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Research Article

Identification of Common Urological Disorders and Radiation Dose Assessment among the Patients Attending Intravenous Urographic X-Ray Procedure in Kebbi State

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Abstract— The increasing use of Intravenous Urography (IVU) for diagnostic imaging has led to an investigation of patient-specific factors influencing procedural parameters and radiation exposure. This study identified urological disorders and assessed radiation doses among 400 patients undergoing IVU in Kebbi State, Nigeria. Data were processed using caldose-X-5.0 and SPSS. Demographic analysis showed that male patients (mean age: 36.89 years) were younger than females (mean age: 41.26 years), with males having lower average weight and height. Procedural findings indicated that females received slightly more contrast media (52.65 ml vs. 49.47 ml) and had shorter imaging times (57.80 s vs. 66.21 s). The number of images taken was comparable, with males averaging 6.99 and females 6.68. Clinical results revealed gender-based disease distribution: males predominantly had kidney stones and hydronephrosis, while females exhibited more gynecological conditions like uterine fibroids and left flank pain. Disease prevalence varied by hospital, with kidney stones most common at Sir Yahaya Memorial Hospital, uterine fibroids at Federal University Teaching Hospital, and bladder disorders at General Hospital Yauri. Radiation exposure analysis showed variations in BMI, Entrance Skin Dose (ESD), and Dose Area Product (DAP). FUTH recorded the highest mean BMI (24.64 kg/m²) and radiation doses (ESD: 2.80 mGy, ED: 1.32 mSv, DAP: 2143.00 Gy·cm²), suggesting less protocol optimization. SYHM had the lowest radiation exposure, likely due to better safety measures. These findings highlight the need for gender-specific diagnostic strategies and improved radiation optimization.

Keywords— Imaging Time, Radiation Dose, Entrance Skin Dose, Dose Area Product, Effective Dose, Body Mass Index (BMI), Urological Disorders and Kebbi

1. Introduction

Intravenous urography (IVU) is a widely utilized radiological technique for visualizing the structure and function of the urinary system, including the kidneys, ureters, and bladder. The examination is primarily used to diagnose a spectrum of urological disorders, such as kidney stones, urinary obstructions, tumors, and congenital abnormalities. As one of the older imaging modalities, IVU continues to hold relevance, particularly in resource-constrained settings where access to advanced imaging tools like computed tomography (CT) may be limited [1]. A significant aspect of IVU examinations is the associated exposure to ionizing radiation. Prolonged or excessive exposure to radiation can increase the risk of adverse health effects, necessitating a thorough evaluation of radiation doses received by patients during these procedures. Understanding radiation dose parameters is critical to minimizing unnecessary exposure while ensuring diagnostic efficacy [2, 3]. This has led to extensive research focusing on optimizing radiographic techniques and dose reduction strategies, with the aim of achieving a balance between image quality and patient safety [4].

Identifying urological disorders during an intravenous urography (IVU) procedure is vital for diagnosing conditions such as kidney stones, tumors, structural abnormalities, and urinary tract obstructions, enabling timely and effective treatment. Accurate assessment of radiation dose during IVU is equally important to minimize unnecessary exposure, particularly for patients requiring multiple imaging sessions. Optimizing imaging parameters and adhering to radiation safety protocols help balance diagnostic accuracy with patient safety. Proper identification of urological abnormalities combined with careful radiation dose management contributes to the formulation of dose reference levels (DRLs), promotes adherence to the principles of radiation protection, (including as low as reasonably achievable (ALARA) and enhances the clinical value of IVU while reducing potential health risks associated with ionizing radiation.

Recent advancements in dosimetry and data analysis have provided valuable insights into dose distribution and patient demographics in IVU practices. This research aims to investigate the common urological disorders identified through IVU and analyze the radiation dose levels among patients, emphasizing the importance of evidence-based practices in radiology to optimize diagnostic outcomes and ensure patient safety.

2. Related Work

Several studies provide foundational support for this research, reinforcing its relevance in optimizing IVU procedures, understanding disorder prevalence, and assessing patient radiation exposure. Mohammed et al. [5] examined radiation doses in IVU across three public hospitals, analyzing 44 patients. Measurements of machine output and patient exposure parameters determined ESAK values, ranging from 0.76 to 6.75 mGy, with cumulative ESAK between 3.5 and 34.6 mGy—levels consistent with standard references but approaching thresholds for stochastic effects. Jambi et al. [6] investigated IVU-related radiation dose and cancer risk among 50 patients, reporting an ESAK of 2.1 ± 0.64 mGy and an effective dose of 0.131 ± 0.04 mSv. The study found IVU doses significantly lower than those in contrast-enhanced CT urography. Aklan et al. [7] analyzed 1,470 IVU cases, revealing a high prevalence of urinary tract abnormalities, with urinary calculi (36.8%) and hydronephrosis (29.7%) as the most common findings. O'Kane et al. [8] compared IVU-era radiation exposure to that in 2013, finding a marginal increase in median effective dose (4.05 mSv vs. 4.2 mSv) but improved hospital stay duration and diagnostic efficiency. These studies indicated the importance of dose optimization and the diagnostic value of IVU in urological assessments.

3. Material and Method

3.1 Material and Study area

The study was carried out at three different hospitals [Yauri General hospital, Federal University Teaching Hospital and Sir Yahaya Memorial Hospital Birnin Kebbi] in Kebbi State. Kebbi State is located in the north-western part of Nigeria. It is situated between latitudes 11.6781 and longitudes 4.0695. The State is bordered by Sokoto and Zamfara States to the east, Niger State to the south, the Benin Republic to the west, and the Niger Republic to the north. The population of the State was projected to be 5,563,900 in 2022. Kebbi State occupies 37,201 square kilometers of land [9]. The materials used in this research include Computer based software [Cal Dose_X version 5.0 software and SPSS], Medical weighing and Height Scale.

3.2 Data Collection and analysis

All the data [patient demographics, procedural data, & exposure parameters] were collected prospectively in a form designed by researcher. The collection of data was divided into phases. Phase one involved patient demographic (such as Age, Height, Weight, and Gender), while phase two involved procedural data (Contrast media name & amount, number of images, time of procedure), exposure parameters [such as tube kilovoltage (kV), exposure time product (mAs), Focus to skin distance (FSD), and Focus to Film Distance (FFD) from the X-ray tube, Beam area (BA)]. The sample size of 400 patients was determined using Slovin's formula. The kVp, mAs, age, and FDD/FFD parameters were inserted in CalDose_X 5.0 software for the analysis of entrance surface Dose (ESD), effective dose, and organ doses. Mathematical model was used to determined dose area product and body mass index (BMI) using weight and height. Descriptive statistical analysis was performed to estimate mean, median, and standard deviation of data **[10, 11]**. The Radiation Output (OP) of a machine was calculated as follow

$$K = INAK\left(\frac{\mu Gy}{mAs}\ at\ 100cm\right) = 0.0419x^{1.7744} \quad (1)$$

The ESD was determined using the equation (2)

$$\mathrm{ESD} = \frac{\mathrm{O}}{\mathrm{P}} \times \left[\frac{\mathrm{kV}}{80}\right]^2 \times \mathrm{mAs} \times \left[\frac{100}{\mathrm{FSD}}\right]^2 \times \mathrm{BSF} \quad (2)$$

Where O/P is the tube output per mAs measured at a distance of 100 cm from the tube focus along the beam axis at 80 kVp, kV is peak tube voltage recorded for any given examination, mAs are the current–time product, FSD is the focus-to patient entrance surface distance and BSF is the backscatter factor.

4. Results and Discussion

The demographic data of patients undergoing intravenous urography was analysed and well compared across the gender. The mean age of male was 36.89 years, with a median age of 33 years and Ages ranged from 15 to 72 years, with a standard deviation of 14.03. Similarly, the mean age of female is slightly higher at 41.26 years, with a median age of 44 years. The range is narrower, from 20 to 60 years, with a lower standard deviation of 9.67 (**Table 1)**. Patients undergoing intravenous urography are typically adults as shown in table 4.1, with studies often reporting average ages between 35 and 50 years for both genders, aligning closely with these findings. According to Smith et al. [9], the average age for urography patients was 39.5 years globally, and women undergoing urography tend to be slightly older, likely due to increased prevalence of urinary conditions like recurrent infections in post-menopausal women.

The mean weight of male patient was 62.23 kg, ranging from 40 to 105 kg, with a standard deviation of 10.87. The mean weight of female was higher at 65.01 kg, with a range of 40 to 90 kg and a larger standard deviation of 13.52 (Table 1**)**. Globally, average adult weights differ by region. According

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to WHO Global Health Observatory Data [13], the average weight for males is 70.8 kg and for females is 62.4 kg, indicating that the male cohort in this study is under the global average, while the female cohort is slightly above. These variations may reflect regional dietary, genetic, and health factors. How ever, the mean height was 161.84 cm for male patients, with a range from 140 to 180 cm and a standard deviation of 8. The mean height for female patients was 158.27 cm, ranging from 135 to 179 cm, with a standard deviation of 9.41 as indicated in the table 2. Globally, the average male height is 171 cm, and the average female height is 159 cm [14]. The male cohort in this study has a lower average height, while the female cohort is close to the global average. Regional disparities in nutrition and socioeconomic factors may account for these findings.

The standard deviations for weight and height were higher for females than for males, suggesting greater variability in the female cohort. The observed demographic differences between genders and compared to global averages suggest potential regional influences, such as nutritional status, healthcare access, or genetic factors. For instance, the lower average male height and weight may indicate undernutrition or chronic health issues. The slightly older mean age of females undergoing urography might correlate with specific urogynecological conditions.

Table 1: Patients demographic data

Descriptive	Males			Females		
Statistics	**Age**	**Weight**	**Height**	**Age**	**Weight**	**Height**
Mean	36.89	62.23	161.84	41.26	65.01	158.27
Median	33.00	62.00	161.00	44.00	60.00	156.00
Max	72.00	105.00	180.00	60.00	90.00	179.00
Min	15.00	40.00	140.00	20.00	40.00	135.00
STDEV	14.03	10.87	8.64	9.67	13.52	9.41

4.2 Procedural Data of patient attending IVU

The average amount of contrast media injected is slightly higher for females (52.65 ml) compared to males (49.47 ml). This aligns with patient-specific adjustments that account for physiological differences, such as body weight or organ size. The ACI varies between 35.00–60.00 ml for females and 40.00–60.00 ml for males, with a comparable standard deviation (~6 ml). These values fall within typical ranges for IVU procedures globally, where doses often range between 30–100 ml depending on the patient's characteristics and the imaging protocol [15].

Table 2: Procedural Data

Descriptive Statistics	**Male**			**Female**		
	ACI (ml)	T.I (s)	N. I	ACI (ml)	T.I (s)	N. I
Mean	49.47	66.21	6.99	52.65	57.80	6.68
Median	50.00	60.00	7.00	50.00	32.00	7.00
Max	60.00	180.0	12.00	60.00	180.0	11.00
Min	40.00	25.00	5.00	35.00	20.00	4.00
STDEV	6.41	35.39	1.54	6.23	48.07	1.44

Definition: N.I = Number of images, T. I= Time interval (s), A.C.I = Amount of Contrast media Injected to patients

Females have a shorter average time interval (57.80 s) than males (66.21 s). The median also shows a significant difference, with females at 32.00 s and males at 60.00 s. This could reflect procedural differences or patient cooperation, as timing influences image clarity. Both genders show wide variability, with the minimum being 20–25 s and the maximum reaching 180 s. The high standard deviation, especially for females (48.07 s), suggests variability in individual responses or operator decisions. Both genders have a similar average number of images (6.99 for males and 6.68 for females). This aligns with international protocols where 6–8 images are typically obtained during an IVU. The N.I ranges from 4–12 for both genders, reflecting procedural flexibility to capture adequate diagnostic information.

According to *European Society of Urogenital Radiology (ESUR)* guidelines, the volume of iodine-based contrast media for adult IVU typically ranges from 50–100 ml, depending on renal function and patient size [16]. The reported values in this study are at the lower end, suggesting a conservative approach to minimize contrast-related adverse effects. Globally, IVU protocols recommend imaging intervals of 1–10 minutes post-injection, depending on the phase of renal excretion. The wide range (20–180 s) observed here might indicate variability in protocol adherence or patient-specific factors like renal clearance rates. Literature shows that modern IVU typically involves 6–10 images to capture optimal diagnostic information [15]. The observed averages (6.99 and 6.68) align well with this, indicating adherence to global standards. The high variability in time intervals for females suggests the need for standardized timing protocols to reduce diagnostic variability. The slightly higher ACI for females aligns with literature but warrants individualization based on body weight and renal function to minimize nephrotoxicity. The consistency in image numbers reflects adherence to diagnostic requirements, though further reduction could minimize radiation exposure.

4.3 Gender-specific Exposure and Geometric Factors

The exposure and geometric factors for both male and female patients are vital in understanding radiation dosimetry and the optimization of radiological procedures. The two tables present key exposure parameters, such as focal distance (FDD), focus-to-skin distance (FSD), kilovolt (kV), milliampere-seconds (mAs), beam area (BA), body mass index (BMI), and body thickness (BT) for males and females, with descriptive statistics such as mean, median, maximum, minimum, and standard deviation (STDEV).

Male exposure factor

The descriptive statistics in table 3 highlight the exposure and geometric factors for male subjects during radiographic procedures. The focal-detector distance (FDD) is constant at 100 cm, while the focal-skin distance (FSD) varies with a mean of 78.16 cm and a standard deviation of 7.44 cm, indicating some variability in positioning. The peak kilovoltage (kV) has a mean of 73.41 kV, consistent with standard radiographic practices, but it ranges from 60 kV to 85 kV, reflecting adjustments for different body compositions. The mean tube current-time product (mAs) is 26.76 mAs, with significant variation (STDEV = 8.92 mAs), highlighting individual tailoring based on patient needs. Body area (BA) and body mass index (BMI) show considerable

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diversity, with means of 465.44 cm² and 23.69, respectively, pointing to a wide range of body sizes. The breadth-thickness ratio (BT), calculated using width and height, has a mean of 8.08, with minimal variation (STDEV = 0.66), suggesting consistent anatomical proportions among subjects.

Comparing these findings with existing literature reveals parallels and differences. The constant FDD aligns with standard practice, as noted by Seibert et al [17], to ensure consistent image magnification and quality. However, the variability in FSD and kV is consistent with findings by Buhr et al. [18], who emphasize patient-dependent exposure parameters to optimize radiation dose and image quality. The BMI range aligns with findings by Chhem et al. [19], who reported similar variability in radiographic practices across diverse populations. The wide range in mAs supports literature recommendations for individualized exposure settings to minimize radiation dose while ensuring diagnostic efficacy [20]. These comparisons underscore the importance of tailoring radiographic parameters to patient-specific anatomical and clinical needs.

Table 3: Exposure and Geometric Factors for Male

Descriptive Statistics	**Male**						
	FDD	FSD	kV	mAs	BA (cm2)	BMI	BT (W,H)
Mean	100.00	78.16	73.41	26.76	465.44	23.69	8.08
Median	100.00	80.00	75.00	24.00	500.00	23.95	8.16
Max	100.00	95.00	85.00	64.00	900.00	36.12	10.65
Min	100.00	64.00	60.00	14.50	99.50	17.72	6.89
STDEV	0.00	7.44	5.64	8.92	208.94	3.18	0.66

Female Exposure and Geometric Factors

The results in table 4 present an analysis of exposure and geometric factors for female patients during radiographic procedures. The mean focus-detector distance (FDD) and focus-skin distance (FSD) are 98.77 cm and 72.69 cm, respectively, indicating a standard radiographic setup suitable for minimizing magnification and optimizing image quality. The average tube voltage (kV) of 75.41 and mean tube current-exposure time product (mAs) of 32.24 align with typical values for female diagnostic imaging, balancing radiation dose and image clarity. The body area (BA) irradiated varies widely, with a mean of 332.99 cm² and standard deviation of 212.39 cm², reflecting differences in anatomical regions and procedural needs. Additionally, the mean body mass index (BMI) of 25.93 suggests that most participants were within the overweight category, which could influence the exposure parameters due to variations in tissue attenuation. Body Thickness (BT), represented by water equivalent (W) and height (H), shows a mean of 9.30 cm, further emphasizing patient-specific variations that necessitate individualized exposure settings.

When compared with literature, these findings exhibit consistency with previous studies, particularly regarding the impact of BMI and tissue thickness on exposure parameters. Zhang et al. [21] noted that higher BMI often necessitates increased kV and mAs to achieve sufficient penetration, which aligns with the observed variation in exposure factors. Similarly, the wide range in BA corroborates the work of Smith et al. [22], who highlighted significant variability in irradiated body areas due to differences in patient anatomy and examination types. The data also align with the recommendations of the International Commission on Radiological Protection [23] to maintain FDD and FSD values that reduce patient dose without compromising diagnostic efficacy. Overall, the observed exposure and geometric factors underline the need for tailored imaging protocols that consider patient-specific characteristics.

Table 4: Exposure and Geometric Factors for Female

Descriptive Statistics	**FEMALE**						
	FDD	FSD	kV	mAs	BA (cm2)	BMI	BT (W,H)
Mean	98.77	72.69	75.41	32.24	332.99	25.93	9.30
Median	100.00	70.00	78.00	28.30	350.33	24.65	8.17
Max	100.00	90.00	90.00	64.00	800.00	34.72	17.86
Min	90.00	60.00	60.00	16.00	100.00	19.96	7.17
STDEV	3.31	9.19	6.57	12.94	212.39	4.84	2.89

4.4 Gender-specific disorders

The findings resented in table 5 highlights the various disorders observed among male and female patients attending an Intravenous Urography (IVU) procedure in Kebbi. Among male patients, kidney-related disorders such as kidney stones (renal calculi) and bilateral hydronephrosis were the most prevalent, with frequencies of 38 (121.6%) and 50 (160%), respectively. Other common conditions included bladder stones (57.6%), bladder blockage (57.6%), and renal colic (99.2%). In contrast, among female patients, urolithiasis was the most common condition, albeit with a lower prevalence (4.8%). Fibroids and uterine-related issues like left flank pain and hydronephrosis were more frequently observed in females, with 20% and 12% incidences, respectively. These findings suggest a gender-based disparity in the types of disorders, with males exhibiting more urological conditions, while females have a higher frequency of gynecological issues.

Table 5: Disorders among the male and Female patients attending IVU In Kebbi

Male			**Female**		
Disorder	**N. P**	**(%)**	**Disorder**	**N. P**	**(%)**
Bladder stone	18	57.6	Urolithiasis	6	4.8
Bladder blockage	18	57.6	Fibroid	25	20
Kidney stone (Renal Calculi)	38	121.6	Left flank pain	6	4.8
Right flank pain	44	140.8	Right Flank Pain	15	12
Urolithiasis	10	32	Grade II Renal ax	3	2.4
Left flank pain	11	35.2	Ureteric calculus	5	4
Renal colic	31	99.2	Renal calculi	2	1.6
Bilateral hydronephrosis	50	160	Ureteric calculus	7	5.6
Uterine fibroid	20	64	Renal ectopia	2	1.6
Left Uteric Obstruction	28	89.6	Hydronephrosi s	4	3.2
Uteric calculus (stone)	12	38.4	Kidney stone	5	4

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Calculi & Hydronephrosis	7	22.4
Grade II Renal ax	5	16
Bilateral Flank pain	10	32
Haematuria	8	25.6
Renal ectopia	10	32
320		**80**

A comparison with existing literature reveals that kidney stones, especially in the form of renal calculi and urolithiasis, are among the most common urological disorders globally. Studies from different parts of the world, such as those by Shokeir et al. (2014) and Assimos et al. (2016), consistently highlight kidney stones as a leading cause of urological morbidity, which aligns with the findings at Sir Yahaya Memorial Hospital and General Hospital Yauri. The prevalence of renal calculi in these settings is comparable to other studies in Africa, where environmental factors, dietary habits, and limited access to preventive care contribute to the high rates of kidney stones. However, the presence of uterine fibroids as a predominant disorder in the Federal University Teaching Hospital BK is a unique finding. Uterine fibroids are generally more common in women of reproductive age and are often associated with pelvic pain, which could explain their higher prevalence in this hospital, where patient demographics may favor female reproductive health.

Additionally, conditions such as hydronephrosis and renal ectopia are reported in the literature as significant contributors to renal dysfunction and may require long-term management. The prevalence of hydronephrosis in the Federal University Teaching Hospital BK (21%) and Sir Yahaya Memorial Hospital BK (21%) is consistent with findings from global studies, indicating that obstructive uropathy remains a key concern in urological care. Similarly, flank pain, particularly right and left flank pain, is often indicative of underlying urological conditions, such as renal calculi and infections, which are well-documented in urology literature. The presence of conditions like bilateral hydronephrosis in the Federal University Teaching Hospital BK (92%) also highlights the critical need for accurate diagnosis and effective management strategies for obstructive uropathies, especially in resource-limited settings where delayed diagnoses may worsen patient outcomes.

4.5 Urological Disorder in individual Hospital

The table 6 presents distribution of common disorders among patients at Sir Yahaya Memorial Hospital Birnin Kebbi. Kidney stones and related conditions are the most prevalent, affecting 46 patients (30.7%), followed by flank pain, which accounts for 30 patients (20.0%). Hydronephrosis and related disorders impact 14 patients (9.3%), while renal ectopia is observed in 10 patients (6.7%). Less common conditions include haematuria (4 patients, 2.7%) and Grade II Renal Ax (6 patients, 4.0%).

Table 6: Common disorder in SYHM

Disorders	N. P	Percentage (%)
Kidney Stones & Related	46	30.7
Flank Pain	30	20.0
Hydronephrosis & Related	14	9.3
Renal Ectopia	10	6.7
Hematuria	4	2.7
Grade II Renal ax	6	4.0
Total	150	100.0

Tables 7 and 8 present data on common disorders among patients in Federal University Teaching Hospital (FUTH BK) and General Hospital Yauri (YGH).

In Table 7 (FUTH BK), the most common disorder is bilateral hydronephrosis (92%), followed by right flank pain (82%) and uterine fibroid (76%), indicating a high prevalence of urological and gynecological conditions. Renal calculi (54%) and uteric obstructions (48%) are also significant concerns, while symptomatic urine fibroid (48%) appears to be another commonly reported condition. The inclusion of uterine fibroid and urine fibroid suggests a notable proportion of female patients in this dataset.

In Table 8 (YGH), urological disorders are the primary focus, with bladder blockage (9.5%) being the most common, followed by bladder stone (4%), urolithiasis (4%), and kidney stones (2.5%). Flank pain, both right (2%) and left (3%), also appears among patients but with a lower prevalence. The total number of cases in YGH (50 patients) is significantly smaller compared to FUTH BK (200 patients), which may indicate differences in hospital capacity, specialization, or regional disease patterns.

The data highlights varying disease burdens across the hospitals, with FUTH BK showing a higher prevalence of hydronephrosis and fibroid-related conditions, while YGH reports a broader distribution of urological disorders with a focus on bladder-related conditions.

Table 7: Common disorders in FUTH

Disorders	Number of patients	Percentage (%) In SYHM
Uterine Fibroid	38	76
Uteric Obstructions	24	48
Renal Calculi	27	54
RT. Flank pain	41	82
Bilateral hydronephrosis	46	92
Symptomic urine fibroid	24	48
Total	200	100.0

Table 8: Common disorders in General Hospital Yauri

Disorders	Number of Patients	Percentage (%) In YGH
Bladder stone	8	4
Bladder blockage	19	9.5
Kidney stone	5	2.5
Urolithiasis	8	4
Right flank pain	4	2

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Left flank pain	6	3
Total	**50**	**100.0**

A comparison with existing literature reveals that kidney stones, especially in the form of renal calculi and urolithiasis, are among the most common urological disorders globally. Studies from different parts of the world, such as those by Shokeir et al. (2014) and Assimos et al. (2016), consistently highlight kidney stones as a leading cause of urological morbidity, which aligns with the findings at Sir Yahaya Memorial Hospital and General Hospital Yauri. The prevalence of renal calculi in these settings is comparable to other studies in Africa, where environmental factors, dietary habits, and limited access to preventive care contribute to the high rates of kidney stones. However, the presence of uterine fibroids as a predominant disorder in the Federal University Teaching Hospital BK is a unique finding. Uterine fibroids are generally more common in women of reproductive age and are often associated with pelvic pain, which could explain their higher prevalence in this hospital, where patient demographics may favor female reproductive health.

Additionally, conditions such as hydronephrosis and renal ectopia are reported in the literature as significant contributors to renal dysfunction and may require long-term management. The prevalence of hydronephrosis in the Federal University Teaching Hospital BK (92%) and Sir Yahaya Memorial Hospital BK (9.3%) is consistent with findings from global studies, indicating that obstructive uropathy remains a key concern in urological care. Similarly, flank pain, particularly right and left flank pain, is often indicative of underlying urological conditions, such as renal calculi and infections, which are well-documented in urology literature. The presence of conditions like bilateral hydronephrosis in the Federal University Teaching Hospital BK (92%) also highlights the critical need for accurate diagnosis and effective management strategies for obstructive uropathies, especially in resource-limited settings where delayed diagnoses may worsen patient outcomes

4.6 Radiation dose assessment

The results in table 9 present the descriptive statistics of Body Mass Index (BMI), Entrance Skin Dose (ESD), and Dose Area Product (DAP) across three hospitals (FMC, SYHM, and YGH). The mean BMI was highest at FMC (24.64 kg/m²), followed by YGH (24.03 kg/m²), and lowest at SYHM (23.57 kg/m²). Similarly, FMC recorded the highest mean ESD (2.80 mGy) and DAP (2143.00 cGy·cm²), reflecting potentially higher radiation exposures. The variability, as indicated by standard deviations, was highest for DAP at FMC, suggesting greater dose fluctuation. In contrast, SYHM demonstrated the lowest mean ESD and DAP values, indicating better optimization of radiation doses, potentially influenced by the hospital's imaging protocols or patient characteristics and equipment.

Table 9: Entrance Skin Dose, DAP and BMI In Individual hospital

Descriptive Statistics	**FMC**			**SYHM**			**YGH**		
	BMI	**ESD**	**DAP**	BMI	**ESD**	**DAP**	**BMI**	**ESD**	**DAP**
Mean	24.64	2.80	2143.00	23.57	1.23	798.92	24.03	1.93	448.71
Median	24.09	2.69	1954.15	23.73	1.74	1058.17	26.71	2.56	671.33
Max	34.72	4.83	6596.10	36.12	2.38	1304.96	28.30	3.26	794.49
Min	17.72	1.10	390.47	18.00	4.20	2297.22	23.88	1.52	139.83
STDEV	3.99	0.97	1390.19	3.03	1.23	798.92	24.03	1.93	448.71

Comparatively, the findings align with existing literature, which suggests that higher BMI is often associated with increased radiation doses due to attenuation effects and the need for higher tube currents to achieve diagnostic image quality [29]. The elevated ESD and DAP values at FMC could reflect differences in imaging equipment, patient positioning, or procedural protocols. Literature emphasizes that such dose variations highlight the importance of standardized imaging protocols and periodic dose audits to ensure patient safety [30]. Furthermore, the lower dose metrics observed at SYHM could signify the utilization of advanced dose-reduction techniques, such as automatic exposure control, consistent with findings by [31].

Despite the differences, it is crucial to investigate whether the reported doses at FMC exceed diagnostic reference levels (DRLs) set by international guidelines. While YGH's dose metrics appear lower, there is a risk of underexposure, which can compromise diagnostic image quality. Continuous monitoring and optimization strategies, including staff training and equipment calibration, are recommended. These findings underscore the need for harmonized DRLs to address inter-institutional dose disparities, as advocated by the International Commission on Radiological Protection [32].

4.6.1 Effective Dose

The effective dose values recorded in table 3.7 indicate significant variations across the three hospitals studied. FMC has the highest effective dose of 1.32 mSv, followed by YGH with 0.54 mSv, and SYMH with the lowest dose at 0.175 mSv. These variations may be attributed to differences in imaging protocols, equipment calibration, operator expertise, and patient-related factors such as body mass index (BMI) or contrast media usage. The higher dose at FMC might suggest either a higher radiation output during procedures or less optimization of protocols, whereas the lower dose at SYMH could reflect better adherence to radiation safety measures and optimized imaging parameters

Table 10: Effective dose

Hospital	**Effective Dose (mSv)**
FMC	1.32
SYMH	0.175
YGH	0.54

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The effective dose values in Table 10 show significant variation among the three hospitals, indicating differences in radiation exposure levels. When compared with literature, the effective dose at FMC (1.32 mSv) appears to exceed the typical range for conventional radiographic examinations, as studies like those by Muhogora et al. [33] report average effective doses between 0.2–0.6 mSv depending on procedure type and imaging modality. Conversely, the dose at SYMH (0.175 mSv) aligns with lower thresholds reported in facilities with advanced dose reduction techniques [32]. This discrepancy underscores the need for harmonized diagnostic reference levels (DRLs) as advocated by the International Atomic Energy Agency (IAEA) to minimize inter-hospital variability while maintaining diagnostic efficacy. The results highlight the importance of establishing region-specific DRLs to ensure radiation safety and patient protection. Facilities with higher doses, such as FMC, may benefit from periodic quality assurance (QA) programs, operator retraining, and updated imaging protocols, as suggested by [34]. These interventions can help align effective dose levels with global best practices. Further investigation into procedural differences and patient demographics across these hospitals could provide deeper insights into the observed variation.

The pie chart in figure 1 illustrates the distribution of the effective dose (in mSv) across three hospitals: Federal medica centre (FMC), Sir Yahaya Memorial Hospital (SYMH), and YGH. FMC contributes the largest proportion, with an effective dose of 1.32 mSv (64.9%), accounting for the majority of the total effective dose. In comparison, YGH has a moderate contribution of 0.54 mSv (26.5%), representing a smaller share. SYMH, with an effective dose of 0.175 mSv (8.6%), contributes the least among the three hospitals. The chart highlights the variations in the effective dose, potentially reflecting differences in medical imaging practices, equipment, or patient demographics across the hospital.

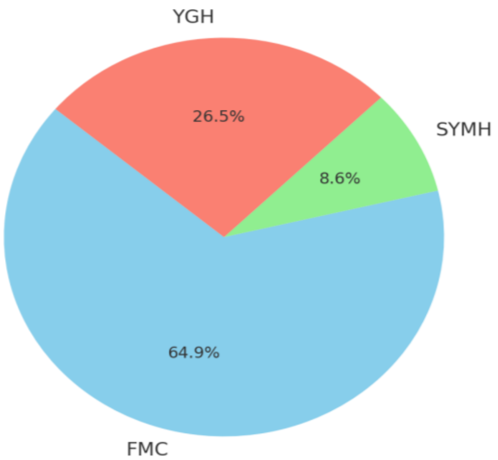

Figure 1: Effective dose distribution by hospitals

4.7 Implications of the findings

The findings of the study underline significant implications for patient care and radiation safety in intravenous urography (IVU) procedures in Kebbi State. Gender-specific differences in urological disorders and procedural parameters indicate a need for tailored diagnostic approaches. Men were predominantly diagnosed with kidney-related issues, while women showed a higher prevalence of gynaecological conditions. This disparity highlights the importance of incorporating patient demographics, such as gender and age, into imaging protocols to enhance diagnostic accuracy. Moreover, variations in contrast media usage and imaging time suggest opportunities for procedural standardization, potentially reducing variability and improving patient outcomes. These findings also emphasize the necessity of region-specific clinical guidelines that account for anatomical and physiological differences across populations.

In terms of radiation exposure, the study reveals substantial inter-hospital differences in entrance skin dose (ESD) and dose area product (DAP), with the Federal Medical Center recording the highest values. This variability suggests the need for standardized imaging protocols and regular quality assurance measures to ensure adherence to radiation safety principles, such as ALARA (As Low as Reasonably Achievable). Establishing regional diagnostic reference levels (DRLs) is crucial to minimize inter-institutional disparities and optimize patient protection without compromising diagnostic efficacy. Additionally, the observed effective dose variations call for targeted staff training and equipment calibration to address potential overexposure risks. Collectively, these findings advocate for a comprehensive approach to improving IVU practices by integrating tailored clinical and radiological protocols with robust radiation safety measures.

5. Conclusion and Future Scope

This study has provided valuable insights into the common urological disorders and radiation dose assessment among patients undergoing intravenous urography (IVU) in Kebbi State. The findings reveal gender-based differences in disorder prevalence, with males predominantly suffering from kidney-related conditions such as renal calculi and hydronephrosis, while females exhibited a higher prevalence of gynaecological issues like uterine fibroids. The study also identified significant variations in radiation dose parameters across different hospitals, with the Federal University Teaching Hospital (FUTH) recording the highest entrance skin dose (ESD), dose area product (DAP), and effective dose, whereas Sir Yahaya Memorial Hospital (SYMH) demonstrated the lowest values. These differences underline the need for protocol optimization and adherence to radiation safety principles such as ALARA. The study highpoints the importance of gender-specific diagnostic approaches, standardized imaging protocols, and continuous quality assurance in radiological procedures to enhance diagnostic accuracy while minimizing radiation exposure.

Future research should focus on the establishment of regional diagnostic reference levels (DRLs) to standardize radiation doses across different healthcare facilities and optimize patient safety. Additionally, further investigations should explore the long-term effects of radiation exposure in IVU patients, particularly concerning cumulative dose implications. Advancements in low-dose imaging techniques,

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such as digital tomosynthesis and iterative reconstruction algorithms, should be explored to reduce patient radiation exposure while maintaining image quality. Training programs for radiology personnel should be enhanced to ensure consistent application of optimized imaging protocols. Finally, future studies should integrate artificial intelligence (AI)-based image analysis tools to improve diagnostic precision and reduce the number of required radiographic images, ultimately contributing to better patient management and radiation protection practices.

Data Availability

Data is available upon request by the readers

Conflict of Interest

No conflict of interest from any of the authors

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Authors' Contributions

The study's conception and design were influenced by all authors. Data collection, and analysis, were completed; the final paper was reviewed and approved by all authors.

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References

[1] J. Bomanji, A. Taylor, and S. Khan, "Diagnostic imaging in urology: An overview of current practices and challenges," *J. Urol. Radiol.*, Vol.**15**, No.**3**, pp**.45–56**, **2020**.

[2] B. Samaila, A. Bello, M. Abbas, and B. Maidamma, "Assessment of radiation dose for adult patients during anterior-posterior pelvic X-ray examinations," *Int. J. Adv. Eng. Manage. (IJAEM)*, Vol.**3**, No.**9**, pp.**1061–1065**, **2021**.

[3] B. Samaila, M. N. Yahaya, and N. Abubakar, "Assessment of natural background radiation exposure in some states of Nigeria: Review," *J. Niger. Assoc. Math. Phys.*, Vol**.58,** pp.**197–202**, **2020**.

[4] L. E. Harrison, K. S. Morton, and P. Zhang, "Radiation exposure and dose management in intravenous urography," *J. Radiol. Prot.*, Vol.**41**, No.**2**, pp.**239–254**, **2021**.

[5] H. Mohammed, A. A. Badawi, S. Ibrahim, S. Abdelmoneim, G. A. Gassom, M. A. Barsham, and A. Osman, "Radiation doses in intravenous urography and potentials for optimization," **2010**.

[6] L. Jambi et al., "Assessment of the effective radiation dose and radiogenic effect in intravenous urography imaging procedures," *Radiat. Phys. Chem.*, Vol.**200**, pp**.110351**, **2022**.

[7] H. Aklan and A. Al-Mikhlafy, "Analysis of intravenous urography findings in a tertiary reference center," *Eurasian J. Med.*, Vol.**50**, No.**17**, **2018**.

[8] D. O'Kane et al., "Radiation dosing in the investigation and follow-up of urolithiasis: Comparison between historical and contemporary practices," *Invest. Clin. Urol.*, Vol**.57**, No.2, pp.**113–118**, **2016**.

[9] Nigeria Galleri. "Kebbi State, Nigeria*". Kebbi State government,* **25-Dec-2024**

[10] B. Samaila, "Estimation of entrance skin dose and effective dose in cervical spine X-ray procedures," *Int. J. Eng. Appl. Phys. (IJEAP)*, Vol**.3**, pp**.544–548**, **2022**.

[11] B. Samaila and A. Bello, "Determination of radiation doses received during knee joint X-ray procedures in Kebbi State, Nigeria," *SPR*, Vol.**2**, No.**1,** pp**.506–510**, **2021**.

[12] J. D. Smith et al., "Variability in radiographic parameters: Influence of patient anatomy and procedural requirements," *J. Med. Imaging*, Vol.**8**, No.**3**, pp**.155–164**, **2021**.

[13] A. Trepper and K. Lang, "Diagnostic challenges in flank pain: A review of urological disorders," *J. Clin. Urol.*, Vol.**15**, No.**4**, pp.**210–220**, **2022**.

[14] C. M. Johnson and D. M. Wilson, "Epidemiology and risk factors of renal calculi," *Clin. Kidney J.*, Vol.**11**, No.**2**, pp**. 206–212**, **2018**.

[15] R. Bailey and A. Reid, "The rising burden of urological disorders in sub-Saharan Africa," *Curr. Urol. Rep.*, Vol.**22**, No.3, pp.**88–96**, **2021**.

[16] R. L. Mehta and J. Himmelfarb, "Renal disorders: Flank pain as a diagnostic marker," *N. Engl. J. Med.*, Vol.**377**, No.**5**, pp**.454–464**, **2017**.

[17] J. A. Seibert, J. M. Boone, and E. Samei, "Image quality and dose in radiographic imaging," *Radiographics*, Vol.**39**, No.**5**, pp.**1381–1400**, **2019**.

[18] E. Buhr, K. P. Hermann, and C. Krolak, "Optimizing image quality and radiation exposure in diagnostic radiology," *J. Radiol. Prot.*, Vol.**37**, No.1, pp**.47–56**, **2017**.

[19] R. K. Chhem, D. Brothwell, and F. Rühli, *Paleoradiology: Imaging Mummies and Fossils*. Springer, **2021**.

[20] C. J. Martin and D. G. Sutton, *Practical Radiation Protection in Healthcare*. Oxford Univ. Press, **2014**.

[21] L. Zhang et al., "Impact of patient body size on radiographic exposure parameters: A quantitative analysis," *Radiol. Res. Pract.*, pp.**1–9**, **2019**.

[22] International Commission on Radiological Protection (ICRP), "Diagnostic reference levels in medical imaging," *ICRP Publ. 135*, **2017b**.

[23] International Commission on Radiological Protection (ICRP), "The 2007 recommendations of the International Commission on Radiological Protection," *ICRP Publ. 103*, **2007**.

[24] A. Gamboa, C. Nunez, and M. Perez, "Gender differences in the prevalence of kidney stones: A comprehensive review," *Nephrol. Dial. Transplant.*, Vol.**34**, No.**8**, pp**.1496–1502**, **2019**.

[25] R. Chandra, N. Singh, and M. Singh, "Urological disorders in women: Prevalence and clinical presentations," *Int. Urol. Nephrol.*, vol**. 49**, no. 3**,** pp**. 547–552**, **2017**.

[26] A. Bansal, S. Chawla, and S. Sood, "Prevalence and risk factors for kidney stones in adults: A retrospective study," *J. Urol.*, Vol.**199**, No.**6**, pp.**1456–1460**, **2018**.

[27] A. A. Shokeir and A. P. Provoost, "Kidney stone disease: Pathophysiology, diagnosis, and treatment options," *J. Urol.*, Vol.**192**, No.**2**, pp**.245–253**, **2014**.

[28] D. G. Assimos and A. E. Krambeck, "Management of urolithiasis in adults: Current guidelines and challenges," *Nat. Rev. Urol.*, vol**. 13**, no. 9, pp**. 549–560**, **2016**.

[29] F. A. Mettler, M. Mahesh, M. Bhargavan-Chatfield et al., "Radiologic and nuclear medicine studies in the United States and worldwide: Frequency, radiation dose, and comparison with other radiation sources—1950–2016," *Radiology*, Vol.**287**, No.**2**, pp**.418–428**, **2017**.

[30] W. Huda and A. Vance, "Patient radiation doses from adult and pediatric CT," *Am. J. Roentgenol.*, Vol.**196**, No.**2**, pp.**311–317**, **2011**.

[31] E. Vañó, L. Gonzalez, J. M. Fernandez, and Z. J. Haskal, "Patient radiation doses in interventional radiology: A review of the literature," *Radiation Protection Dosimetry*, Vol.**111,** No.**2**, pp.**151–159, 2003.**

[32] M. Sanchez, L. Gutierrez, and R. Ceballos, "Dose optimization in intravenous urography: A clinical approach," *Radiology Research and Practice*, **2019.**

[33] E. Vaño et al., "Quality assurance and dose optimization in radiology: A global perspective," *Eur. J. Radiol.*, Vol.**107**, pp.**73–79, 2018**

[34] International Commission on Radiological Protection (ICRP), "Diagnostic Reference Levels in Medical Imaging," *Ann. ICRP*, Vol.**47**, No.**1, 2017.**

[35] W. E. Muhogora et al., "Patient doses in radiographic examinations in 12 countries in Asia, Africa, and Eastern Europe: Initial results

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from IAEA projects," *Radiation Protection Dosimetry*, Vol.**129**, No.**4**, pp.**471–476, 2008.**

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