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***Original Research Article***

# Trends of Primary Renal Tumors in Adult Pakistani Population. A Single Center Study

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**Abstract:** *Renal cell carcinoma (RCC) represents a heterogeneous group of tumors with diverse histopathological subtypes and clinical behaviors. Locoregional studies are essential to understand various subtypes, prevalence, demographic patterns, and staging profiles for effective disease management.* ***Objective:*** *The purpose of this study is asses the histological spectrum, demographic characteristics, and pathological staging of renal tumors diagnosed at a specialized diagnostic center in Pakistan.* ***Methods:*** *A cross-sectional analysis was conducted at Chughtai Lab from March 2023 to September 2024. A total of 267 cases of renal tumors, including both malignant and benign entities, were reviewed. Tumors were classified according to the 2022 WHO Classification. Pathological staging was performed using the AJCC 8th edition TNM system. Data were analyzed using SPSS v26.0, with descriptive statistics for frequency, percentage, and mean age calculations.* ***Results:*** *Clear cell RCC is the most prevalent subtype (61.79%), followed by papillary RCC (8.61%) and chromophobe RCC (4.86%). Rare malignant tumors account for 5.61% of cases. Among benign tumors, oncocytoma is the most common (4.1%). The mean age of patients is 53.8 years, with a male-to-female ratio of 1.47:1. Pathological staging reveals pT1b (30.00%) followed by pT3a (22.91%) and pT2a (20.83%) are the most frequent stages among 240 patients.* ***Conclusion:*** *Clear cell RCC remains the predominant renal tumor subtype in our population. Most cases are diagnosed at early pathological stages, indicating improved detection trends. This study contributes essential locoregional data that support global epidemiological patterns and highlights the importance of accurate histopathological classification for optimal patient management.*

**Keywords:** Clear Cell RCC, Papillary RCC, Chromophobe RCC, Oncocytoma

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## Introduction

Renal tumors represent a significant proportion of urological malignancies, with renal cell carcinoma (RCC) accounting for approximately 85% of all primary renal neoplasms worldwide (1). The global incidence of RCC has been rising and the risk factors such as smoking, obesity, hypertension, and diabetes mellitus playing crucial roles in disease progression (2). In Pakistan, there is limited epidemiological data on the trends, histopathological patterns, and clinical presentation of primary renal tumors, necessitating further research to better understand the disease burden in the local population. Given the increasing use of radiological imaging techniques, an increasing proportion of renal tumors are now diagnosed incidentally at an earlier stage, influencing treatment decisions and survival outcomes (3).

The Pakistani population faces unique challenges in the detection and management of renal tumors due to lack of awareness, delayed presentations, and limited access to specialized oncological care (4). Despite these concerns, no large-scale studies have been conducted in Pakistan to determine the clinicopathological trends of renal tumors, particularly their epidemiologic charecteristics, histological subtypes and TNM staging. The absence of such data limits the development of national guidelines and early screening protocols, which are essential for improving patient outcomes (5).

Several studies from Western countries report that clear cell renal cell carcinoma (ccRCC) is the most frequent histological subtype, followed by papillary (pRCC) and chromophobe RCC (6).

Current advancements in renal cancer treatment have emphasized the role of nephron-sparing surgery in early-stage tumors and targeted therapies for metastatic disease, improving survival rates (7). However, adopting these treatment strategies in Pakistan remains unclear due to variations in healthcare infrastructure, financial constraints, and limited availability of molecular diagnostics (8). Understanding the tumor distribution, staging, and histopathological characteristics will aid in developing evidence-based guidelines for renal cancer management in Pakistan and facilitate early diagnosis through improved screening efforts.

Based on data from a tertiary referral pathology center, this study aims to analyze the clinicopathological characteristics and staging trends of primary renal tumors in the Pakistani population. By analyzing tumor subtypes, demographic patterns and disease staging, this research seeks to contribute essential epidemiological data that can guide future screening strategies, risk stratification models, and therapeutic interventions in Pakistan.

## Methodology

This cross-sectional study was carried out at the Department of Histopathology, Chughtai Lab, Pakistan, over 18 months from March 2023 to September 2024. The study aimed to evaluate the histopathological spectrum, demographic patterns, and pathologic staging distribution of renal tumors diagnosed at a tertiary-level diagnostic center. Ethical approval was granted by the Institutional Review Board of Chughtai Lab before data collection, and the Declaration of Helsinki conducted all procedures. Patient confidentiality was maintained, and no identifiable personal data were used.

Two hundred and sixty-seven cases of renal tumors diagnosed on Radical and partial nephrectomy specimens were included. Eligibility criteria encompassed patients of adult age group with a confirmed histological diagnosis of a primary renal tumor. Cases were excluded if they had incomplete pathological records, biopsies other than partial or complete nephrectomy, fragmented specimens, patient <18years of age, secondary/metastatic renal involvement, or recurrent disease.

All specimens were processed according to standardized protocols. Demographic data, including age and sex, were retrieved from electronic pathology records. At least two consultant histopathologists independently reviewed histological slides stained with hematoxylin and

eosin (H&E). Tumors were classified according to the 2022 World Health Organization (WHO) Classification of Tumours of the Urinary System and Male Genital Organs. Histological subtypes of malignant tumors included clear cell RCC, papillary RCC, urothelial carcinoma, chromophobe RCC, clear cell papillary renal cell tumor, renal cell carcinoma with Sarcomatoid / Rhabdoid differentiation, renal cell carcinoma NOS and rare tumors such as Eosinophilic solid and cystic RCC, epithelioid angiomyolipoma, mucinous tubular and tpindle cell carcinoma, TFE3 rearranged RCC, collecting duct carcinoma, and tubulocystic RCC. Benign tumors evaluated included oncocytoma, papillary adenoma, angiomyolipoma, leiomyoma, metanephric adenoma, multilocular cystic renal neoplasm of low malignant potential and adult cystic nephroma.

Among 267 cases 240 malignant cases had complete tumor checklists available. Pathological tumor staging was assigned according to the 8th edition of the American Joint Committee on Cancer (AJCC) TNM staging system. The stage distribution was based on the pathological (pT) component. Tumor size was measured in the greatest dimension, and the involvement of perirenal soft tissue, adrenal gland and vascular invasion were recorded when applicable. Total 27 cases were benign and size of the tumor was single most important recorded parameter.

Data was compiled and analyzed using Microsoft Excel and SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic variables and tumor subtypes. Frequencies and percentages were calculated for categorical variables such as sex, histological subtype, and tumor stage. Continuous variables like age were reported as mean and standard deviation.

**Results**

Two hundred and sixty-seven cases of renal masses are included in this study, with a mean age of 53.8 years. The male-to-female ratio is 1.47:1, indicating a higher prevelance among males. Average maximum dimension estimated in our population was 10.9 cm. In malignant tumors clear cell RCC is the most frequently observed histological subtype, accounting for 165 cases (61.79%) followed by papillary RCC in 23 cases (8.61%), urothelial carcinoma in 14 cases (5.24%), chromophobe RCC in 13 cases (4.86%). Less common malignant variants include renal cell carcinoma not otherwise specified (5 cases, 1.87%) and clear cell papillary renal cell tumor (5cases, 1.87). In addition, 15 cases (5.61%) are classified under rare malignant tumors. (Table 1).

Benign renal tumors are also observed in the sample, with oncocytoma being the most common, identified in 11 patients (4.1%). Other benign subtypes include papillary adenoma (6 cases, 2.24%), angiomyolipoma, classic variant (3 cases, 1.11%), leiomyoma (2 cases, 0.74%), metanephric adenoma (2 cases, 0.74%), multi-locular cystic renal neoplasm of low malignant potential (2 cases, 0.74%) and adult cystic nephroma (1 case, 0.37%). (Table 2)

Out of the total cohort, 240 patients labelled as malignant have complete synoptic data available. The most common tumor stage is pT1b, seen in 72 patients (30.00%), followed by pT3a in 55 patients (22.91%) and pT2a in 50 patients (20.83%). Stage pT1a is observed in 39 patients (16.25%), while pT2b is seen in 19 patients (7.91%). Additionally, pT3b in identified in 2 patients (0.83%), and pT4 in 3 patients (1.25%). (Table 3)

**Table 1: Malignant RCC Tumors (n = 267)**

| Morphological Subtype | Frequency | (%) |
|---|---|---|
| Clear cell renal cell carcinoma | 165 | 61.79 |
| Papillary Renal cell carcinoma | 23 | 8.61 |
| Urothelial Carcinoma | 14 | 5.24 |
| Chromophobe Renal Cell Carcinoma | 13 | 4.86 |
| Clear cell Papillary renal cell tumor | 5 | 1.87 |
| Renal cell carcinoma NOS | 5 | 1.87 |
| Rare Tumors (combined) | 15 | 5.61 |

**Table 2: Benign RCC Tumors (n = 267)**

| Morphological Subtype | Frequency | (%) |
|---|---|---|
| Oncocytoma | 11 | 4.11 |
| Papillary Adenoma | 6 | 2.24 |
| Angiomyolipoma (Classic Variant) | 3 | 1.4 |
| Leiomyoma | 2 | 0.74 |
| Metanephric Adenoma | 2 | 0.74 |
| Multilocular Cystic Renal Neoplasm of Low Malignant Potential | 2 | 0.74 |
| Adult Cystic Nephroma | 1 | 0.37 |

**Table 3: Distribution of Pathological Tumor Staging in Malignant Renal Tumors (n = 240)**

| Pathological Stage (PT) | Frequency (n=240) | Percentage (%) |
|---|---|---|
| pT1a | 39 | 16.25 |
| pT1b | 72 | 30.00 |
| pT2a | 50 | 20.83 |
| pT2b | 19 | 7.91 |
| pT3a | 55 | 22.91 |
| pT3b | 2 | 0.83 |
| pT4 | 3 | 1.25 |

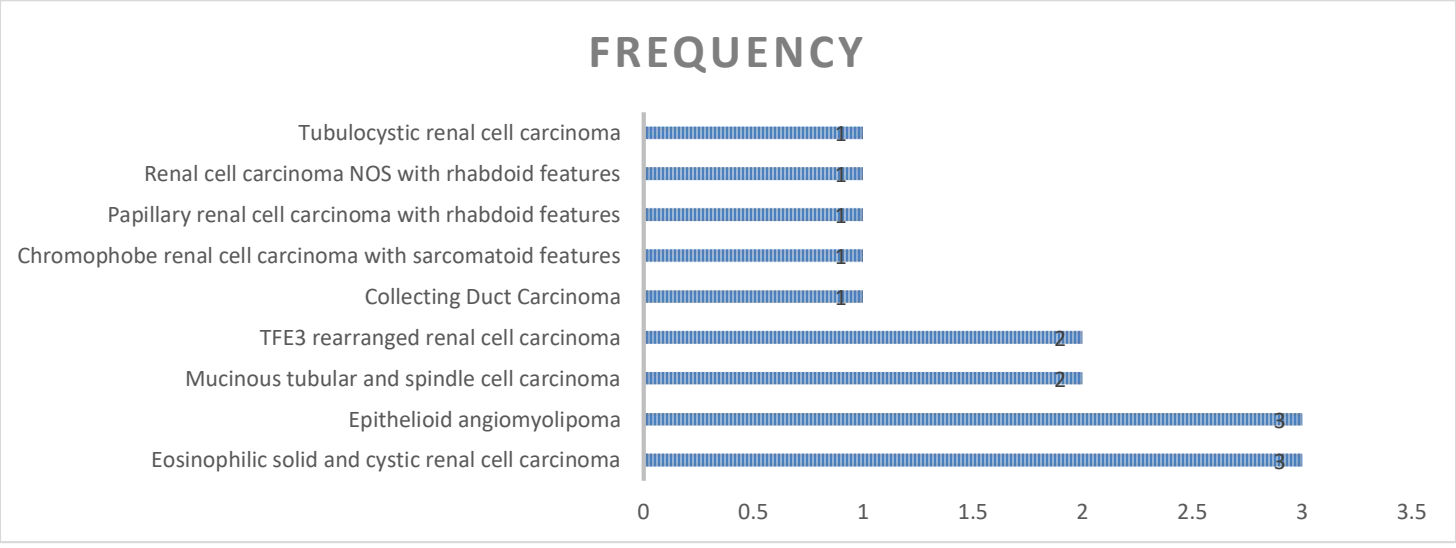


**Figure 1: Rare Malignant RCC Tumors (n = 15)**

**Discussion**

The trend of primary renal tumors in the adult population of Pakistan reflects a growing clinical concern, with renal cell carcinoma (RCC) emerging as the predominant histological subtype. Recent studies indicate a rise in the incidence of RCC, potentially attributed to increased imaging use, better diagnostic access, and lifestyle-related risk factors such as smoking, hypertension, and obesity. Notably, regional data suggest that patients in Pakistan often present at a younger age and with more advanced-stage disease compared to Western populations, highlighting the need for earlier detection and public awareness strategies. Moreover, histopathological reviews underline the importance of subclassifying RCC accurately due to its prognostic and therapeutic implications (9). This study comprehensively evaluates renal cell carcinoma (RCC) histological subtypes, demographic trends, and pathological staging in a cohort of 267 patients and the findings align well with existing global literature and contribute new insights into the regional epidemiology of RCC.

In our cohort Clear cell RCC was the dominant subtype, constituting 66.29% of renal masses in our population (n=267) and 68.75% of all malignant cases (n=240). These findings are comparable with other international and locoregional studies that report clear cell RCC prevalence between 70% and 80% of all RCCs (Albasri et al., 2017; Wang, 2009) (10,11). The relative frequencies of papillary RCC (10.36%) and chromophobe RCC (4.64%) also correspond closely with previously reported estimates of 10–15% and 4–6%, respectively (Bhatta et al, 2009). (12). Additionally, 5.36% of cases were categorized as rare malignant tumors. These included uncommon histological variants of RCC such as eosinophilic solid and cystic RCC, mucinous tubular and spindle cell carcinoma, TFE3 rearranged RC, and tubulocystic RCC and non RCC malignant tumors of kidney like Collecting duct carcinoma and epithelioid angiomyolipoma. RCC with sarcomatoid/rhabdoid features is not a distinct subtype, rather it represents progression of other subtypes of RCC. (13) In our survey, among 165 cases reported as Clear cell RCC, 19 cases (7.1%) showed sarcmomatoid/rhabdoid features, ISUP grade 4 which was mentioned in the diagnosis. Additionally, single case of Papillary RCC with rhabdoid features and another case of Chromophobe RCC with rhabdoid features was also encountered. Although infrequent, recognizing these subtypes is essential, as they carry distinct clinical behavior and therapeutic implications (14,15). Benign renal tumors were also well represented in this series. Oncocytoma was the most frequent benign lesion (4.1%), followed by papillary adenoma (2.24%) and angiomyolipoma (1.11%). These findings are in agreement with the available data authorizing that oncocytomas can account for 2–7% of surgically resected renal masses (16,17). Accurate preoperative identification of such lesions is critical, as a significant proportion of small renal masses ultimately prove benign, highlighting the importance of renal mass biopsy and active surveillance in selected patients (18). No case of Molecularly defined RCCs including TFE-B altered RCC, ELOC mutated RCC, Fumarate Hydratase deficient RCC, Succinate hydratase deficient RCC, ALK rearranged RCC or SMARCB1 deficient Renal Medullary carcinoma was diagnosed at our centre owing to limited resources and unavailability of required immunohistochemical stains and molecular adjuncts. Histopathological classification to establish the tumor subtype (clear-cell vs non-clear cell variant histology) and presence of sarcomatoid or rhabdoid features on histology is essentially recommended owing to diverse biological behavior of distinct subtypes and well established therapeutic and prognostic implications. According to 2022 WHO classification differentiating between type 1 and type 2 papillay RCC is no longer important, reducing its relevance. The clinical significance of the recently added molecularly defined WHO subtypes remains uncertain (19). The demographic profile of our cohort demonstrates that mean age of presentation was 53.8 years as compared to the mean age 64 years reported in west in a study by Thompson et all (20). Male-to-female ratio of 1.45:1 was recorded in our cohort which was comparable to a similar study by Latif et all which reported male to female ratio of 1.9:1 (21). Average maximum tumor size estimated in our population was 10.9 cm. This is lower than maximum mean diameter of 13.6cm estimated in a local study from Pakistan (22). The demographic patterns associated with renal cancers reported across various populations are thought to reflect a combination of hormonal, occupational, and lifestyle-related risk factors (23). According to an estimate 6%-9% of renal cancers carry germline mutations in genes associated with hereditary cancer predisposition. Several syndromic associations have been described most common being von Hippel–Lindau syndrome (VHL) (24). The statistical analysis of tumor stage revealed that the majority of cases were diagnosed at earlier stages, pT1b being the most common, seen in 72 patients (30.00%), pT1a was observed in 39 patients (16.25%), pT2a in 50 patients (20.83%) and pT2b was seen in 19 patients (7.91%). This distribution suggests a trend toward earlier detection, likely facilitated by the increasing use of cross-sectional imaging for unrelated conditions (25). Similar pattern was observed in a study conducted in India by Srivastava et all who reported pT1 as the most common stage at presentation (65.6%) (26). A significant 55 patients (22.91%, second most common after pT1b) were assigned pT3a demonstrating the tumor extension into perirenal soft tissues (peri-renal/hilar fat), renal vein or pelvicalyceal system. Such patients are shown to have relatively worse disease specific and overall survival with increased recurrence rates (27). 2 patients (0.83%) were designated as pT3b via histological confirmation of tumor emboli in Vena cava which was significantly reduced in compasrion to a study by Bocordo et al which showed 10% cases with involvement of renal vein (28). Further more 3 patients were lablled as pT4 (1.25%) owing to direct involvement of the adrenal gland. Contiguous involvement of ipsilateral adrenal gland in RCC is a quite rare event with significantly worse prognosis. A study by Hank et al reported 2.5% of radical nephrectomy specimens showing adrenal gland involvement which surpassed that of our analysis (29). In our study proptionately lesser number of cases presenting at higher stages (pT3, pT4) reflects the effectiveness of imaging and clinical surveillance in identifying tumors before progression to advanced disease (30).

In conclusion, our study reaffirms the predominance of clear cell RCC and highlights the growing role of early diagnosis and subtype-specific classification in managing renal tumors. These findings align with global data and reinforce the importance of integrating histological, clinical, and imaging data for optimal treatment planning and prognostication.

**Conclusion**

Clear cell RCC emerged as the most prevalent malignant renal tumor subtype in this cohort, with most tumors diagnosed at an early pathological stage. The distribution of benign tumors, such as oncocytoma, was also consistent with global patterns. These findings highlight the critical role of standardized histopathological classification and early diagnosis in guiding appropriate clinical management. Further multicenter studies with extended immunohistochemistry and molecular profiling are are crucial to expand the understanding of RCC behavior across diverse populations.

**Declarations**

**Data Availability statement**

All data generated or analysed during the study are included in the manuscript.

**Ethics approval and consent to participate**

Approved by the department concerned. (CIP-IRB-1171A)

**Consent for publication**

Approved

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**Conflict of interest**

The authors declared the absence of a conflict of interest.

**Author Contribution**

***MF, KB, HB***
*Review of Literature, Data entry, Data analysis, and drafting article. Study Design, manuscript review, critical input.*
***RY, OC, AB***
*Conception of Study, Development of Research Methodology Design Manuscript drafting, Study Design,*

*All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.*

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