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## ORIGINAL RESEARCH

# Pulmonary function tests and stages of chronic kidney disease, what's the correlation?

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**ABSTRACT**

**Background:**Chronic kidney disease (CKD) is a devastating medical, social, and economic problem for patients and their families.The present study correlated findings in pulmonary function test with stages of chronic kidney disease.

**Materials & Methods:**100 confirmed cases of CKD and 40 controls were included. Standard spirometric pulmonary function tests were performed immediately before and after the midweek hemodialysis session.

**Results:** Most common age group was 31-40 years [34 (34%)] followed by 21-30years [17 (17%)] and 41-50 years [16 (16%)].Most commonly observed PFT pattern was Mild restrictive [22 (22%)] followed by moderate restrictive [19 (19%)]. 25 patients with mild restrictive pattern, 13 (52%)belong to stage 3, 5 (20%) belong to stage 4, 6 (24%) belong to stage 2 and 1 (4%) belong to stage 5 CKD whereas, out of 19 patients with moderate restrictive pattern, 9 (47.36%) belong to stage 5 and 5 (26.31%) each belong to stage 2 and 3 respectively. Out of 12 patients with moderately severe restrictive pattern 6 (50%) in each belong to stage 4 and 5 respectively. All two severe restrictive pattern patients belong to stage 5 CKD.

**Conclusion:** In CKD patients there exists a significant pulmonary morbidity in restrictive pattern. This restrictive abnormality depends on stage of CKD and worsens as the CKD stage worsens. Most common finding was mild restrictive pattern suggesting that clinically patient may not get debilitating symptoms due to this.

**Key words**: CKD,hemodialysis session, pulmonary function tests

## Introduction

Chronic kidney disease (CKD) is a devastating medical, social, and economic problem for patients and their families.Prevalence CKD patients will continue to rise, reflecting the growing elderly population and increasing numbers of patients with diabetes and hypertension.[1] CKD being a multisystem disorder has many ill effects on various organs involving heart, lungs, blood, liver and brain. Pulmonary involvement causes considerable morbidity to the patient. The initial insult to the pulmonary function is supposed to occur

during early stages of CKD itself. Assessment of such clinically unapparent yet pathologically important changes is important to reduce morbidity of the patient.[2] This is particularly important in light of increased life expectancy for ESRD patient by means of kidney transplantation.[3]

Dialysis is another potential therapy in management of ESRD especially in developing countries. In developed countries also, dialysis remain main modality of management because of discrepancy in the need and availability of organ donors.[4] Patients with CKD undergoing dialysis can develop dysfunction in multiple systems such as the musculoskeletal, cardiovascular, metabolic and respiratory systems. The musculoskeletal system is seriously affected, and there are several interrelated causal factors in the development of muscle problems in patients with CKD.[5] Various toxins that accumulate in the body due to impaired renal function as well as electrolyte abnormalities are responsible for the muscular involvement as per many studies.[6] The muscles responsible for respiratory function such as the diaphragm and intercostal, among others, are classified as skeletal muscles and may show decreases in muscle strength and endurance properties resulting from uremic myopathy.[7]The present study correlated findings in pulmonary function test with stages of chronic kidney disease.

## Materials & methods

The present study comprised of 100 confirmed cases of CKD and 40 controlsadmitted in medicine ward aged between 16-50 years. Exclusion criteria comprised of known cases of Asthma, Heart disease, COPD, Pulmonary TB and ILD, all critically ill and hemodynamically unstable patients.

Body mass index (BMI) was calculated as the ratio weight/height$^2$ (kg/m$^2$). Blood samples were collected from all patients for the biochemical and hematological parameters. Standard spirometric pulmonary function tests were performed immediately before and after the midweek hemodialysis session. Forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), peak expiratory flow rate (PEFR), mean forced expiratory flow between 25% and 75% of the FVC (FEF25–75), and the FEV1/FVC ratio were measured and calculated as%predicted using normal values determined on the basis of age, race, height, and sex (FVC%, FEV1%, PEFR%, and FEF 25–75%).All the data were analyzed using IBM SPSS Ver. 20 software. Data were expressed as percentage and mean±SD. The data was analyzed with "the independent samples t-test." This was significant if the p-value is <0.05.

## Results

**Table 1: Age Distribution**

| Age group | No of patients | Percentage |
|---|---|---|
| 10-20 | 6 | 6 |
| 21-30 | 17 | 17 |
| 31-40 | 34 | 34 |
| 41-50 | 18 | 18 |
| 51-60 | 16 | 16 |
| 61-70 | 9 | 9 |
| **Total** | **100** | **100.0** |

Table I shows that most common age group was 31-40 years [30 (30%)] followed by 21-30 [16 (16%)] and 41-50 years [16 (16%)].

**Table II Distribution of patients according to CKD Staging**

| | | Frequency | Percent |
|---|---|---|---|
| CKD Stage | Stage 2 | 14 | 20.0 |
| | Stage 3 | 17 | 24.2 |
| | Stage 4 | 18 | 25.8 |
| | Stage 5 | 21 | 30.0 |
| | **Total** | **70** | **100** |

Table II shows that out of 70 patients, most of them were having stage 5 CKD [21 (30%)] followed by stage 4 [18 (25.8%) and 3 [17 (24.2%) and stage 2 [14 (20%)].

**Table III Distribution of patients according to PFT findings**

| PFT Findings | | Frequency | Percent |
|---|---|---|---|
| PFT Findings | MILD RESTRICTIVE | 22 | 22 |
| | MODERATE RESTRICTIVE | 21 | 21 |
| | MODERATELY-SEVERE RESTRICTIVE | 11 | 11 |
| | SEVERE RESTRICTIVE | 4 | 4 |
| | NORMAL | 42 | 42 |
| | **Total** | **100** | **100** |

Table III shows that most commonly observed PFT pattern was Mild restrictive [22 (22%)] followed by moderate restrictive [21(21%)].

**Table IV Distribution of patients according to PFT findings based on CKD stages**

| PFT pattern | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Total |
|---|---|---|---|---|---|
| Normal | 9(100) | 0 (0) | 0 (0) | 0 (0) | 9 (100) |
| Mild restrictive | 6 (24) | 13 (52) | 5 (20) | 1 (4) | 25 (100) |
| Moderate restrictive | 0 (0) | 5 (26.31) | 5 (26.31) | 9 (47.36) | 19 (100) |
| Moderately severe restrictive | 0 (0) | 0 (0) | 6 (50) | 6 (50) | 12 (100) |
| Severe restrictive | 0 (0) | 0 (0) | 0 (0) | 2 (100) | 2 (100) |
| Total | 15 | 18 | 16 | 18 | |

Table IV shows that out of 25patients with mild restrictive pattern, 13 (52%)belong to stage 3, 5 (20%) belong to stage 4, 6 (24%) belong to stage 2 and 1 (4%) belong to stage 5 CKD whereas, out of 19 patients with moderate restrictive pattern, 9 (47.36%) belong to stage 5 and 5 (26.31%) each belong to stage 2 and 3 respectively. Out of 12 patients with moderately severe restrictive pattern 6 (50%) in each belong to stage 4 and 5 respectively. All two severe restrictive pattern patients belong to stage 5 CKD.

**Table VBaseline parameters between case and control groups**

| Cohort | | N | Mean | Std. deviation | Std. Error Mean | p |
|---|---|---|---|---|---|---|
| Age | Control | 40 | 39.17 | 11.18 | 2.04 | 0.447 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Case | 60 | 41.47 | 14.45 | 1.87 | |
| Urea | Control | 40 | 32.10 | 5.47 | 1.00 | <0.001 |
| | Case | 60 | 89.52 | 49.86 | 6.44 | |
| Creatinine | Control | 40 | 0.81 | 0.26 | 0.05 | <0.001 |
| | Case | 60 | 4.50 | 3.80 | 0.49 | |
| CrCl | Control | 40 | 96.93 | 3.28 | 0.60 | <0.001 |
| | Case | 60 | 28.10 | 20.22 | 2.61 | |
| FVC | Control | 40 | 95.46 | 4.14 | 0.76 | <0.001 |
| | Case | 60 | 69.32 | 12.14 | 1.57 | |
| FEV1 | Control | 40 | 94.77 | 4.29 | 0.78 | <0.001 |
| | Case | 60 | 78.46 | 11.07 | 1.43 | |
| FEV1/ FVC | Control | 40 | 95.05 | 3.93 | 0.72 | <0.001 |
| | Case | 60 | 102.56 | 8.28 | 1.07 | |
| FEF 25-75 | Control | 40 | 76.81 | 2.93 | 0.53 | <0.001 |
| | Case | 60 | 70.90 | 7.57 | 0.98 | |
| PEF | Control | 40 | 90.35 | 5.91 | 1.08 | <0.001 |
| | Case | 60 | 84.92 | 7.35 | 0.95 | |

Table V shows that while comparing between Cases and Control, urea, creatinine and FEV1/FVC was significantly higher, whereas CrCl, FVC, FEV1, FEF 25-75 and PEF was significantly lower respectively.

**Table VI Correlation between renal and PFT parameters**

| **Descriptive Statistics** | | | | |
|---|---|---|---|---|
| CKD | | Mean | Std. Deviation | N |
| Control | Urea | 31.1234350 | 5.335346 | 40 |
| | Creatinine | .808667 | .2665575 | 40 |
| | CrCl | 95.453544 | 3.253445 | 40 |
| | FVC | 95.4735563 | 4.632445 | 40 |
| | FEV1 | 94.434654 | 4.1232254 | 40 |
| | FEV1/ FVC | 95.3433312 | 3.8978898 | 40 |
| | FEF 25-75 | 76.5448437 | 2.9674236 | 40 |
| | PEF | 90.345000 | 5.9096115 | 40 |
| Stage 2 | Urea | 61.250000 | 6.7973925 | 15 |
| | Creatinine | 1.580833 | .1845121 | 15 |
| | CrCl | 60.700000 | .8964577 | 15 |
| | FVC | 86.675000 | 7.5603181 | 15 |
| | FEV1 | 92.250000 | 4.5094850 | 15 |
| | FEV1/ FVC | 102.908333 | 2.4130171 | 15 |
| | FEF 25-75 | 78.933333 | 1.3337121 | 15 |
| | PEF | 95.991667 | 3.5025856 | 15 |
| Stage 3 | Urea | 55.800000 | 9.5259045 | 18 |
| | Creatinine | 2.023333 | .3565242 | 18 |
| | CrCl | 37.180000 | 5.4137655 | 18 |
| | FVC | 70.725333 | 4.6706896 | 18 |
| | FEV1 | 83.060000 | 2.4694707 | 18 |
| | FEV1/ FVC | 103.906667 | 3.0834736 | 18 |

| | | | | |
|---|---|---|---|---|
| | FEF 25-75 | 75.753333 | 4.3928297 | 18 |
| | PEF | 87.293333 | 2.2808102 | 18 |
| Stage 4 | Urea | 74.333333 | 20.6870100 | 16 |
| | Creatinine | 3.699333 | .7083428 | 16 |
| | CrCl | 17.980000 | 3.8921533 | 16 |
| | FVC | 65.806667 | 8.0712423 | 16 |
| | FEV1 | 75.926667 | 6.7308954 | 16 |
| | FEV1/ FVC | 104.020000 | 7.3394433 | 16 |
| | FEF 25-75 | 69.160000 | 6.6994456 | 16 |
| | PEF | 82.806667 | 3.2901295 | 16 |
| Stage 5 | Urea | 149.122222 | 51.3799063 | 18 |
| | Creatinine | 9.165000 | 3.8155337 | 18 |
| | CrCl | 7.216667 | 2.4684480 | 18 |
| | FVC | 59.494444 | 8.7058785 | 18 |
| | FEV1 | 67.527778 | 9.2090624 | 18 |
| | FEV1/ FVC | 99.993889 | 13.1013350 | 18 |
| | FEF 25-75 | 62.938889 | 2.9500028 | 18 |
| | PEF | 77.316667 | 3.1205674 | 18 |

Table VI shows that there was correlation between renal and PFT parameters.

**Discussion**

The relationships between the lungs and the kidneys are clinically important ones in both health and disease. Chronic renal failure may affect respiratory function.[8] Pulmonary dysfunction may be the direct consequence of circulating uremic toxins or may result indirectly from volume overload, anaemia, immune suppression, extra osseous calcification, malnutrition, electrolyte disorders, and/or acid–base imbalances.[9,10]

In the study, most common age group was 31-40 years and there is clear cut male predominance (64%). This trend is same as those in many other studies indicating the risk of male gender for CKD. In the study, most commonly observed PFT pattern was Mild restrictive (25%) followed by moderate restrictive (19%).Out of 70 patients with mild restrictive pattern, 13 (52%) belong to stage 3, 5 (20%) belong to stage 4, 6 (2%) belong to stage 2 and 1 (4%) belong to stage 5 CKD whereas, out of 19 patients with moderate restrictive pattern, 9 (47.36%) belong to stage 5 and 5 (26.31%) each belong to stage 2 and 3 respectively. Out of 12 patients with moderately severe restrictive pattern 6 (50%) in each belong to stage 4 and 5 respectively. All three severe restrictive pattern patients belong to stage 5 CKD.Navaneetetal[12]evaluated 7,610 participants.Prevalence of obstructive lung function adjusted to the mean age of 55 years and 50% men in the CKD and non-CKD groups were 15.6% and 13.3%, respectively (P = 0.2).

In present study out of 60 patients 46.67% were diabetic and 52.75% were hypertensives, but both are considered as the important risk factors for the development of renal complications. Most of them were having stage 5 CKD (35%) followed by stage 3 (20%) and stage 4 (30%) and stage 2 (15%). In this study 28 patients were diabetics. Of them 31.76% were each in stage 4 and stage 5 while 20.28% each in stages 2 & 3. Many studies conducted in diabetics' patients has found a restrictive pattern in PFT. Studies by Nandiniet al[13], Sanjeevverma et al[14]concluded that diabetics can produce a restrictive pattern.

Out of 38 Hypertensive patients, most of them had stage 5 CKD [12 (31.57%)] followed by Stage 4 [11 (28.94%)] and Stage 3 [7 (18.4%)]and stage 2 [8 (21.05%)].Hypertension

anddiabetes also has deleterious effect of spirometry findings. Out of 22 patients who were on MHD, 9 (40.9%) belong to stage 4 whereas 13 (59.1%) belong to stage 5 CKD. Study has not shown any statistically significant difference in patients on hemodialysis and not on hemodialysis. Most of the studies have shown an improvement in PFT parameters after dialysis compared to before hemodialysis. But this study compared PFT before and after hemodialysis while my study compared patients on hemodialysis with patient not on hemodialysis. Also patients were not grouped according to duration of hemodialysis.

Abdalla et al[15] studied 60 subjects after classifying them into 3 groups: Hemodialysis group (HDG) included 20 patients with end stage renal disease (ESRD) on regular hemodialysis for at least six months and were clinically stable and compared with control. They reported that There was a significant difference between HDG, TG and CG regarding FVC% of predicted, FEV1% of predicted, FEF 25–75% of predicted and PEFR% of predicted which is in agreement with the present study findings.

Finally, correlation between PFT changes and abnormal RFT was analyzed. No significant correlation was found. Most probably this is because, only single cross sectional value was considered and not the average value over a period of time. CKD is a state of delicately balanced homeostasis. Even mild conditions like infections, diarrhea, vomiting etc. is sufficient to disturbed this balance and cause abnormal RFT. Commonly used drugs like NSAIDS, ACE/ARBS etc. can also disturb this balance.

## Conclusion

This study found out that in CKD patients there exista significant pulmonary morbidity in restrictive pattern. This restrictive abnormality depends on stage of CKD and worsens as the CKD stage worsens. Most common finding was mild restrictive pattern suggesting that clinically patient may not get debilitating symptoms due to this. But since CKD is a multisystem disorder and a delicately balanced state, reduction in pulmonary reserve have significance.

## References

1. Abdalla ME, AbdElgawad M, Alnahal A. Evaluation of pulmonary function in renal transplant recipients and chronic renal failure patients undergoing maintenance hemodialysis. Egyptian Journal of Chest Diseases and Tuberculosis 2013; 62:145-150.
2. Banerjee T, Nataraj SM, Shirur SY. A comparative study of pulmonary function in chronic kidney disease patients pre and post hemodialysis. International journal of Recent Trends in Science and Technology 2014; 13 (1):67-9.
3. Lee HY, Stretton TB. The lungs in renal failure. Thorax 1975; 30: 46-53.
4. Bush A, Gabriel R. Pulmonary function in chronic renal failure: effects of dialysis and transplantation. Thorax 1991 46: 424-8.
5. de Souza Faria R, Fernandes N, Lovisi JCM, de MouraReboredo M, de Moura Marta MS, Bruno do Valle Pinheiro. Pulmonary function and exercise tolerance are related to disease severity in pre-dialytic patients with chronic kidney disease: a cross-sectional study. BMC Nephrology 2013;14:184.
6. Palamidas AF, Gennimata SA, Karakontaki F, Kaltsakas G, Papantoniou I, Koutsoukou A et al. Impact of Hemodialysis on Dyspnea and Lung Function in End Stage Kidney Disease Patients. BioMed Research International 2014; 2014: 1-10.
7. CuryJL, Brunetto AF, Aydos RD. Negative effects of chronic kidney failure on lung function and functional capacity. Rev Bras Fisioter. 2010;14 (2):91-8.

8. Bush A, Gabriel R. Pulmonary function in chronic renal failure: effects of dialysus and transplantation. Thorax. 1991;46 (6):424-8.
9. Gómez-Férnandez P, Sánchez Agudo L, Calatrava JM, Escuin F, Selgas R, Martínez ME, et al. Respiratory muscle weakness in uremic patients under continuous ambulatory peritoneal dialysis. Nephron. 1984;36(4):219-23.
10. Oh-Park M, Fast A, Gopal S, Lynn R, Frei G, Drenth R, et al. Exercise for the dialyzed: aerobic and strength training during hemodialysis. Am J Phys Med Rehabil. 2002;81(11):814-21.
11. Becker-Cohen R, Nir A, Rinat C, Feinstein S, Algur N, Farber B, et al. Risk factors for cardiovascular disease in children and young adults after renal transplantation. Clin J Am SocNephrol. 2006;1(6):1284-92.
12. Sietsema KE, Amato A, Adler SG, Brass EE. Exercise capacity as a predictor of survival among ambulatory patients with end-stage renal disease. Kidney Int. 2004;65(2):719-24.
13. Reboredo MM, Henrique DMN, Faria RS, Bergamini BC, Bastos MG, Paula RB. Correlação entre a distânciaobtida no teste de caminhada de seisminutos e o pico de consumo de oxigênioempacientesportadores de doença renal crônicaemhemodiálise. J Bras Nefrol. 2007;29(2):85-9.
14. Khamis OA, TAE E, Abd El-Rahman Ibrahim Mohammed Ali. Prevalence of Pulmonary Hypertension among Chronic Kidney Disease Patients and its Relation to Location and Blood Flow of Vascular Access. Int J ClinCardiol 2015;2:045.
15. Yilmaz S, Yildirim Y, Yilmaz Z, Kara AV, Taylan M, Demir M et al.Pulmonary Function in Patients with End-Stage Renal Disease: Effects of Hemodialysis and Fluid Overload. Med SciMonit, 2016; 22: 2779-2784.