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RESEARCH

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Assessment of pulmonary hypertension in patients diagnosed with chronic kidney disease

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Abstract

Background Pulmonary hypertension (PH) represents a condition affecting small arteries of the pulmonary vasculature, inducing progressive blockage that results in increased pulmonary vascular resistance (PVR) as well as pulmonary arterial pressure (PAP), which are defining features of such a disorder. This work was aimed at investigating the PH prevalence among chronic kidney disease (CKD) cases and its linkage to disease severity and the relations between CKD management and PH.

Methods Our prospective observational descriptive cross-sectional study was conducted on 120 CKD patients at the Chest Department, Tanta University Hospitals and Air Forces Specialized Hospitals from December 2020 to December 2022.

Results The most frequent diagnosis of PH was Group 1 pulmonary arterial hypertension (36.7%) followed by Group 2 cardiac causes (30%) followed by Group 4 chronic thromboembolic PH (26.7%) and (6.7%) experienced normal pulmonary hemodynamics by RHC. Also, a statistically significant correlation was documented among CKD staging as well as risk assessment of PH (p 0.024). A significant association was documented among treatment as well as risks for developing PH (p 0.034). Patients on medical treatment (60%) showed low risk while (33.3%) of patients depending on dialysis showed high risk.

Conclusions PH was diagnosed in 28 CKD patients confirmed by right (RT) side cardiac catheterization among 120 CKD patients studied for PH assessment representing 23.5%. Right-side cardiac catheterization is more accurate than echocardiography in confirming the diagnosis of PH. The severity of PH showed significant association with the CKD stage.

Keywords Right heart catheter, Chronic kidney disease, Pulmonary arterial hypertension, Pulmonary vascular resistance

Introduction

Pulmonary hypertension (PH) represents a condition affecting small arteries of the pulmonary vasculature, inducing progressive blockage that results in increased pulmonary vascular resistance (PVR) as well as pulmonary arterial pressure (PAP), which are defining features of such a disorder [1, 2]. Elevated PVR is often linked to right ventricular failure, resulting in higher death rates [3].

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The PH mechanisms are not well understood. Acid–base balance among individuals having chronic kidney disease (CKD) can be induced and worsened by left ventricular disorders as well as common CKD risk factors involving volume overload, an arteriovenous fistula, sleep-related breathing problems, contact with dialysis membranes, endothelial dysfunction, vascular calcification, stiffening, along with severe anemia [4].

Pulmonary hypertension is defined by a mean pulmonary arterial pressure (mPAP) of 20 mmHg at rest., as determined by right-sided cardiac catheterization. To diagnose pulmonary artery hypertension, formerly known as pre-capillary PH (group I in the WHO classification), the pulmonary wedge pressure must be less than or equal to 15 mm Hg and the PVR must be equal to or more than 2 Woods units [5].

Doppler echocardiography investigations may provide noninvasive estimations of pulmonary pressure. Diagnosing PH, especially pulmonary artery hypertension, necessitates right-sided cardiac catheterization. PASP is measured in Doppler echocardiography investigations utilizing the tricuspid regurgitation jet, representing a phenomenon seen in many physiological as well as pathological conditions [6].

Estimating the PH frequency among CKD cases remains challenging due to limited epidemiological data, mostly relying on retrospective data as well as small studies with methodological constraints. Some international experts addressed that diagnosing PH should rely on right-sided cardiac catheterization and be characterized by a mean PASP of ≥ 25 mm Hg. However, only one research has used invasive techniques to detect PASP among CKD cases [7].

This work was aimed at investigating the PH among CKD cases and its association to disease severity and the relations between CKD management and severity PH.

Patients and methods

A prospective observational descriptive cross-sectional study involved 120 cases, whose ages fell between 35 and 64 years old, both sexes, diagnosed with CKD (either kidney damage or a reduced glomerular filtration rate (GFR) of below 60 mL/min/1.73 m^2 for a minimum of 3 months), 30 cases had clinical and echocardiograph feature of PH and 28 cases of them confirmed that they had PH by RHC. The study was carried out within a timeframe between December 2020 and December 2022 following the Ethical Committee's approval at Tanta University Hospitals and Air Forces Specialized Hospitals.

Exclusion criteria involved cases developing uncorrectable bleeding diathesis, bleeding time of more than 10 min, platelet count of below 50,000/ml, prothrombin time exceeding 1.5 times of reference range, individuals having acute kidney injury along with cases developing other PH etiologies.

The subjects underwent comprehensive medical history taking, clinical assessment, lab investigation (CBC, prothrombin time (PT) and activity, liver and renal function tests, arterial blood gases (ABG) and brain natriuretic peptide (BNP)] and radiological investigations: (chest x-ray (P-A View), CT Chest ECG, abdominal ultrasound and 6MWT).

Right heart catheterization (RHC) procedure

It was carried out using a Swan Ganz catheter through the superior vena cava utilizing percutaneous entry via the internal jugular either blindly or ultrasound-guided in some difficult cases using a high-frequency linear probe. The transducer is positioned at the mid-axillary line in the fourth intercostal space and then zeroed through exposing the system to room air [8, 9]. Every PA catheter port was meticulously cleaned, and then a complete balloon inflation was verified. The catheter was placed via the central venous sheath till it reached a depth of about 15 cm or till the right atrium waveforms were visible. Balloon inflation was then accomplished then gently moved forward. Fluoroscopy guided the placement within the catheterization lab. The catheter is moved gradually from the PA to reach the wedge location. Typically, the pulmonary capillary wedge pressure (PCWP) tracing extends up to 50–55 cm when the catheter is inserted into the internal jugular vein. After recording the PCWP, balloon deflation was accomplished and then confirmed that a clear PA trace was acquired. Additionally, the air volume necessary for balloon deflation to achieve the wedge was verified. When the volume is below 1.5 cc, the catheter is retracted to prevent "over-wedging." Oximetric measurement was utilized for verifying the precise wedge location via collecting a blood sample with a saturation level of ≥ 95%.

To minimize risk, all patients were subjected to a bleeding profile including INR, PT, PTT coagulation, and bleeding time; X-ray immediately after the procedure; and close monitoring of the patient during and after the procedure within 6 h including monitoring of heart rate (HR), rhythm, blood pressure, and oxygen saturation; high infection control application methods and any disposable materials were burned.

Ethical considerations

The study was carried out within a timeframe between December 2020 and December 2022 following the Ethical Committee's approval at Tanta University Hospitals and Air Forces Specialized Hospitals, Egypt (approval code: 34161/9/20). The Ethical Committee approved

the research plan. Patients or their families provided informed consent for the procedure.

Statistical analysis

Data underwent a statistical analysis utilizing SPSS v27 (IBM©, Chicago, IL, USA). The Shapiro-Wilks test as well as histograms were utilized for assessing the normality of data distribution. Quantitative parametric data were displayed as mean as well as SD then underwent an analysis utilizing ANOVA (F) test with post hoc test (Tukey). Quantitative non-parametric data were displayed as median as well as interquartile range (IQR) and then underwent analysis utilizing the Kruskal–Wallis test with the Mann–Whitney test for comparing each group. Qualitative variables were displayed as frequency as well as percentage (%) then underwent analysis utilizing the chi-square test. A two tailed *P* value below 0.05 was deemed statistically significant.

Results

This study included 120 CKD patients, 30 patients with clinical and echocardiographic data of PH, and 28 patients with PH confirmed by RHC (Fig. 1).

The assessed cases' mean age exhibited 53.1 ± 7.69 years. Sixteen patients were females, while 14 were males. According to co-morbidities, 15 patients (50%) were diabetic, 8 patients of patients (26.7%) were hypertensive, 2 patients (6.7%) were diabetic and hypertensive, while 5 patients (16.7%) were negative for diabetes and hypertension. As regards CKD management in the examined patients, most of the cases were on medical treatment 18 patients (60%), 8 patients (26.7%) were managed by dialysis shunt, while 4 patients (13.3%) were managed by dialysis catheter. As regards CKD duration, the mean of the examined patients was 18.6 ± 1. As regards stage of CKD 2 patients (6.7%) were stage 1, 13 patients (43.3%) developed stage 2, six cases (20%) developed stage 3, three cases (10%) exhibited stage 4, while six cases (20%) exhibited stage 5 (Table 1).

Right atrial surface area, 66.7% (20 patients) were < 18 cm^2, 16.7% (5 patients ranged from 18 to 26 cm^2, while 16.7% (5 patients) were > 26 cm^2. TAPSE/sPAP ratio was less than < 0.19 mm/mmHg in 5 patients (16.7%), 5 patients (16.7%), while 20 patients (66.7%) were showing TAPSE/sPAP ratio of more than 0.32 mm/mmHg. Pericardial effusion were absent in 20 patients (66.7%),

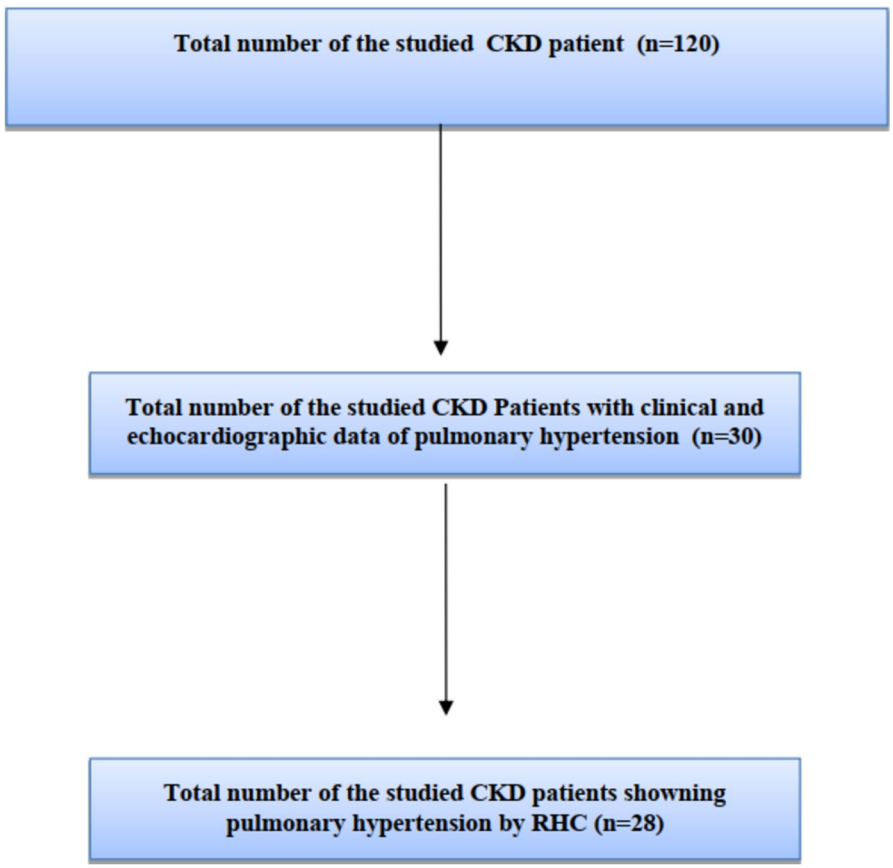

Fig. 1 Flowchart of the CKD cases

Table 1 Demographic data, co-morbidities, as well as clinical assessment of the studied CKD cases

		N = 30
Age (years)		53.1 ± 7.69
Sex	**Male**	14 (46.7%)
	Female	16 (53.3%)
Co-morbidities	**DM**	15 (50.0%)
	HTN	8 (26.7%)
	DM and HTN	2 (6.7%)
CKD management	**Medical TTT**	18 (60.0%)
	Dialysis shunt	8 (26.7%)
	Dialysis catheter	4 (13.3%)
History of CKD (month)		18.6 ± 11.94
US stage of CKD	**Stage 1**	2 (6.7%)
	Stage 2	13 (43.3%)
	Stage 3	6 (20.0%)
	Stage 4	3 (10.0%)
	Stage 5	6 (20.0%)
WHO functional class	**1**	13 (43.3%)
	2	9 (30.0%)
	3	7 (23.3%)
	4	1 (3.3%)
6 MWT	**< 165 m**	8 (26.7%)
	165–440 m	2 (6.7%)
	> 440 m	20 (66.7%)
Syncope	**Occasional**	5 (16.7%)
	Repeated	5 (16.7%)
BNP	**< 50 ng/L**	20 (66.7%)
	50–800 ng/L	7 (23.3%)
	> 800 ng/L	3 (10.0%)
Signs of right HF		5 (16.7%)

Data are displayed as mean ± SD or frequency (%)

DM diabetes mellitus, *HTN* hypertension, *CKD* chronic kidney disease, *WHO* World Health Organization, *6 MWT* 6 min' walk test, *BNP* brain natriuretic peptide, *HF* heart failure

Table 2 Echocardiographic, VQ scan data, sPAP, dPAP, and mPAP according to RHC and percentage of radiological signs of CT chest of the studied CKD patients

		N = 30
Right atrial surface area	**< 18 cm^2**	20 (66.7%)
	18–26 cm^2	5 (16.7%)
	> 26 cm^2	5 (16.7%)
ECHO TAPSE/sPAP	**< 0.19 mm/mmHg**	5 (16.7%)
	0.19–0.32 mm/mmHg	5 (16.7%)
	> 0.32 mm/mmHg	20 (66.7%)
Pericardial effusion	**Minimal**	5 (16.7%)
	Moderate	4 (13.3%)
	Large	1 (3.3%)
VQ scan	**Normal**	22 (73.3%)
	+ ve evidence of PE	8 (26.7%)
sPAP		51.9 ± 19.10
dPAP		34.2 ± 13.65
mPAP		41.1 ± 19.08
Radiological signs of CT chest	**Pericardial effusion**	3 (4.0%)
	Pulmonary congestion	12 (16.0%)
	Pleural effusion	4 (5.0%)
	Mosaic lung pattern and multiple atelactic band	8 (10.0%)
	Cardiomegaly	23 (30.0%)
	Normal	2 (3.0%)
	Dilated pulmonary artery	25 (32.0%)

Data are displayed as mean ± SD or frequency (%)

RHC right heart catheterization, *CKD* chronic kidney disease, *TAPSE* tricuspid annular plane systolic excursion, *sPAP* pulmonary artery pressure, systolic, *V/Q* ventilation/perfusion, *CT* computerized tomography

5 patients (16.7%) were showing a minimal amount, 4 patients (13.3%) experienced a moderate amount, while 1 patient (3.3%) was showing a large amount of pericardial effusion. VQ scans were normal in 22 of patients (73.3%), while 8 patients (26.7%) were associated with positive evidence of pulmonary embolism. The mean of sPAP was 51.9 ± 19.10 mmHg, dPAP was 34.2 ± 13.65 mmHg, while mPAP was 18.0–82.0 mmHg. Regarding radiological signs of CT Chest, in the examined patients, the most frequent radiological sign was dilated pulmonary artery in 25 (32%) patients followed by cardiomegaly in 23 (30%) patients, while the least radiological sign was pericardial effusion in 3 (4%) patients and 2 (3%) patients showed no abnormal CT Chest findings (Table 2).

The CKD patients' risk assessment according to RHC hemodynamics 20 patients (66.7%) were low risk, five cases (16.7%) exhibited intermediate, while 5 cases (16.7%) developed high risk. As regards pulmonary arterial hypertension (PAH) causes among the assessed cases (diagnosed following CT, VQ scan, lab testing, ECHO, RHC), the predominant PAH diagnosis was idiopathic PAH 11(36.7%) of all cases followed by PAH due to cardiac causes in 9(30.0%) cases followed by chronic thromboembolic PH in 8(26.7%) cases and 2(6.7%) experience normal pulmonary hemodynamics by RHC (Table 3).

In the relation between CKD stage and risk assessment of PH in the studied patients, a statistically significant association was documented between CKD stage and risk assessment of PH within stage 3 CKD patients p value 0.001. Association between CKD management and risk assessment of PH of the studied patients. A statistically significant association was documented among CKD patients undergoing dialysis as well as risk assessment of PH *P* value 0.002. In patients on medical treatment, 13

Table 3 Risk assessment of PH and pulmonary HTN type the studied CKD patients

		N = 30
Risk assessment of PH	**Low**	20 (66.7%)
	Intermediate	5 (16.7%)
	High	5 (16.7%)
Type	**Idiopathic PAH**	11 (36.7%)
	PH associated with left heart disease	9 (30.0%)
	PH associated with pulmonary artery obstructions	8 (26.7%)
	Normal	2 (6.7%)

Data are presented as frequency (%)

HTN hypertension, *PAH* pulmonary arterial hypertension, *CKD* chronic kidney disease, *PH* pulmonary hypertension

patients (72.2%) showed low risk while 2 patients (50%) of patient depending on dialysis showed high risk (Table 4).

Discussion

PH represents a condition affecting the pulmonary vasculature's small arteries, inducing progressive blockage that results in increased PVR as well as PAP, which are defining features of such a condition [10]. Elevated PVR often is linked to right ventricular failure, resulting in higher death rates [11]. The PH mechanisms are still unclear.

Based on the WHO functional class for dyspnea within our research, 43.3% of the cases developed class I, whereas 30% exhibited class II. D'Alto, M. et al. [12] found that the mean WHO FC ± SD was 2.6 ± 0.6 in patients with suspicion of PH. Some clinics often use the subclavian vein over the femoral vein due to greater chances of infections as well as thrombotic problems associated with the latter. The right internal jugular vein is a suitable choice based on recommendations along with prior research. In contrast, Waheed, O. et al. [13] addressed that antecubital venous access for right heart catheterization (RHC) exhibits greater success rates and a quick learning curve and is quite safe even when done with complete anticoagulation. According to right atrial surface area, 66.7% (20 patients) were < 18 cm^2, 16.7% (5 patients ranged from 18 to 26 cm^2, while 16.7% (5 patients) were > 26 cm^2. According to TAPSE/sPAP ratio 16.7% (5 patients) were less than < 0.19 mm/mmHg, 16.7% (5 patients) ranged from 0.19 to 0.32 mm/mmHg, while 66.7% (20 patients) were more than 0.32 mm/mmHg. According to the presence of pericardial effusion, 66.7% (20 patients) experienced no pericardial effusion, 16.7% (5 patients) experience a minimal amount, 13.3% (4 patients) experienced a moderate amount, while 3.3% (1 patient) experienced a large amount of pericardial effusion. According to RAP, 66.7% (20 patients) were < 8 mmHg, 16.7% (5 patients) ranged from 8 to 14 mmHg, while 16.7% (5 patients) were more than 14 mmHg. According to SVI, 66.7% (20 patients) were > 38 mL/m2, 16.7% (5 patients) ranged from 8 to 14 mmHg, while 16.7% (5 patients) were < 31 mL/m^2. According to CI, 66.7% (20 patients) were > 2.5 L/min/m^2, 16.7% (5 patients) ranged from 2.0 to 2.4 L/min/m^2, while 16.7% (5 patients) were < 2.0 L/min/m^2. According to hemodynamics SVO2, 66.7% (20 patients) were > 65%, 16.7% (5 patients) ranged from 60 to 65%, while 16.7% (5 patients) were < 60%. According to signs of right, HF was absent in 83.3% (25 patients) and was present in 16.7% (5 patients).

Papolos et al. [14] reported that tricuspid annular planar systolic excursion (TAPSE (cm) was 1.9 ± 0.6.

Mean CO ± SD exhibited 3.7 ± 1.25 L/min (ranging from 1.9 to 6 L/min). Mean cardiac index CI ± SD exhibited 1.7 ± 0.55 L/min/m^2. Grymuza, M. et al. [15] addressed a mean CO ± SD of 5.5 ± 1.7 L/min. the mean ± SD CI exhibited 2.9 ± 0.8 L/min/m^2. Additionally,

Table 4 Association between stages of the studied CKD and CKD management and risk assessment in the studied CKD patients with PH

		Risk assessment			*P*
		Low (*n* = 20)	**Intermediate (*n* = 5)**	**High (*n* = 5)**	
US stage of CKD	**Stage 1 (*n* = 2)**	2(100.0%)	0(0.0%)	0(0.0%)	0.585
	Stage 2 (*n* = 12)	10(83.3%	0(0.0%)	2(16.7%)	0.125
	Stage 3 (*n* = 6)	2(33.3%)	4(66.7%)	0(0.0%)	**0.001***
	Stage 4 (*n* = 3)	1(33.3%)	1(33.3%)	1(33.3%)	0.435
	Stage 5 (*n* = 7)	5(71.4%)	0(0.0%)	2(28.6%)	0.312
CKD management	**Medical ttt (*n* = 18)**	13(72.2%)	3(16.7%)	2(11.1%)	0.974
	Dialysis shunt (*n* = 8)	7(87.5%)	0(0.0%)	1(12.5%)	0.295
	Dialysis catheter (*n* = 4)	0(0.0%)	2(50.0%)	2(50.0%)	**0.002***

Data are displayed as frequency (%)

* Significant *P* value < 0.05, *CKD* chronic kidney disease

D'Alto, M. et al. [19], Lindqvist, P. et al. [16], and Swanson, RL. et al. [17], in agreement with our research.

PAH is caused among assessed cases (diagnosed following CT, Lab testing, ECHO, RHC). Our findings addressed; the predominant etiology was idiopathic PAH, 36.7% ($n=11$) of all procedures followed by PAH due to left side heart disease 30% ($n=9$) followed by chronic thromboembolic PH 26.7% ($n=8$). Pre-capillary PH were 66.7% ($n=20$) while post-capillary PH 26.7% ($n=8$) and 2 cases were experiencing normal range of pulmonary hemodynamics representing 6.7%, which supported Papolos et al. [14] addressing, 196 (65%) exhibited type 1. 44 (15%) exhibited type 2, 28 (9%) developed type 3, 17 (6%) developed type 4 while 6 (2%) exhibited type 5.

In the present study, according to co-morbidities 56.7% (17 patients) were diabetic. Sobh et al. [18] addressed, the renal disease predominant etiology was DM (31.3%), then hypertension (25%), and obstructive uropathy (12.5%).

A statistically significant association was documented among CKD stage as well as risk assessment of PH, which supported Suresh et al. [19] reported 108 cases developing CKD managed were selected. Among CKD cases developing stage 3 and 4, most cases developed mild PH; however, within stage 5, the majority exhibited moderate PH (23 out of 97 [23.7%]) cases, addressing that the PH severity worsened as CKD progressed, but they reported no significance, as few cases exhibited stage 3 as well as stage 4. Also, O'Leary et al. [20] in total, 4635 patients underwent catheterization: 1873 (40%) cases exhibited CKD stage III or higher, with 1518 cases at stage III, 230 cases at stage IV, and 125 cases at stage V. 1267 cases developing CKD exhibited PH, representing a frequency of 68%. The PH occurrence rose as the CKD stage advanced ($P<0.001$). The PH cases exhibited higher prevalence of other co-morbidities, involving DM (25% vs 16%; $P<0.001$). Li et al. found that the PH occurrence among CKD stages 1-5D exhibited 2.2%, 6.7%, 7.9%, 15.2%, 20.0%, and 37.5%, respectively.

There was a statistically significant correlation P value of 0.008. Patients on medical treatment 60% (12 patients) showed low risk while 33.3% of patients depending on dialysis showed high risk. This was in line with Bolignano et al. [4] addressed a PH occurrence falling between 9 and 39% among stage 5 CKD cases, 18.8 and 68.8% among cases undergoing hemodialysis, while 0 and 42% of cases undergoing peritoneal dialysis therapy. Kumari et al. [21] addressed, that the PH occurrence was more among patients on hemodialysis (27.78%).

It shows that the mean heart rate ± SD was (86.68 ± 13.685 beat/min), and the mean blood pressure ± SD was (125.91 ± 15.519 mmHg). Concerning the right atrium pressure (RAP), the mean systolic RAP ± SD exhibited 10.04 ± 2.738 mmHg ranging from 5 to 16 mmHg, and the mean diastolic RAP ± SD exhibited 3.53 ± 2.796 mmHg ranging from 0 to 10 mmHg, the mean RAP ± SD exhibited 7.84 ± 2.118 mmHg ranging from 4 to 14 mmHg. Concerning the right ventricle pressure, the mean systolic RVP ± SD exhibited 49.77 ± 9.986 mmHg ranging from 31 to 69 mmHg, the mean diastolic RVP ± SD exhibited 8.19 ± 3.907 mmHg ranging from 1 to 16 mmHg, and the mean RVP ± SD exhibited 36.03 ± 7.503 mmHg ranging from 1 to 16 mmHg. With reference to PAP, mean systolic PAP ± SD exhibited 53.01 ± 11.192 mm Hg (ranging from 35 to 75 mm Hg), mean diastolic PAP ± SD exhibited 32.99 ± 8.283 mm Hg (ranging from 20 to 51 mm Hg), and mean PAP ± SD exhibited 46.35 ± 10.036 mm Hg (ranging from 30 to 67 mmHg). Furthermore, PCWP, mean PAWP ± SD exhibited 23.48 ± 5.009 mm Hg (ranging from 15 to 34 mmHg). Mean CO ± SD exhibited 4.00 ± 0.773 L/min ranging from 2.41 to 5.57 L/min. mean CI ± SD exhibited 1.94 ± 0.416 L/min/m^2 ranging from 0.99 to 2.78 L/min/m^2). Pre-capillary PH was 66.7% ($n=20$) when combined pre- and post-capillary PH 6.7% ($n=2$) and lastly isolated post-capillary PH 26.7% ($n=8$). O'Leary et al. [20] reported that those with PH had higher RAP (11 mmHg). Post-capillary PH represented the most frequent PH phenotype between CKD cases referred for RHC, 965 (76%) vs 302 (24%) for pre-capillary PH ($P<0.001$). Papolos et al. [14] reported that the heart rate (BPM) was 77 ± 15.7. PCWP was 11.4 ± 5.9. Fick cardiac index (L/min/m^2) was 2.8 ± 2.3.

Conclusion

PH was diagnosed in 28 CKD patients confirmed by right (RT) side cardiac catheterization among 120 CKD patients studied for PH assessment representing 23.5%. Rt-side cardiac catheterization is more accurate than echocardiography in confirming the diagnosis of PH. The severity of PH showed significant association with the CKD stage. CKD patients on regular dialysis were noticed to have high-risk stratification of PH.

Limitations

The sample size was relatively small numbers of patients, so we recommended further studies on large numbers of patients, regular follow up of CKD patients with a clinical probability of PH to detect early pulmonary hemodynamic changes, and further comparative studies to evaluate the effect of management strategies on pulmonary hemodynamics in CKD patients.

Abbreviations

PH	Pulmonary hypertension
PVR	Pulmonary vascular resistance
PAP	Pulmonary arterial pressure
CKD	Chronic kidney disease
RHC	Right heart catheterization

PASP	Pulmonary artery systolic pressure
TRV	Tricuspid regurgitation velocity
PT	Prothrombin time
ABG	Arterial blood gases
BNP	Brain natriuretic peptide
PCWP	Pulmonary capillary wedge pressure
PAH	Pulmonary arterial hypertension
GFR	Glomerular filtration rate
RT	Right

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None.

Authors' contributions
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [EHH, and AAF], [AMAA, and AAF] and [MSH]. The first draft of the manuscript was written by [EHH] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Competing interests
The authors declare no competing interests.

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