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COVID-19 in End-Stage Renal Disease, Does It Differ? Multicentre, Retrospective Study

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ABSTRACT

Background: Patients with end-stage renal disease (ESRD) are highly liable to COVID-19 and are liable for its severe complications. Assessment of the infection of covid-19 in this special group of population is mandatory in their medical follow up strategies. **Methods:** In this multicenter retrospective cohort study (February to may2023, Menoufia, Egypt), 57 ESRD patients on maintenance hemodialysis with confirmed COVID-19 were compared with 482non-ESRD COVID-19 patients from general population. Clinical data and outcomes were collected and analyzed. Odds ratio (ORs) with 95% confidence intervals (CIs) were calculated.

Results: ESRD patients reported fewer typical symptoms, including fever (38.6% vs. 73.9, $p < 0.001$) and cough (10.5% vs. 67.8%, $p < 0.001$). However, outcomes were significantly worse: intensive care unit (ICU) admission was over fourfold higher (31.6% vs. 6.8%; RR 4.64, 95% CI 2.55–8.44), mortality nearly doubled (26.3% vs. 15.1%; RR 1.74, 95% CI 1.02–2.96), and post-COVID thrombosis tripled (8.8% vs. 2.7%; RR 3.24, 95% CI 1.10–9.55). Adverse events after CoronaVac vaccination were less frequent in ESRD patients, including injection-site pain (26.3% vs. 42.3%, $p = 0.020$) and fatigue (12.3% vs. 25.9%, $p = 0.023$). **Conclusion:** ESRD patients with COVID-19 present atypically but suffer more severe outcomes, including higher ICU admission, mortality, and thrombosis. Vaccination was well tolerated, though reduced reactogenicity may reflect blunted immune responses. These findings highlight the need for early testing, close monitoring, and optimized vaccination strategies in dialysis populations.

Keywords: COVID-19, End-stage renal disease, Hemodialysis, Vaccine safety, Mortality, Thrombosis.

INTRODUCTION

Patients with end-stage renal disease (ESRD) on maintenance dialysis have consistently shown higher susceptibility to SARS-CoV-2 infection and worse outcomes than the general population. Early multicenter registry data from Europe (ERACODA) reported a 28-day case-fatality rate of ~25% in dialysis patients with COVID-19, with age and frailty being the strongest predictors of death [1]. Single-center cohorts from hard-hit regions mirrored the signal of severe disease; for example, a New York series observed 31% in-hospital mortality overall and 75% of death of patients was among those requiring mechanical ventilation [2]. Facility-level surveillance during the Delta and early Omicron waves further confirmed that maintenance dialysis patients experienced substantially higher infection and death rates than the U.S. population, although vaccination attenuated these risks [3].

Clinical presentation in dialysis often resembles that of the general population (fever, cough, dyspnea), but the obligatory thrice-weekly attendance at in-center units and reliance on shared transport increase exposure risk. Outbreak-control strategies tailored to dialysis settings can work: a Korean multicenter experience demonstrated that "cohort isolation" of exposed hemodialysis contacts limited within-unit transmission to 0.66% across 11 centers [4]. Modality and setting may modify risk. An analysis from the U.S. Renal Data System periodicals showed outcome differences by dialysis modality and treatment setting, with home modalities generally associated with lower exposure opportunities than in-center care [5].

In contrast, ERACODA's dedicated peritoneal dialysis analysis (2023) found higher 3-month mortality in PD than HD after adjusting for patient characteristics and disease severity, underscoring that selection and illness severity likely influence observed modality differences [6]. Beyond acute survival, recovery appears possible for many survivors. ERACODA investigators reported that, at three months post-diagnosis, most hemodialysis survivors returned to pre-COVID functional (87%) and mental (94%) status, though outcomes were worse after ICU care and among older/frail patients [7].

Vaccination in ESRD shows a characteristic pattern: blunted but meaningful immunogenicity and clear clinical effectiveness. Large serology cohorts documented attenuated antibody responses after primary series in dialysis [8], while a national dialysis-provider study showed that a third (booster) mRNA dose elicited a high seroresponse in most patients, including prior poor responders [9]. A comprehensive nephrology review concluded that mRNA-1273 often generates higher antibody titers than BNT162b2 in dialysis, that vector vaccines are less immunogenic, and that boosters are needed because of waning and immune-escape variants

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[10].Crucially, a population-wide effectiveness study in Ontario dialysis patients demonstrated that two mRNA doses were highly effective against infection (adjusted HR ~0.31) and severe outcomes (adjusted HR ~0.17) versus unvaccinated periods [11].

Despite substantial international evidence, there is a striking lack of multicenter data from Egypt and the broader MENA region describing COVID-19 in ESRD, where care patterns (predominantly in-center hemodialysis with low home-dialysis uptake), vaccine portfolios (heavy early use of inactivated platforms with heterogeneous booster coverage), and variant waves differ from high-income settings. A pragmatic, multicenter Egyptian cohort linking dialysis-unit records with standardized COVID-19 case definitions could quantify infection, hospitalization, ICU admission, and mortality across variant epochs; compare outcomes of dialysis patients to the general population will close a critical evidence gap for Egyptian dialysis care.So, we aimed in this work to discuss if the infection with covid-19 in patients suffering from ESRD differ from general population or not regarding the clinical features, outcomes, post-COVID sequelae, and vaccine-related adverse events.

PATIENTS AND METHODS

Study Design and Population

This retrospective multicenter cohort study was done at dialysis centers in Menoufia governorate, Egypt between February 2023 and May 2023. The study included two main groups:

- **ESRD group:** 400 patients with end-stage renal disease (ESRD) on maintenance hemodialysis in dialysis units in Menoufia governorate, Egypt. Only 57 patients from them were confirmed to had covid-19 infection.
- **General population group:** 900 individuals from the community. Only 482 of them were confirmed to had covid-19 infection.

Inclusion criteria

- Age ≥18 years.
- ESRD group: all ESRD patients who are on dialysis for more than 6 months.
- General population group: all welling participants (employees, university students, neighbors, relatives)

Exclusion criteria

- Age <18 years.
- **For ESRD participants**: dialysis duration less than 6 months, ESRD patients with malignant tumor, autoimmune disease, chronic liver disease, COPD or heart failure.
- **For general population participants**: anyone with any chronic disease (CKD, COPD, chronic liver cell failure, chronic heart failure or autoimmune disease)

Data Collection

Data were obtained retrospectively from hospital records and supplemented by direct patient interviews, first degree relative interviews, nurses working in dialysis centers, nephrology residents in dialysis centers.

Collected variables included:

- **Sociodemographic characteristics:** age, sex, residence.
- **Medical history:** comorbidities (hypertension, diabetes mellitus) any chronic disease for exclusion (heart disease, COPD, or other chronic conditions), smoking status, and mask-wearing compliance.
- **COVID-19–related data:**
  - Infection status and source of exposure (if known).
  - Clinical manifestations (fever, dry cough, fatigue, anosmia, dizziness, loss of concentration, vomiting, dyspnea, diarrhea, bone/joint pain, headache, sore throat, wheezes, skin rash).
  - Duration and persistence of symptoms, as well as new or residual symptoms post-recovery (e.g., loss of taste/smell, fatigue, psychological distress).
  - Place of treatment (treated at home, admitted to hospital ward, or admitted to intensive care unit [ICU]).
  - Oxygen requirement (at home or admitted to hospital) and treatment protocol.
  - Clinical outcome, including recovery, complications, and mortality.
  - Complication occurrence after covid-19 vaccination and what was the complication.

  For ESRD patients, mortality data and causes of death were confirmed from hospital files and resident physician reports and resident themselves.

Diagnostic Methods

COVID-19 was diagnosed by either **polymerase chain reaction (PCR)** testing or **chest computed tomography (CT)** findings consistent with SARS-CoV-2 infection. All included participants we examined their CT of diagnosis of COVID to confirm the diagnosis or see the positive covid-19 laboratory investigation (PCR).

Ethical Considerations

Ethical approval: The Institutional Review Board of Menoufia University approved the study and all patients provided informed consent (Approval No.: 8/2023/INTM4-4). The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

Statistical analysis was conducted using SPSS software, version 28.0 (SPSS Inc., Chicago, IL, USA). Qualitative data were reported as absolute frequencies and percentages, while quantitative data was expressed as mean (M)±standard deviation (SD). We used the Chi-square and t-test to analyze the statistically significant differences ($p<0.05$) regarding qualitative and

quantitative data, respectively. To define potential confounders, we compared characteristics between non-ESRD and ESRD COVID-19 patients using Odds Ratio (OR) with 95% confidence intervals (CIs).

RESULTS

Baseline Characteristics

The two groups were largely comparable with respect to age, sex distribution, residence, smoking history, and the prevalence of hypertension, diabetes mellitus, and chest diseases, with no significant differences observed (Table 1). However, cardiovascular disease was significantly more prevalent in ESRD patients (24.6%) than in non-ESRD patients (12.4%), corresponding to an Odds ratio (OR) of 1.98, 95% CI [1.07–3.65], p = 0.012.

Acute COVID-19 Symptoms

Symptom profiles differed markedly between groups (Table 2). ESRD patients had a significantly lower prevalence of major COVID-19 symptoms, including fever (38.6% vs. 73.9%; OR 0.52, 95% CI [0.39–0.70]), dry cough (10.5% vs. 67.8%; RR 0.15, 95% CI [0.08–0.29]), general fatigue (15.8% vs. 52.7%; OR 0.30, 95% CI [0.17–0.51]), and loss of smell (21.1% vs. 44.6%; OR 0.47, 95% CI [0.27–0.81]), all p < 0.001. Similar risk reductions were observed for dizziness (OR 0.43, p < 0.001), diarrhea (OR 0.47, p = 0.044), bone pain (OR 0.53, p = 0.002), dyspnea (RR 0.72, p = 0.027), and headache (OR 0.63, p = 0.023). Differences in lack of concentration, sore throat, and joint pain were not statistically significant (Table 2).

Post-COVID Sequelae

Most long-term complications—including persistent dyspnea, digestive problems, fatigue, anosmia, memory impairment, and severe headache were not significantly different between groups (Table3). However, post-COVID thrombosis was significantly more frequent in ESRD patients (8.8% vs. 2.7%), with an RR of 3.24, 95% CI [1.10–9.55], p = 0.016.

Clinical Outcomes

Clinical outcomes revealed significant disparities (Table 4). ESRD patients were less often managed at home (42.1% vs. 74.3%; OR 0.57, 95% CI [0.42–0.76], p < 0.001) and more frequently required ICU admission (31.6% vs. 6.8%; OR 4.64, 95% CI [2.55–8.44], p < 0.001). Oxygen requirements did not differ significantly between groups (p = 0.226). Mortality was significantly higher in the ESRD group (26.3% vs. 15.1%), with an OR of 1.74, 95% CI [1.02–2.96], p = 0.031, underscoring the elevated risk of fatal outcomes.

Post-Vaccination Adverse Events

Adverse events following SINOVAC® vaccination were less frequent among ESRD patients (Table 5). Injection-site pain (26.3% vs. 42.3%; OR 0.62, 95% CI [0.38–0.99], p = 0.020), fatigue (12.3% vs. 25.9%; RR 0.47, 95% CI [0.22–0.99], p = 0.023), and low-grade fever (1.8% vs. 9.5%; OR 0.19, 95% CI [0.03–0.83], p = 0.049) were significantly less common. Headache and myalgia also showed a trend toward lower frequency but without statistical significance.

Table 1: Comparison of basic history data between the studied groups

variables	Non-ESRD COVID-19 Patients (n =482)	ESRD COVID-19 Patients (n =57)	P value
Age (years)	**49.4 ± 19.3**	**54.6 ± 14.1**	**0.096**
Sex			**0.235**
Male	**189 (39.2%)**	**27 (47.4%)**	
Female	**293 (60.8%)**	**30 (52.6%)**	
Residence			**0.078**
Rural	**187 (38.8%)**	**29 (50.9%)**	
Urban	**295 (61.2%)**	**28 (49.1%)**	
History of Smoking			**0.733**
Yes	**150 (31.1%)**	**19 (33.3%)**	
No	**332 (68.9%)**	**38 (66.7%)**	
Co-morbidities			
HTN	**150 (31.1%)**	**20 (35.1%)**	**0.542**
DM	**159 (33.0%)**	**23 (40.4%)**	**0.266**
Chest diseases	**53 (11.0%)**	**10 (17.5%)**	**0.146**
CVD	**60 (12.4%)**	**14 (24.6%)**	**0.012* (OR) of 1.98, 95% CI [1.07–3.65]**

Data is represented as mean ± SD or numbers(n) (%), CVD: Cardiovascular disease, DM: Diabetes melilites, ESRD: End stage renal disease, HTN: Hypertension, *Statistically significant as p value <0.05.

Table 2: Comparison of covid-19 Symptoms between the studied groups

variables	Non-ESRD COVID-19 patients (n =482)	ESRD COVID-19 patients (n =57)	P value	Odds ratio	CI (95%)
Fever	**356 (73.9%)**	**22 (38.6%)**	**<0.001***	**OR 0.52**	**[0.39–0.70]**
Dry cough	**327 (67.8%)**	**6 (10.5%)**	**<0.001***	**RR 0.15**	**[0.08–0.29]**
General fatigue	**254 (52.7%)**	**9 (15.8%)**	**<0.001***	**OR 0.30**	**[0.17–0.51]**
Loss of smell	**215 (44.6%)**	**12 (21.1%)**	**<0.001***	**OR 0.47**	**[0.27–0.81]**
Lack of concentration	**231 (47.9%)**	**22 (38.6%)**	**0.182**	**OR 0.43**	**-**
Dizziness	**254 (52.7%)**	**13 (22.8%)**	**<0.001***	**OR 0.47**	**-**
Diarrhea	**106 (22.0%)**	**6 (10.5%)**	**0.044***	**OR 0.53**	**-**
Bone pain	**223 (46.3%)**	**14 (24.6%)**	**0.002***	**RR 0.72**	**-**
Difficulty in breathing	**269 (55.8%)**	**23 (40.4%)**	**0.027***	**OR 0.63**	**-**
Headache	**202 (41.9%)**	**15 (26.3%)**	**0.023***	**-**	**–**
Sore throat	**230 (47.7%)**	**22 (38.6%)**	**0.192**	**-**	**–**
Joint pain	**118 (24.5%)**	**11 (19.3%)**	**0.386**	**-**	**–**

Data is represented as n (%), *Statistically significant as p value <0.05.

Table 3: Comparison of Post COVID-19 syndromes in the studied groups

variables	Non-ESRD COVID-19 patients (n =482)	ESRD COVID-19 patients (n =57)	P value
Difficulty in breathing	**46 (9.5%)**	**3 (5.3%)**	**0.607**
Digestive problems	**21 (4.4%)**	**1 (1.8%)**	**0.348**
Dizziness	**16 (3.3%)**	**0 (0.0%)**	**0.163**
Fatigue	**81 (16.8%)**	**5 (8.8%)**	**0.117**
Irregular blood sugar	**34 (7.1%)**	**3 (5.3%)**	**0.613**
Loss of smell	**23 (4.8%)**	**1 (1.8%)**	**0.296**
Memory impairment	**9 (1.9%)**	**0 (0.0%)**	**0.298**
Severe headache	**54 (11.2%)**	**2 (3.5%)**	**0.072**
Thrombosis	**13 (2.7%)**	**5 (8.8%)**	**0.016* OR 3.24 CI95% [1.10–9.55]**

Data is represented as n (%), ESRD: End stage renal disease, *statistically significant as p value <0.05.

Table 4: Comparison of Clinical outcomes in the studied groups

Variables COVID-19 treatment	Non-ESRD COVID-19 patients (n =482)	ESRD COVID-19 patients (n =57)	P value	Odds ratio	CI (95%)
At home	**358 (74.3%)**	**24 (42.1%)**	**<0.001***	**OR 0.57**	**[0.42–0.76]**
Hospital	**91 (18.9%)**	**15 (26.3%)**	**0.216**		
ICU	**33 (6.8%)**	**18 (31.6%)**	**<0.001***	**OR 4.64**	**[2.55–8.44]**
Need of oxygen					
Yes	**94 (19.5%)**	**15 (26.3%)**	**0.226**	**-**	**-**
No	**388 (80.5%)**	**42 (73.7%)**			
Mortality			**0.031***	**1.74**	**[1.02–2.96]**
Yes	**73 (15.1%)**	**15 (26.3%)**			
No	**409 (84.9%)**	**42 (73.7%)**			

Data is represented as n (%), ESRD: End stage renal disease, Different superscript letters denote significant difference between proportions, *statistically significant as p value <0.05.

Table 5:Comparison of Post COVID-19 vaccine (SINOVAC®) outcomes between the studied groups

Variables	Non-ESRD COVID-19 patients (n =482)	ESRD COVID-19 patients (n =57)	P value	Odds ratio	CI (95%)
Injection-site pain	**204 (42.3%)**	**15 (26.3%)**	**0.02***	**OR 0.62**	**[0.38–0.99]**
Fatigue	**125 (25.9%)**	**7 (12.3%)**	**0.023***	**OR 0.47**	**[0.22–0.99]**
Headache	**95 (19.7%)**	**6 (10.5%)**	**0.093**	**OR 0.19**	**0.03–0.83]**
Myalgia	**58 (12.0%)**	**4 (7.0%)**	**0.262**	**-**	**-**
Low-grade fever	**46 (9.5%)**	**1 (1.8%)**	**0.049***	**-**	**-**

Data is represented as n (%), ESRD: End stage renal disease, Different superscript letters denote significant difference between proportions, *statistically significant as p value <0.05.

DISCUSSION

Our study aimed to compare the clinical presentation, outcomes, post-COVID sequelae, and vaccine-related adverse events between patients suffering from end-stage renal disease (ESRD) and those who are non-ESRD individuals infected with COVID-19. The importance of this investigation lies in the fact that dialysis patients represent one of the most clinically vulnerable populations during the pandemic, yet they are often underrepresented in large-scale COVID-19 studies. By directly contrasting ESRD with non-ESRD cohorts, this study provides valuable insight into differences in symptomatology, risk of severe disease, and vaccine safety in a high-risk group.

Although previous research confirmed high mortality and hospitalization rates in dialysis patients, few studies have comprehensively compared symptom burden, long-term complications, and vaccine reactogenicity between the two groups. In particular, the observation of reduced symptom prevalence alongside increased severity and mortality has not been widely reported[12,14,18]. Our findings therefore fill an important knowledge gap by showing that less symptomatic disease does not equate to benign disease in ESRD, and by drawing attention to thrombotic complications and vaccine tolerability.

In this cohort, patients with end-stage renal disease (ESRD) who contracted COVID-19 exhibited a paradoxical profile: fewer typical acute symptoms yet markedly worse clinical outcomes, including higher intensive care unit (ICU) admission, mortality, and greater risk of post-COVID thrombosis compared with non-ESRD patients. These findings align with reports from multicenter cohorts and systematic reviews confirming dialysis as an independent Factors that increase the likelihood of experiencing severe illness or death from COVID-19. [12–14].

Our observation of a substantially lower prevalence of "classic" COVID-19 symptoms (fever, cough, fatigue, anosmia) in ESRD patients is consistent with earlier studies of maintenance hemodialysis, which showed that these patients often present with atypical or attenuated symptomatology [15,16]. Immune dysfunction, chronic inflammation, and blunted febrile responses may underlie these patterns, raising concern for delayed diagnosis and missed early therapeutic opportunities [17].

Despite having fewer acute symptoms, ESRD patients in our dataset had significantly higher ICU admission and mortality rates. This is consistent with international registry analyses and meta-analyses reporting that chronic dialysis patients face two- to three-fold higher burden of hospitalization and death due to COVID-19 persistence despite adjustment for demographic factors and underlying illnesses [12,14,18]. Mechanistically, endothelial dysfunction, systemic inflammation, and high cardiovascular comorbidity likely exacerbate the extent of illness caused by SARS-CoV-2 among these patients [19].

threefold increase in post-COVID thrombosis among ESRD patients in our study underscores a clinically significant risk. COVID-19 is a pro-thrombotic illness driven by endothelial injury and hypercoagulability [20]. Hemodialysis patients already have elevated thrombotic risk, and case series have documented late thrombotic events and dialysis-circuit clotting after COVID-19 infection in this population [21]. These findings suggest that ESRD patients require closer monitoring and potentially extended thromboprophylaxis following acute infection.

We found that ESRD patients reported fewer adverse effects following CoronaVac vaccination. This result aligns with prospective studies showing that inpatients receiving dialysis, inactivated vaccines are typically associated with acceptable tolerability, with mostly mild adverse events and often lower rates of local/systemic reactions than in healthy comparators [22,23]. Meta-analyses confirm that while immunogenicity is attenuated in renal replacement therapy, vaccine safety remains robust [24,25]. This suggests that reduced reactogenicity may reflect impaired immune activation rather than enhanced tolerability, emphasizing the importance of booster dosing in ESRD populations.

Several mechanisms may explain the dissociation between symptom burden and adverse outcomes. Uremia-associated immune dysfunction likely attenuates cytokine-driven symptoms while impairing viral clearance [17,19]. Pre-existing endothelial injury and pro-thrombotic states amplify COVID-19-related coagulopathy [20,21]. In addition, the higher prevalence of cardiovascular disease in ESRD exacerbates the risk of decompensation during infection [12,18].

Our findings underscore the need for vigilance in dialysis populations. First, symptom-based screening alone is insufficient; low-threshold testing protocols should be adopted in dialysis units [15,17]. Second, given the elevated thrombotic risk, dialysis centers should implement enhanced surveillance and consider tailored thromboprophylaxis strategies [20,21]. Third, while ESRD patients may experience fewer vaccine side effects, booster doses and monitoring of immunogenicity remain crucial to ensure adequate protection [23–25].

One of the principal strengths of this work is the comprehensive assessment of acute presentation, outcomes, post-COVID sequelae, and vaccine safety within a single cohort. Limitations include retrospective design, possible reporting bias in symptom ascertainment, and lack of immunogenicity data following vaccination. Future multicenter studies incorporating both clinical outcomes and serological responses are needed to better define optimal vaccination strategies and long-term monitoring in ESRD patients.

Together with recent literature, our results indicate that ESRD patients may manifest fewer classic COVID-19 symptoms yet face disproportionately severe outcomes, including higher ICU admission, mortality, and thrombotic complications. CoronaVac vaccination was well tolerated, with fewer adverse events reported among ESRD patients, but immunogenicity gaps warrant continued focus on booster strategies. These findings support early detection, tailored preventive approaches, and intensified monitoring of this vulnerable group [12–25].

Based on these findings, several recommendations emerge: Routine COVID-19 screening in dialysis units should not rely on symptoms alone. Low threshold testing strategies must be implemented, given the atypical presentation in ESRD patients.

Anticoagulation protocols: Given the threefold higher risk of thrombosis, clinicians should consider extended post-COVID thromboprophylaxis and maintain heightened surveillance for thrombotic complications in ESRD patients.Booster vaccination and use of highly immunogenic platforms (e.g., mRNA vaccines where available) should be prioritized to overcome reduced immunogenicity in dialysis populations. Future studies should include larger dialysis cohorts, assess vaccine immunogenicity alongside safety, and evaluate long-term post-COVID sequelae to better guide evidence-based clinical care.

CONCLUSION

This study demonstrates that COVID-19 manifests differently in end-stage renal disease (ESRD) patients compared with the population in general. ESRD patients COVID-19 infected presented with fewer acute symptoms but were at significantly greater probability of requiring intensive care, post-COVID thrombosis, and mortality. Vaccine-related adverse effects were less frequent in this group, possibly reflecting altered immune responses. These observations strongly support the critical importance of early detection, ongoing monitoring with targeted preventive approaches for ESRD patients during the COVID-19 pandemic.

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