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END-STAGE RENAL DISEASE PREVALENCE, MANAGEMENT, AND ASSOCIATION WITH DIABETES AND HYPERTENSION: A CROSS-SECTIONAL STUDY IN SOUTH PUNJAB, PAKISTAN

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Abstract

Diabetes and hypertension have greatly increased end-stage renal disease (ESRD) in developing countries, like Pakistan, which requires early diagnosis and management to prevent ESRD. Blood samples were collected from patients suspected of having ESRD and processed for the identification of diabetes and ESRD, with measurement of hypertension in South Punjab, Pakistan. This cross-sectional study aimed to determine the prevalence of ESRD, its management, and the association with hypertension and diabetes. Out of 126 participants, 36 (28.6%) were healthy and 90 (71.4%) had ESRD, including 50 (55.6%) with hypertension + ESRD, 27 (30%) with diabetes + hypertension + ESRD, 10 (11.1%) with ESRD alone, and 3 (3.3%) with diabetes + ESRD. Healthy and ESRD families had hypertension (55% and 50%), diabetes (44.4% and 36.7%), and renal issues (13.9% and 21.1%). Compared to ESRD patients, healthier individuals were more active, non-smokers, non-obese, and taking and eating healthily (97.1% - 77.8%). Except for 24%, ESRD patients had diabetes (31.1%) and hypertension (58.9%) before diagnosis. ESRD patients had 8.9% type I diabetes, 17.8% type II, and 73.3% uncertainty. In binary logistic regression analysis, age, married status, family with diabetes and hypertension, lack of physical exercise, and poor diet increased ESRD risk. ESRD was significantly associated with age, marital status, physical activity, healthy diet, diabetes/hypertension diagnosis, and management ($p < 0.05$), but not with gender, location, or family history ($p => 0.05$). Our study found a high prevalence of ESRD among diabetic and hypertensive patients. Sociodemographic, clinical and management factors also increased the risk for ESRD, emphasizing the need for awareness, early diagnosis, and effective treatment.

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INTRODUCTION

Chronic kidney disease (CKD) progresses to end-stage renal disease (ESRD), which causes permanent renal function loss. Dialysis or a kidney transplant are the two ways end-stage renal failure patients can survive [1]. Although risk prediction algorithms have improved, it is still difficult to identify risk factors for ESRD. However, diabetes, hypertension, cardiac disease, drug addiction, inflammation, urinary tract obstruction, family history, and certain genetic diseases increase the risk of CKD, which can lead to renal failure [2]. The multiple pathophysiological processes showed that diabetes and hypertension are the main causes of CKD, which can lead to ESRD if untreated. Cohort research found that diabetes worsens the prognosis for CKD patients and increases the risk of ESRD, which is caused by hyperglycaemia-induced kidney impairment [3,4]. Simultaneously, hypertension showed a strong association with ESRD, suggesting a significantly increased risk for patients with hypertension compared to those without, because of increased glomerular pressure and corresponding fibrosis [5,6]. Diabetes causes 40.2% of CKD cases in the US, and hypertension causes 24.6% [7], which may account for up to 80% of patients [4]. Their coexistence increases the risk of renal deterioration and cardiovascular disorders, which are frequent among diabetics and hypertensive patients [3,8].

Recently, diabetes, hypertension, and ESRD have received attention due to their alarming increase worldwide. Kidney illnesses rose from 13th to 10th in mortality rate from 2000 (0.81 million) to 2019 (1.3 million), accounting for 74% of non-communicable disease fatalities worldwide [9]. About 4.9-9.7 million ESRD patients will need renal replacement therapy (RRT), primarily in low- to middle-income countries (LMICS) and up to 3.2 million people die yearly from therapeutic failure, worldwide. Finding the causes of CKD that lead to ESRD is essential for early diagnosis and treatment, and to reduce disease burden [10].

Diabetes and hypertension patients must control blood pressure and glucose to avoid ESRD, although the best risk reduction technique is uncertain. ESRD prevalence and consequences vary among diabetics and hypertensives, especially in poor and minority groups. Improved access to renal replacement treatment and preventative care requires targeted measures to address socioeconomic determinants of health [11]. Patients with diabetes and hypertension have a much greater risk of ESRD than those with either illness alone, thereby increasing gradually worldwide, especially in underdeveloped countries, such as Saudi Arabia [12]. In Pakistan, diabetes, hypertension, and ESRD cases increased, which suggests comprehensive public health initiatives to treat diabetes and hypertension to reduce kidney diseases [13,14] . No study has been conducted in South Punjab for the last five years. So, the objective of this study was to determine the prevalence of ESRD and its correlation with diabetes and hypertension, as well as to assess the level of knowledge and management of these conditions among the population residing in South Punjab, Pakistan.

2. METHODOLOGY

2.1 Study Design and Ethical Approval

This cross-sectional study was conducted from March to April 2024 in collaboration with the Department of Medical Laboratory Technology (MLT), Islamia University of Bahawalpur (IUB), Pakistan, and two renowned hospitals in South Punjab, Pakistan: Sheikh Zayed Medical Hospital, Rahim Yar Khan, Pakistan, and Bahawal Victoria Hospital (BVH), Bahawalpur, Pakistan. Convenience sampling was used to collect blood samples from volunteers aged 12 and above, without gender or race discrimination. Participants were also surveyed regarding their family history of diabetes, hypertension, and renal disease; lifestyle factors (physical activity, smoking, obesity, diet); and management of diabetes and hypertension among healthy and ESRD patients.

The study was conducted under ethical standards and was approved by the “Departmental Ethical Review Committee” of the Department of MLT, IUB, Pakistan, before its commencement (Ref No: 1731/MLT). All research participants gave informed consent before their enrolment in this study and were informed they could quit at any time without penalty. We protected participants' rights and privacy by concealing and securing study data according to the Declaration of Helsinki.

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2.2 Study Population

The study population consisted of 126 suspected individuals of having ESRD based on their clinical signs and symptoms of renal failure, like tiredness, oedema, and reduced urine production, who came into the hospital for their medical checkups [15]. The sample size was calculated by Slovin's formula, which was 123, based on a combined population of 1,462,000 (South Punjab: BWP 945,000 and RYK=517,000) and a 09% margin of error.

2.3 Sample Collection and Storage

Blood samples were collected in a plain vial (for the biochemistry test) and a lavender top vial (for the haematology test) and sent to the laboratory for processing within time according to the instructions [16]. After processing, these samples were kept in a refrigerator for one week.

2.4 Screening Procedures for ESRD, Hypertension and Diabetes

Each participant was screened for renal function by detecting blood urea and creatinine levels with a biochemistry analyser (Beckman Coulter, Indiana 46268, United States). After processing samples, clinical guidelines provided a normal range for serum creatinine of 0.6 to 1.2 mg/dl and urea of 5 to 20 mg/dl and renal impairment was confirmed by elevated serum urea and creatinine [17].

In addition, blood pressure was measured using a calibrated sphygmomanometer (Huaxin instrument, Beijing, China) and recorded after the patient was seated for five minutes to ensure accuracy. Following American College of Cardiology/American Heart Association (ACC/AHA) recommendations, hypertension was defined as systolic blood pressure > 130 mmHg or diastolic blood pressure ≥ 80 mmHg [18].

Fasting and random blood glucose levels were measured using a biochemistry analyzer to identify diabetes. Fasting blood glucose was taken following an overnight fast, whereas random blood glucose was monitored during the day. Glycated haemoglobin (HbA1c) was also tested using a haematology analyser (MQ-6000 HbA1c analyzer, Shanghai, China) to determine a two- to three-month average blood glucose level. Diabetes is diagnosed using American Diabetes Association criteria, which include fasting blood glucose levels > 100 mg/dL, random blood glucose values ≥ 140 mg/dL, and HbA1c levels ≥ 5.7 [19,20].

2.5 Characterization and Data Collection from Participants

After screening tests, participants were divided into healthy and ESRD patients or those with diabetes, hypertension, or both. Data related to ESRD, hypertension, and diabetes, as well as other clinical factors like age, gender, socioeconomic status, medical history, family history, risk management etc, were collected through face-to-face interviews conducted by medical staff using a pre-structured questionnaire. The questions were designed to be clear and concise, ensuring that patients could easily comprehend and respond to them. This strategy was used to obtain reliable data and answer patient inquiries. The interviews were private to preserve confidentiality and promote honesty. Participants were told of the study's goal and gave consent before the interview. This data and characterisation of healthy and ESRD patients were crucial for understanding the population's health condition and for identifying potential factors linked to ESRD, hypertension, and diabetes.

2.6 Statistical Analysis

Binary logistic regression was used to examine the association between ESRD prevalence and demographic and clinical variables. The dependent variable was ESRD frequency in a population, and the independent variables were clinical factors like age, gender, socioeconomic status, medical history, family history, and risk management, as well as urea, creatinine, and glucose levels in this analysis. The binary logistic regression determined the odds ratios (COR and AOR with 95% CI) for each independent variable, showing clinical variables that significantly affected the population with ESRD. All analyses were done using statistical tools (IBM SPSS 25, New York, USA), and statistical significance was defined at $p<0.05$.

Before regression analysis, normality and multicollinearity were checked. All variables had descriptive statistics, while categorical variables had frequencies. Means and standard deviations summarized for continuous variables. A chi-square

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test was performed to determine the p-value, which was significant at $p < 0.05$.

3. RESULTS

3.1 Characterization of Healthy and ESRD Patients

A total of 126 participants, 36 individuals (28.6%), were healthy with normal values of RFTs (urea and creatinine), diabetes (BGF, BGR, and Hba1c), and hypertension (Systolic/diastolic). In contrast, the remaining 90 participants (71.4%) were diagnosed with ESRD, consisting of 50 individuals (55.6%) having both hypertension (Systolic/Dia systolic ↑) and ESRD ((Urea ↑, creatinine ↑), followed by 27 individuals (30%) having diabetes (BGF ↑, BGR ↑, HBA1c ↑), hypertension (Systolic/Dia systolic ↑), and ESRD (Urea ↑, Creatinine ↑). Additionally, 10 individuals (11.1%) had ESRD alone (Urea ↑, Creatinine ↑), and 3 individuals (3.3%) had diabetes (BGF ↑, BGR ↑, HBA1c ↑) and ESRD (Urea ↑, Creatinine ↑) (**Table 1**).

Table 1: Prevalence of ESRD with diabetes and hypertension patients among the South Punjab population.

Clinical Testing Mean ± SD	Healthy 36 (28.6)	ESRD 90 (71.4)			
		ESRD 10 (11.1)	D+ESRD 3 (3.3)	H+ESRD 50 (55.6)	D+H+ESRD 27 (30)
RFTs					
Urea	12.16 ± 5.49	↑ 80.8 ± 54.00	↑ 141.67 ± 73.58	↑ 100.28 ± 56.00	↑ 81.15 ± 59.78
Creatinine	0.84 ± 0.15	↑ 6.28 ± 3.60	↑ 12.37 ± 8.11	↑ 11.28 ± 16.20	↑ 9.156 ± 3.33
D.M					
BGF	83.11 ± 11.76	75.7± 14.48	↑ 103 ± 12.12	63.82 ± 15.68	↑ 131.11 ± 32.50
BGR	106.03 ± 15.89	106.2 ± 14.12	↑ 169 ± 33.78	97.52 ± 18.78	↑ 211.93 ± 92.13
HBA1c	4.53 ± 1.07	4.82 ± 0.82	↑ 6.5 ± 0.92	4.07 ± 0.72	↑ 6.5 ± 1.12
B. P					
Systolic	109.67 ± 13.47	115 ± 7.07	96.67 ± 32.14	↑ 151.9 ± 17.87	↑ 155.44 ± 17.14
Dia systolic	75.36 ± 10.60	72 ± 7.89	73.33 ± 5.77	↑ 92.1 ± 11.25	↑ 85 ± 10.16
Others					
Uric acid	5.25 ± 1.28	↑ 6.93 ± 1.10	↑ 11.77 ± 7.14	↑ 7.51 ± 1.57	↑ 6.80 ± 1.63

SD= Standard deviation, RFT= renal function test, D= diabetes mellitus, B. P= blood pressure, BGF= blood glucose fasting, BGR= blood glucose random, HBA1c= hemoglobin A1c

3.2 Sociodemographic Data of Healthy and ESRD Patients

A total of 36 healthy individuals, the majority of whom were male, aged between 21 to 40 years, unmarried, and resided in urban areas. Among ESRD patients, the majority were male, aged ranged from 41 to 60 years, married, and resided in urban areas (Table 2).

A binary logistic regression showed that age (COR=3.07) and marital status (COR=34.35) had a high risk for ESRD and were significantly associated with it (p=0.000). Area (p=0.59) and gender (p=0.31) were not significantly associated with ESRD but showed a greater risk for ESRD by gender (COR=1.25) (**Table 2**).

3.3 Family History of diabetes, hypertension, and renal disease

The family of both healthy and ESRD participants had hypertension (55% and 50%, respectively), more prevalent, followed by diabetes (44.4% and 36.7%, respectively) and renal diseases (13.9% and 21.1%, respectively).

Binary logistic regression showed a non-significant relationship between ESRD and a family history of having ESRD (p=0.35), diabetes (p=0.42) or hypertension (p=0.57), while diabetes (COR=1.38) and hypertension (COR=1.25) had a higher risk for ESRD (**Table 3**).

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Table 2: Socio-demographic data associated with healthy and ESRD individuals

Variables	Healthy n (%)	ESRD n (%)	Crude COR (95% Cl)	AOR (95% Cl)	*p-value*
Age					
12-20	10 (27.8)	4 (4.4)	1	1	0.000*
21-40	26 (72.2)	32 (35.6)	3.07 (0.86 10.95)	1.75 (0.42 - 7.18)	
41-60	0 (0.0)	41 (45.6)	0.0	0.0	
61-80	0 (0.0)	13 (14.4)	0.0	0.0	
Gender					
Male	25 (69.4)	58 (64.4)	1	1	0.59
Female	11 (30.6)	32 (35.6)	1.25 (0.55 - 2.87)	0.45 (0.11 - 1.90)	
Area					
Rural	10 (27.8)	44 (48.9)	1	1	0.31
Urban	26 (72.2)	46 (51.1)	0.40 (0.17 - 0.93)	0.56 (0.18 - 1.71)	
Marital status					
Single	32 (88.9)	17 (18.9)	1	1	0.000*
Married	4 (11.1)	73 (81.1)	34.35 (10.7 - 110.21)	2.63 - 55.40)	

*Significant association with ESRD due to p <0.05, which was measured by a Chi-square test.
COR: crude odds ratio, AOR: adjusted odds ratio, CI: confidence interval

Table 3: Binary logistic regression analysis for assessing family history and its relation to ESRD

Variables	Healthy n (%)	ESRD n (%)	Crude COR (95% Cl)	AOR (95% Cl)	*p-value*
Do the patient's family members have diabetes?					
Yes	16 (44.4)	33 (36.7)	1	1	0.42
No	20 (55.6)	57 (63.3)	1.38 (0.63 - 3.03)	1.51 0.65 - 3.5)	
Do the patient's family members have hypertension?					
Yes	20 (55.6)	45 (50)	1	1	0.57
No	16 (44.4)	45 (50)	1.25 (0.57 - 2.72)	1.26 (0.55 - 2.87)	
Do the patient's family members have renal disease?					
Yes	5 (13.9)	19 (21.1)	1	1	0.35
No	31 (86.1)	71(78.9)	0.60 (0.21 -1.76)	0.49(0.16 - 1.51)	

*Significant association with ESRD due to p <0.05, which was measured by a Chi-square test.
COR: crude odds ratio, AOR: adjusted odds ratio, CI: confidence interval

3.4 Assessment of Lifestyle Factors: Physical Activity, Smoking, Obesity, and Dietary Habits

Most healthy people were physically active (97.2%), non-smokers (97.2%), non-obese (91.6%), taking (77.8%) and maintaining their healthy diet (83.3%). Similarly, most of the ESRD patients were also physically active (66.7%), non-smokers (85.6%), obese (77.8%), taking (78.9%) and maintaining their healthy diet (67.8%) **(Table 4).**

A binary logistic regression showed a higher risk of ESRD due to a lack of physical activity (COR=17.5) and maintaining a diet (COR=2.37). ESRD was significantly associated with physical activity (p= 0.000) but not with smoking status (p= 0.14), obesity (p= 0.07), taking (p= 0.89) and maintaining a healthy diet (p= 0.07) **(Table 4)**.

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Table 4: Binary logistic regression analysis for assessing lifestyle factors among healthy and ESRD individuals

Variables	Healthy	ESRD	Crude		*p-value*
	n (%)	n (%)	COR (95% CI)	AOR (95% CI)	
Is the patient physically Active?					
Yes	35 (97.2)	60 (66.7)	1	1	0.000*
No	1 (2.8)	30 (33.3)	17.5 (2.29 - 133.98)	19.1 (2.32 - 158.39)	
Does the patient smoke?					
Yes	0 (0.0)	8 (8.9)	1	1	0.14
No	35 (97.2)	77 (85.6)	>10 (0.00)	0.00	
Partial	1 (2.8)	5 (5.6)	0.44 (0.05 - 3.91)	0.00	
Is the patient obese (overweight)?					
Yes	3 (8.3)	20 (22.2)	1	1	0.07
No	33 (91.6)	70 (77.8)	0.32 (0.09 - 1.15)	0.43 (0.11 - 1.71)	
Is the patient eating a healthy diet?					
Yes	28 (77.8)	71 (78.9)	1	1	0.89
No	8 (22.2)	19 (21.1)	0.93 (0.37 - 2.38)	0.39 (0.11 - 1.38)	
Is the patient maintaining a diet?					
Yes	30 (83.3)	61 (67.8)	1	1	0.07
No	6 (16.7)	29 (32.2)	2.37 (0.89 - 6.34)	2.12 (0.65 - 6.92)	

*Significant association with ESRD due to p=<0.05, which was measured by a Chi-square test.

Table 5: Management of diabetes and hypertension among ESRD individuals.

Variables	Healthy	ESRD	Crude		*p-value*
	n (%)	n (%)	COR (95% CI)	AOR (95% CI)	
Is the patient diagnosed with diabetes before ESRD?					
Yes	3 (8.3)	28 (31.1)	1	1	0.007*
No	33 (91.7)	62 (68.9)	0.20 (0.06 - 0.71)	0.84 (0.15 - 4.87)	
Is the patient diagnosed with hypertension before ESRD?					
Yes	4 (11.1)	53 (58.9)	1	1	0.000*
No	32 (88.9)	37 (41.1)	0.08 (0.02 - .27)	0.11 (0.03 - 0.36)	
Is the patient monitored blood glucose monitored regularly?					
Yes	16 (44.4)	68 (75.6)	1	1	0.001*
No	20 (55.6)	22 (24.4)	0.84 (0.38 - 1.82)	1.02 (0.43 - 2.43)	
Is the patient monitored blood pressure monitored regularly?					
Yes	16 (44.4)	68 (75.6)	1	1	0.001*
No	20 (55.6)	22 (24.4)	0.26 (0.11 – 58)	0.50 (0.20 - 1.23)	
Type of Diabetes					
Type 1	2 (5.6)	8 (8.9)	1	1	
Type 2	5 (13.9)	16 (17.8)	0.8 (0.13 - 5.07)	1.35 (0.076 - 23.89)	0.68
None	29 (80.6)	66 (73.3)	0.57 (0.11 - 2.84)	8.20 (0.52 - 129.04)	
Has the patient had diabetes for > 6 months?					
Yes	1 (2.8)	27 (30)	1	1	0.001*
No	35 (97.2)	63 (70)	0.06 (0.01 - 0.51)	0.02 (0.01 – 0.28)	

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3.5 Diabetes and Hypertension Management among Healthy and ESRD Patients

Diabetes and hypertension, common risk factors, were found in 31.1% and 58.9% of patients, respectively, before diagnosis of ESRD, and they monitored their blood glucose levels and blood pressure properly, except for 24% of individuals. Type I and Type II diabetes were found among 8.9% and 17.8% of ESRD patients, respectively, but the remaining (73.3%) were not clear about it. Statistical analysis showed a significant association between ESRD and diagnosis of diabetes and hypertension before ESRD and their management ($p < 0.007$) (**Table 5**).

4. DISCUSSION

The incidence of end-stage renal disease (ESRD) is more prevalent among diabetic and hypertension patients and has increased extraordinarily worldwide, particularly in low- and middle-income countries (LMICs). Timely diagnosis and treatment of diabetes and hypertension are crucial for mitigating ESRD, particularly in developing countries like Pakistan. Our study found that 28.6% of individuals had normal RFTs, diabetes, and hypertension while the remaining (71.4%) had ESRD, with 55.6% having both hypertension and ESRD (H+ESRD), were more prevalent followed by 30% having diabetes, hypertension and ESRD (H+D+ESRD), 11.1% having ESRD alone, and 3.3% having diabetes and ESRD (D+ESRD). These findings confirm prior evidence showing that hypertension and diabetes are the primary causes of kidney failure [12,21,22]. Previous research has shown that hypertension increases the risk of ESRD, especially in diabetics [4,23,24]. Our participants had high rates of ESRD due to hypertension and diabetes, which is confirmed by other studies that reported similar patterns in other communities, highlighting the worldwide impact of chronic diseases as primary causes of renal failure [25,26]. Research has demonstrated that hypertension and diabetes commonly coexist and worsen renal function, causing ESRD in many cases [27,28].

Healthy adults and ESRD patients were compared demographically (Age, marital status, and gender), which differed greatly between groups. A Binary logistic regression analysis showed that marriage (COR=34.35) and older age (COR=3.07) significantly increased ESRD risk ($p=0.000$), which is consistent with previous research linking age to CKD and ESRD because older patients often have comorbidities that worsen renal function [29-33]. Marriage is significantly linked to ESRD risk, probably due to social and psychological factors impacting health management and healthcare access [34]. Our study found that gender and location (rural or urban) were not significantly associated with ESRD, while males and urban residents had a high risk for ESRD, which is like other studies conducted in Pakistan [35], Nigeria [36], Yemen [6], and the United States [37].

This study found the high prevalence of hypertension and diabetes in families of both healthy individuals and ESRD patients, suggesting an inherited or environmental cause of these disorders, which is confirmed by various studies [38-41]. Diabetes and hypertension are known risk factors for CKD progression to ESRD [42,43].

This study revealed that ESRD patients were less physically active, had higher rates of smoking and obesity, and were less likely to take and maintain a proper diet compared to healthy individuals. These findings are similar to previous studies showing that inactive lifestyle, smoking, and poor dietary habits are prevalent among ESRD populations [44]. Physical inactivity and obesity are linked to inflammation and cardiovascular risk, which can increase renal dysfunction [45]. Our results are consistent with research by Liebman et al. (2011), which also found increased smoking rates among ESRD patients [46]. However, unlike a study by Stavropoulou et al. (2020), which reported that many ESRD patients adopt healthier diets post-diagnosis [47]. This discrepancy could be due to low health literacy and limited access to renal-friendly foods in our study region. Thus, targeted lifestyle interventions remain essential for this high-risk group.

This study found that 31.1% of patients had diabetes and 58.9% had hypertension before diagnosis of ESRD, aligning with previous research findings that these conditions as major risk factors for CKD progression to ESRD [48,49]. Although most patients reportedly monitored their blood glucose and blood pressure regularly, 24% did not,

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suggesting a critical gap in disease self-management. Poor glycemic and blood pressure control accelerates nephron damage and worsens renal outcomes [50]. Studies indicate that early detection and consistent monitoring of these parameters significantly delay CKD progression [51]. The noncompliance observed in our population may be attributed to limited health literacy, financial constraints, or insufficient access to primary care. These findings highlight the urgent need for targeted educational and screening programs at the community level to promote early intervention and slow the onset of ESRD among high-risk individuals. In this cross-sectional study, small sample size (n=90) is a key limitation that affects both the generalizability and ability to infer causality. Future longitudinal studies with larger samples are needed to validate our findings and better understand the relationship between diabetes, hypertension, and ESRD in South Punjab.

5. CONCLUSION

The study found a high prevalence of end-stage renal disease (ESRD) in South Punjab, Pakistan, which was significantly associated with diabetes and hypertension. The findings highlight the critical need for enhanced diabetes and hypertension awareness, early diagnosis, and appropriate therapy to avoid ESRD. The study also emphasized the influence of lifestyle variables like physical activity and food on the risk of ESRD, highlighting the need to encourage healthy behaviours among the general population. The findings suggest comprehensive public health activities to promote awareness of diabetes and hypertension risks leading to ESRD. Specific strategies should enhance renal replacement treatment and preventive care for underprivileged and minority communities. To minimise kidney disease in the region, diabetes and hypertension screening and monitoring should be improved to detect and treat renal disease early. To understand diabetes, hypertension, and ESRD in South Punjab, longitudinal research is needed. The impact of socioeconomic variables on ESRD prevalence and management may be studied. Innovative lifestyle and healthcare access programs may lower ESRD in the region.

Author contributions:
Study concept and design- AQ MN & MMI; acquisition of data- AQ, MN, K, ZA; analysis and interpretation of data– AQ, MN, MMI, & MF; drafting of the manuscript- NZ, ZA & SA; statistical analysis- MF, HI & K; technical assistance- NZ, ZA, FD & SA; study supervision- MMI & SY; Corresponding author- MMI

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