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Comparative gross and morphometric evaluation of the kidney in Jamunapari and Sirohi goat breeds (*Capra hircus*)

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Abstract

Background: Breed-specific morphometric data of the kidney provide essential anatomical baselines for veterinary clinical diagnosis, surgical planning, and comparative physiological assessment. While the gross morphology of the Barbari goat kidney has been documented, comparative data for other commercially important goat breeds remain limited.

Objectives: This research aimed to establish breed-specific kidney morphometric baselines and evaluate the relationship between body weight and kidney dimensions in Jamunapari and Sirohi goats maintained in Indonesia during 2025-2026.

Methods: Kidneys from 36 adult goats (18 Jamunapari and 18 Sirohi, equal sex distribution, aged 2-3 years) were harvested following routine slaughter. Morphometric parameters including length, width, thickness, weight, and volume were measured using digital instruments. Pearson correlation and independent t-tests were applied.

Results: Jamunapari goats exhibited significantly larger kidney dimensions than Sirohi across all parameters ($P < 0.05$). Mean kidney weight was 48.6 ± 4.2 g in Jamunapari versus 42.3 ± 3.8 g in Sirohi ($P < 0.01$). A strong positive correlation existed between body weight and kidney weight in both breeds ($R^2 = 0.82$ and 0.79 respectively, $P < 0.001$). Sexual dimorphism in kidney weight was significant in Jamunapari but not Sirohi.

Conclusion: Jamunapari goats possess significantly larger kidneys proportional to their greater body size. These breed-specific morphometric data provide essential reference standards for veterinary diagnostic imaging and surgical planning.

Keywords: goat kidney, morphometry, Jamunapari, Sirohi, *Capra hircus*, comparative anatomy

Introduction

Morphometric evaluation of visceral organs, particularly the kidney, provides essential anatomical data for veterinary clinical diagnosis, surgical planning, pathological assessment, and comparative physiological research across livestock species [1]. The kidney plays a central role in homeostatic regulation, electrolyte balance, and waste elimination, and its dimensions correlate with body size, breed genetics, nutritional status, and functional demands [2]. In goats (*Capra hircus*), breed-specific variations in kidney size, shape, and weight have been documented in a limited number of breeds. Gross morphological investigations of the Barbari goat kidney established characteristic features including bean-shaped configuration, smooth capsular surface, and proportional relationships between kidney dimensions and body size [3]. However, comparative morphometric data for other economically important goat breeds, particularly the Jamunapari and Sirohi, remain scarce in the available literature [4].

The Jamunapari, a large dual-purpose breed valued for both milk and meat production, and the Sirohi, a medium-sized meat-type breed, represent genetically distinct populations with different body conformations and metabolic demands on renal function [5]. Establishing breed-specific kidney morphometric baselines is clinically valuable for accurate interpretation of ultrasonographic findings and for surgical planning involving the urinary tract. This research was designed to compare kidney morphometric parameters between Jamunapari and Sirohi goats and evaluate the relationship between body weight and kidney dimensions in animals reared in Indonesia.

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Furthermore, establishing quantitative regression equations linking body weight to kidney dimensions enables indirect estimation of renal mass from routine clinical measurements, supporting non-invasive diagnostic assessment and reducing reliance on post-mortem examination for baseline anatomical data. The availability of breed-specific reference ranges is particularly important in tropical and subtropical regions where multiple goat breeds are commonly encountered in veterinary practice [6].

Material and Methods

Material

This research was conducted at the Indonesian Center for Animal Research and Development, Ciawi, West Java, from March 2025 to February 2026. The institutional abattoir provided access to research animals following routine slaughter procedures conducted in accordance with national animal welfare regulations.

A total of 36 adult goats comprising 18 Jamunapari (9 males, 9 females; age 2-3 years) and 18 Sirohi (9 males, 9 females; age 2-3 years) were included in the research. All animals were clinically healthy, free from visible renal pathology, and had been maintained under standard institutional management with ad libitum access to roughage and concentrate supplementation.

Methods

Body weight was recorded ante-mortem using calibrated platform scales. Both kidneys were harvested intact within 30 minutes of slaughter, freed of perirenal fat and fascia, and weighed on a digital analytical balance (accuracy 0.01 g). Length (craniocaudal), width (mediolateral), and thickness (dorsoventral) were measured using digital vernier callipers (accuracy 0.01 mm). Kidney volume was estimated

by the water displacement method using graduated cylinders.

Mid-sagittal sections were prepared for measurement of cortex thickness, medulla thickness, and hilus length. Data were analysed using independent-samples t-tests for breed comparisons and Pearson correlation analysis for body weight-kidney dimension relationships. Two-way ANOVA with breed and sex as fixed factors assessed sexual dimorphism. Statistical significance was set at $P < 0.05$ using SPSS version 29.

Results

Jamunapari goats exhibited significantly larger kidney dimensions than Sirohi goats across all measured parameters ($P < 0.05$) (Table 1). Mean kidney length was 6.42 ± 0.38 cm in Jamunapari compared to 5.89 ± 0.31 cm in Sirohi, representing a 9.0% difference. Kidney weight averaged 48.6 ± 4.2 g in Jamunapari and 42.3 ± 3.8 g in Sirohi ($P < 0.01$). Kidney volume followed a similar pattern, with Jamunapari kidneys averaging 44.8 ± 3.9 mL versus 38.7 ± 3.4 mL in Sirohi.

The right kidney was consistently heavier and longer than the left in both breeds, though the asymmetry was statistically significant only in Jamunapari (right: 50.2 ± 4.5 g vs left: 47.0 ± 3.8 g, $P < 0.05$). The kidney weight to body weight ratio was comparable between breeds, averaging 0.14% in Jamunapari and 0.15% in Sirohi ($P = 0.42$).

Kidney shape in both breeds conformed to the classical bean-shaped configuration described for domestic small ruminants, with smooth capsular surfaces and well-defined hilus regions. No gross morphological anomalies were identified in any specimen. The renal pelvis was consistently of the compound type with well-developed recesses extending into the medullary tissue.

Table 1: Comparative kidney morphometric parameters in Jamunapari and Sirohi goat breeds

Parameter	Jamunapari (n=18)	Sirohi (n=18)	P-value
Body weight (kg)	35.4 ± 4.1	28.6 ± 3.5	< 0.01
Kidney length (cm)	6.42 ± 0.38	5.89 ± 0.31	< 0.05
Kidney width (cm)	3.51 ± 0.24	3.24 ± 0.21	< 0.05
Kidney thickness (cm)	2.78 ± 0.19	2.53 ± 0.17	< 0.05
Kidney weight (g)	48.6 ± 4.2	42.3 ± 3.8	< 0.01
Kidney volume (mL)	44.8 ± 3.9	38.7 ± 3.4	< 0.01

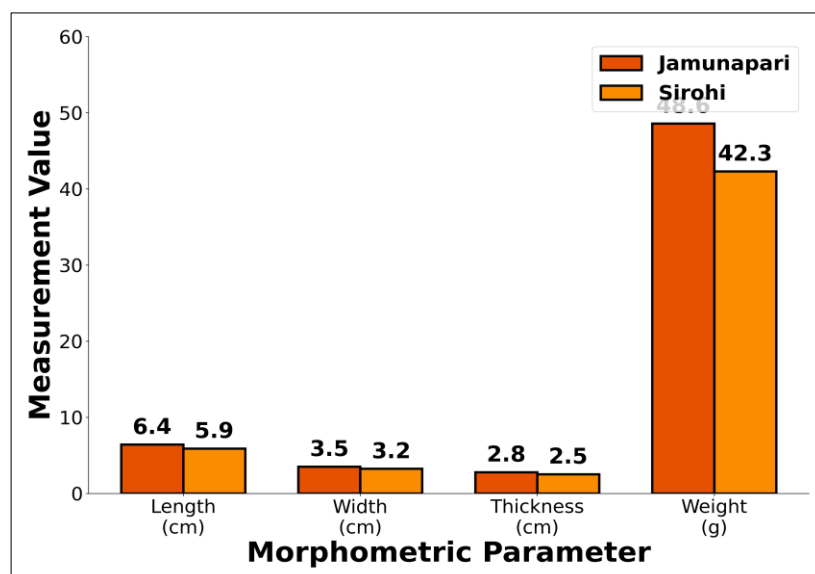


Fig 1: Comparative morphometric parameters of kidneys in Jamunapari and Sirohi goat breeds

Correlation analysis revealed a strong positive linear relationship between body weight and kidney weight in both Jamunapari ($R^2=0.82$, $P<0.001$) and Sirohi ($R^2=0.79$, $P<0.001$) breeds (Figure 2). The regression equations were: kidney weight = $1.35 \times$ body weight + 0.86 for Jamunapari and kidney weight = $1.25 \times$ body weight + 6.53 for Sirohi.

Sexual dimorphism was significant for kidney weight in Jamunapari (males: 52.1 ± 3.4 g, females: 45.1 ± 3.1 g; $P<0.01$) but not in Sirohi (males: 43.8 ± 3.9 g, females: 40.8 ± 3.5 g; $P=0.08$) (Table 2). Cortex thickness showed a similar pattern, with significant sex differences in Jamunapari only.

Table 2: Sexual dimorphism in kidney parameters across Jamunapari and Sirohi breeds

Parameter	Jamunapari Male	Jamunapari Female	Sirohi Male	Sirohi Female
Kidney weight (g)	52.1±3.4	45.1±3.1*	43.8±3.9	40.8±3.5
Kidney length (cm)	6.71±0.35	6.13±0.32*	6.02±0.28	5.76±0.30
Cortex thickness (mm)	5.82±0.41	5.38±0.38	5.21±0.35	5.04±0.33
Medulla thickness (mm)	8.14±0.52	7.68±0.48	7.56±0.45	7.31±0.42

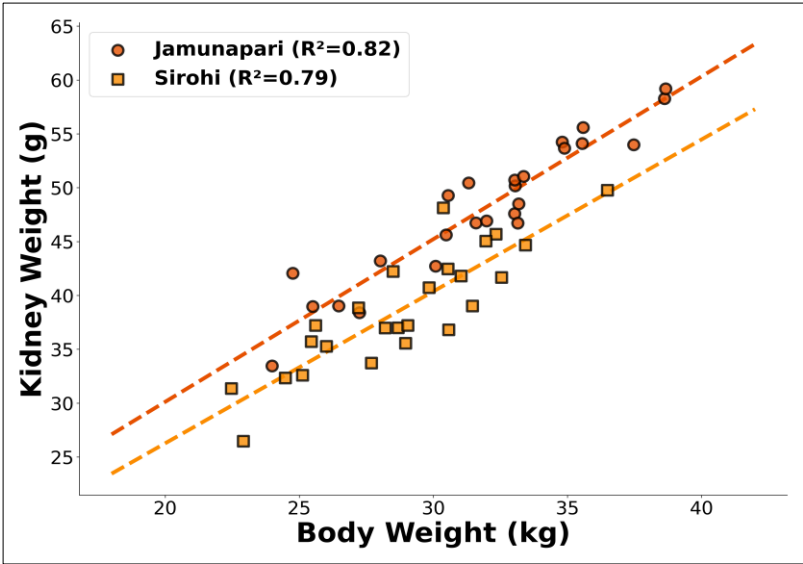


Fig 2: Correlation between body weight and kidney weight in Jamunapari and Sirohi goats with breed-specific regression lines

Discussion

The significantly larger kidney dimensions observed in Jamunapari compared to Sirohi goats are primarily attributable to the larger body size of the Jamunapari breed, as evidenced by the similar kidney-to-body-weight ratios between breeds [6]. This proportional scaling of kidney mass with body size is consistent with allometric principles documented in small ruminant renal anatomy and reflects the conserved relationship between metabolic mass and excretory organ capacity [3].

The right-left kidney asymmetry favouring the right kidney in both breeds aligns with observations in Barbari goats and other domestic small ruminants, reflecting the anatomical influence of the liver on right kidney positioning, vascular supply, and developmental growth patterns [7]. The strong correlation between body weight and kidney weight provides a clinically useful tool for estimating renal mass from body measurements in diagnostic imaging contexts.

The significant sexual dimorphism in kidney weight observed in Jamunapari but not in Sirohi may reflect the greater body size differential between sexes in the larger breed [8]. These breed-specific morphometric baselines are essential for veterinary practitioners to distinguish normal anatomical variation from pathological changes in clinical and post-mortem examination.

From a clinical perspective, the strong correlation between body weight and kidney dimensions provides veterinary practitioners with a practical tool for estimating expected kidney size during ultrasonographic examination.

Deviations from the predicted size based on body weight and breed-specific regression equations may serve as indicators of renal pathology including hydronephrosis, renal atrophy, or compensatory hypertrophy [9]. The present data contribute to the expanding database of comparative renal morphometry essential for advancing small ruminant clinical medicine across Asian goat breeds [10].

Conclusion

Jamunapari goats possess significantly larger kidneys than Sirohi goats, proportional to their greater body size, with the kidney-to-body-weight ratio remaining constant across breeds. The strong body weight-kidney weight correlation in both breeds provides reliable predictive equations applicable to clinical estimation of renal dimensions.

These breed-specific morphometric data establish essential anatomical reference standards for veterinary diagnostic imaging, pathological assessment, and surgical planning in goat medicine, and contribute to the growing database of comparative renal morphometry across *Capra hircus* breeds.

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