DW, Marwick TH. Correlates of subclinical left ventricular dysfunction in ESRD. *Am J Kidney Dis*. 2003;41(5):1016–25. doi:10.1016/S0272-6386(03)00198-5
15. Migliacci R, Falcinelli F, Imperiali P, Floridi A, Nenci GG, Greseli P. Endothelial dysfunction in patients with kidney failure and vascular risk factors: acute effects of hemodialysis. *Ital Heart J*. 2004;5(5):371–7.
16. Issa N, Krowka MJ, Griffin MD, Hickson LJ, Stegall MD, Cosio FG. Pulmonary hypertension is associated with reduced patient survival after kidney transplantation. *Transplantation*. 2008;86(10):1384–8. doi:10.1097/TP.0b013e318188d6bc
17. Abraham G, Patel P, Pratap B, Ramalakshmi R, Mathew M, Jeevan JM, et al. Clinical and biochemical parameters in chronic kidney disease with pulmonary hypertension. *Indian J Nephrol*. 2007;17(1):4.
18. Bapat U, Nayak SG, Kedleya PG, Gokulnath. Demographics and social factors associated with acceptance of treatment in patients with chronic kidney disease. *Saudi J Kidney Dis Transpl*. 2008;19(1):132–6.
19. Pabst S, Hammerstingl C, Hundt F, Gerhardt T, Grohé C, Nickenig G, et al. Pulmonary hypertension in patients with chronic kidney disease on dialysis and without dialysis: results of the PEPPER-study. *PLoS One*. 2012;7(4):e35310. doi:10.1371/journal.pone.0035310
20. Emar MM, Habeb MA, Alnahal AA, Elshazly TA, Alatawi FO, Masoud AS. Prevalence of pulmonary hypertension in patients with chronic kidney disease on and without dialysis. *Egypt J Chest Dis Tuberc*. 2013;62(4):761–8.
21. Navaneethan SD, Wehbe E, Heresi GA, Gaur V, Minai OA, Arrigain S, et al. Presence and outcomes of kidney disease in patients with pulmonary hypertension. *Clin J Am Soc Nephrol*. 2014;9(5):855–63. doi:10.2215/CJN.10191013
22. Telles CT, Dobner T, Pomatti G, Fortes VF, Brock F, Bettinelli LA. Socio-demographic, clinical and laboratory profile of patients submitted to hemodialysis. *Rev Rene*. 2014;15(3):420–8. doi:10.15253/2175-6783.2014000300006
23. Nomani AZ, Iqbal M, Bacha F, Mughal S, Rajput HM, Badshah M, et al. Demographic profile and associations of dialysis dependent chronic kidney disease patients in federal capital of Pakistan. *Pakistan Journal of Neurological Sciences (PJNS)*. 2016;11(1):13–9.
24. Reque J, Garcia-Prieto A, Linares T, Vega A, Abad S, Panizo N, et al. Pulmonary hypertension is associated with mortality and cardiovascular events in chronic kidney disease patients. *Am J Nephrol*. 2017;45(2):107–14. doi:10.1159/000455166
25. Allawi AAD. Prevalence and Risk of Pulmonary Hypertension in Chronic Kidney Disease. *International Journal of Science and Research (IJSR)*. 2017;6(7):947–50.
26. O'Leary JM, Assad TR, Xu M, Birdwell KA, Farber-Eger E, Wells QS, et al. Pulmonary hypertension in patients with chronic kidney disease: invasive hemodynamic etiology and outcomes. *Pulm Circ*. 2017;7(3):674–83. doi:10.1177/2045893217717239
27. Selvaraj S, Shah SJ, Ommerborn MJ, Clark CR, Hall ME, Mentz RJ, et al. Pulmonary hypertension is associated with a higher risk of heart failure hospitalization and mortality in patients with chronic kidney disease. *Circ Heart Fail*. 2017;10(6):e003940. doi:10.1161/CIRCHEARTFAILURE.116.003940
28. Arun BS, Suresh H, Moger V, Vijayalaxmi PB, Mohan KTKM. A prospective study of pulmonary hypertension in patients with chronic kidney disease: A new and pernicious complication. *Indian J Nephrol*. 2017;27(5):363–9.
29. Piccin C, Girardon-Perlin NMO, Coppetti LDC, Da Cruz TH, Beuter M, Burg G. Perfil sociodemográfico e clínico de pacientes renais crônicos em hemodiálise. *Rev Enferm UFPE On Line*. 2018;12(12):3212.
30. Zhang Q, Wang L, Zeng H, Lv Y, Huang Y. Epidemiology and risk factors in CKD patients with pulmonary hypertension: a retrospective study. *BMC Nephrol*. 2018;19(1):70. doi:10.1186/s12882-018-0866-9
31. Mehta K, Shirkande A, Bhurke S, Pajai A, Swami R, Jadhav S. Pulmonary hypertension in various stages of chronic kidney disease in Indian patients. *Indian J Nephrol*. 2019;29(2):95–101.
32. Indhumathi E, Nithiya N, Jagadeswaran D, Jayaprakash V, Jayakumar M. Pulmonary hypertension – prevalence, risk factors, and its association with vascular calcification in chronic kidney disease and hemodialysis patients. *Saudi J Kidney Dis Transpl*. 2020;31(2):380–9.
33. Kanyari SS, Panda S, Shruthi P. A cross-sectional study on socio-demographic profile and associated risk factors of chronic kidney disease patients in a tertiary care hospital of Andhra Pradesh. *Int J Community Med Public Health*. 2020;7(11):4512–8.
34. Khan A, Jan FA, Rashid H. Socio demographic profile of end stage renal disease patients. *World Journal of Pharmaceutical and Medical Research*. 2020;6(12):277–80.
35. Kumar V, Yadav AK, Sethi J, Ghosh A, Sahay M, Prasad N, et al. The Indian Chronic Kidney Disease (ICKD) study: baseline characteristics. *Clin Kidney J*. 2022;15(1):60–9. doi:10.1093/ckj/sfab149
36. Mann A, Kampani G, Bansal S, Ranga S. Study of pulmonary arterial hypertension in patients with chronic kidney disease stage IV and V. *J Assoc Physicians India*. 2021;69(10):11–2.
37. Meremo A, Paget G, Duarte R, Dickens C, Dix-Peek T, Bintabara D, et al. Demographic and clinical profile of black patients with chronic kidney disease attending a tertiary hospital in Johannesburg, South Africa. *PLoS One*. 2022;17(9):e0266155. doi:10.1371/journal.pone.0266155
38. Cowdhury SM, Ferdous T, Hafiz SM, Quayum S, Yousuf FB, Das D. Socio-demographic status of patients with chronic kidney diseases. *Saudi J Med*.