

## Gender Effects on Renal Stereological Parameters in Sheep and Goat

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**Abstract:** The aim of this study was to compare gender effects on renal stereological parameters in sheep and goat. 10 healthy adult sheep (5 male and 5 female) and 10 healthy adult goats (5 male and 5 female) of the Lori Bakhtyari breed, aged from 1.5 to 2 years were selected in the abattoir of Shahrekord. Results showed that in both species, the mean kidney weight was significantly greater in males than in females ( $p < 0.05$ ). In both sexes, the mean kidney weight was significantly greater in sheep than in goats ( $p < 0.05$ ). In both species, there was no significant difference in the mean glomerular number between the sexes. In both species, the mean glomerular volume (GV) and mean total glomerular volume (the product of glomerular number and average glomerular volume) were significantly greater in males compared to females ( $p < 0.05$ ). In both sexes, there were no significant differences in the mean glomerular number, mean glomerular volume and mean total glomerular volume between the species.

### Key words:

### INTRODUCTION

Most of the activities of the urinary system are performed by the kidneys, which exist as a pair of organs regardless of species [1]. In humans, male sex is associated with more rapid progression of chronic renal disease [2, 3]. Reduction of the number of functioning nephrons due to any etiology may lead to glomerular hypertrophy, hypertension and hyperfiltration [4, 5], resulting in glomerulosclerosis and additional nephron loss. Glomerular hypertrophy has been found as a frequent concomitant finding with increased glomerular pressure [6] and these two factors likely exert additive effects via Laplace's law, leading to glomerular sclerosis [7, 8]. Increased glomerular volume has been linked also to the development of glomerular sclerosis [9-11]. In available literature there is little information characterizing differences in renal structure between the sexes in domestic ruminants. The aim of the present study was therefore to evaluate the effects of sex on renal stereological parameters in sheep and goat.

### MATERIALS AND METHODS

Ten healthy adult sheep (5 male and 5 female) and 10 healthy adult goats (5 male and 5 female) of the Lori

Bakhtyari breed, aged from 1.5 to 2 years were selected according to their dental formula [12] in the abattoir of Shahrekord. Immediately after slaughtering, right kidneys were removed, split and weighed after immersion fixation. Glomeruli were counted in a sample consisting of a known fraction of each kidney. The total number of glomeruli per kidney was estimated from the number of glomeruli in the sample multiplied by the inverse of the sampling fraction. Glomeruli were counted using the fractionator-sampling method which has been described in detail and validated in an earlier publication [13]. The mean glomerular volume was calculated from the volume fraction of glomeruli in the cortex divided by the numerical density of glomeruli in the cortex. The total glomerular volume was calculated as the product of the glomerular number and the mean number of glomeruli.

Data were expressed as means  $\pm$  SEM. Differences between the means were tested for statistical significance using One-way ANOVA and Student's t test. Differences were considered significant for  $p < 0.05$ .

### RESULTS

Results obtained from the present investigation are compared in Figures 1-4. The important findings are as follows:

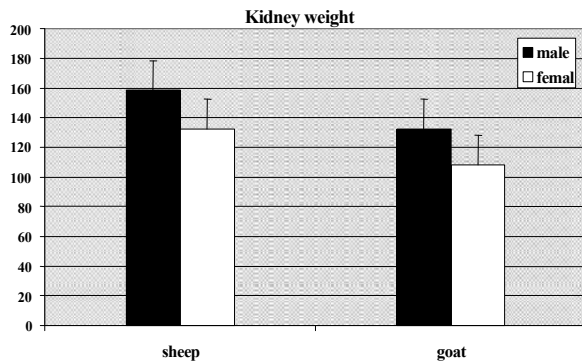


Fig. 1: Kidney weight (g.) in experimental groups

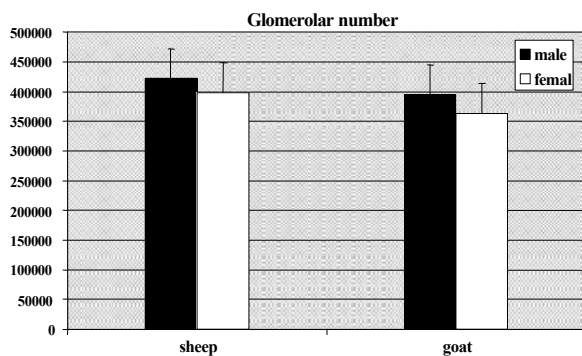


Fig. 2: Glomerular number in experimental groups

- In both species, the mean kidney weight was significantly greater in males than in females (sheep:  $158.4 \pm 7.12$  vs.  $132.6 \pm 8.4$  g,  $p < 0.05$ ; goat:  $132.6 \pm 8.24$  vs.  $108.6 \pm 6.8$  g,  $p < 0.05$ ).
- In both sexes, the mean kidney weight was significantly greater in sheep than in goats ( $p < 0.05$ ).
- In both species, there was no significant difference in the mean glomerular number between the sexes (sheep:  $422880 \pm 24480$  (males) vs.  $398440 \pm 36860$  (females); goat:  $394840 \pm 18880$  (males) vs.  $364200 \pm 20140$  (females)).
- In both species, the mean glomerular volume (GV) and mean total glomerular volume (the product of glomerular number and average glomerular volume) were significantly greater in males compared to females [(sheep: GV:  $6.51 \pm 0.38$  VS.  $5.44 \pm 0.24 \times 10^6 \mu\text{m}^3$ ,  $p < 0.05$ ; Tgv:  $4.19 \pm 0.33$  vs.  $3.21 \pm 0.26 \text{ cm}^3$ ,  $p < 0.05$ ); (goat: GV:  $6.49 \pm 0.21$  VS.  $5.38 \pm 0.26 \times 10^6 \mu\text{m}^3$ ,  $p < 0.05$ ; Tgv:  $4.33 \pm 0.26$  vs.  $3.24 \pm 0.32 \text{ cm}^3$ ,  $p < 0.05$ )].
- In both sexes, there were no significant differences in the mean glomerular number, mean glomerular volume and mean total glomerular volume between the species.

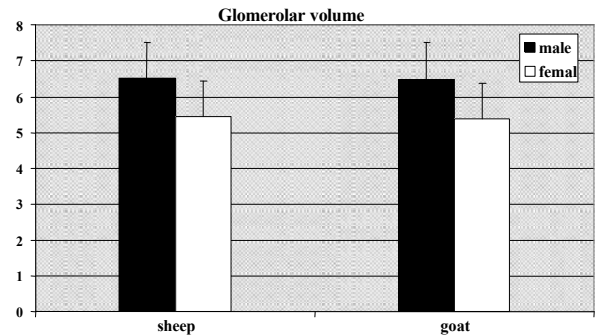


Fig. 3: Glomerular volume ( $\mu\text{m}^3$ ) in experimental groups

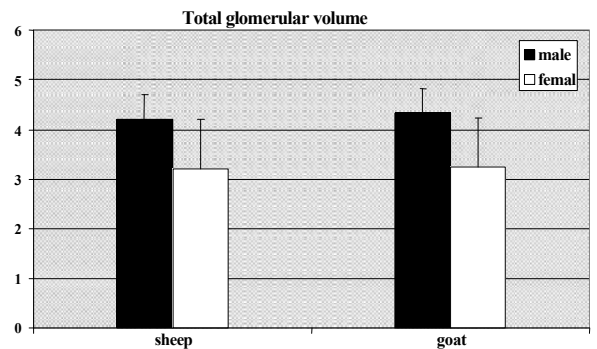


Fig. 4: Total glomerular volume ( $\text{cm}^3$ ) in experimental groups

## DISCUSSION

It has been elucidated that in humans, sex [2, 3] and race [14] influence the rate of progression of chronic renal disease. Numerous observations suggest that sex hormones, rather than genetically determined differences in renal structure, account for the greater susceptibility of the male kidney to progressive renal injury [2, 3]. Potential mechanisms for gender related protection include differences in renal structure including glomerular number and size, renal hemodynamics and other effects of estrogen or androgen on the synthesis and release of vasoactive substances, growth factors and cytokines [2, 3, 15]. Elucidation of the mechanisms responsible for the effects of sex on the progression of chronic renal disease requires knowledge of the effects of sex on renal structure. However, in available literature on the subject, there is a lack of information characterizing the effects of gender on renal structure in domestic ruminants. Results obtained from the present study elucidate for the first time, the effects of above mentioned factors on ovine and caprine renal structure.

Our results showed that in both species, the mean kidney weight was significantly greater in males than in

females. This result is in agreement with that of Silbiger and Neugarten [2] and Bertram *et al.* [16] in humans, who stated that men have larger kidneys than women.

Results obtained from the present study also showed that in both sexes, the mean kidney weight was significantly greater in sheep than in goats. Bertram *et al.* [16] stated that kidney weight was lower in Australian Aborigines than non-Aborigines.

Data obtained from the present study revealed that despite the difference in kidney weight, no differences in glomerular number exist between the sexes. This finding is also in agreement with that of Silbiger and Neugarten [2] in rats and that of McLachlan *et al.* [17] in humans. Munger and Baylis [18] stated that the number of glomeruli per kidney do not differ between male and female rats of the same age. Total glomerular (nephron) number is proposed determinant within the multifactorial aetiology of hypertension. Individuals with low glomerular number are suggested to be at increased risk of hypertension and progressive kidney disease in a later stage of life [19-21].

Results obtained from the present study also showed that in both species, the mean glomerular volume (GV) and mean total glomerular volume (the product of glomerular number and average glomerular volume) were significantly greater in males compared to females. Estradiol may induce protective effects on the kidney. Compared with age-matched men, the rate of progression of renal disease in premenopausal women is decreased [3, 15]. However, with the onset of menopause and decreased synthesis of 17 beta-estradiol, the progression of renal diseases accelerates and estradiol replacement therapy slows this process [2, 3, 15]. Numerous investigators have demonstrated a correlation between glomerular size and progressive glomerular sclerosis in humans [22]. Li *et al.* [23] described in human beings an increase in glomerular size between infancy and adolescence, but later on the growing was slower; there was no difference between females and males. Strong correlation has been shown between the degree of glomerular sclerosis and glomerular size in the remnant kidney models [24, 25] and in specific glomerular diseases in humans [26]. Ellis *et al.* [27] found no relationship between glomerular filtration surface and sex. Lombet *et al.* [28] also reported that mean glomerular volume was comparable for age-matched male and female rats despite different kidney weight between the sexes. Francois *et al.* [29] stated that glomerular volume, urinary space,

capillary lumen area and mesangial domains of deep and superficial nephrons were larger in male than in female rats. Glomerular hypertrophy was evidenced with age in both males and females. The hypertrophy was greater in female than in male rats. Age-related hypertrophy concerned equally the urinary space and the glomerular tuft. The mesangial domain, however, increased more markedly than glomerular volume.

It was concluded that in both species, the mean kidney weight was significantly greater in males than in females. In both sexes, the mean kidney weight was significantly greater in sheep than in goats. In both species, there was no significant difference in the mean glomerular number between the sexes. In both species, the mean glomerular volume and mean total glomerular volume were significantly greater in males compared to females. In both sexes, there were no significant differences in the mean glomerular number, mean glomerular volume and mean total glomerular volume between the species.

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