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Association of body weight, scrotal circumference, heart girth and penile development with spermatogenesis in the Nubian bucks

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This study was designed to monitor the morphological development of the reproductive tract of the Nubian bucks in relation to puberty. Thirty-two Nubian male kids were used in this study. Their ages ranged between 1 day and 24 weeks. The study was undertaken to correlate the body weight (BW), heart girth circumference (HG), scrotal circumference (SC), testicular descent into the scrotum and penile separation from prepuce (PS) with age at puberty. Penile separation started slightly at 12 weeks of age and continued with advancing age till it was completely achieved between 22 and 24 weeks of age. Strong correlation has been established between the levels of the reproductive hormones and the morphological maturation of the reproductive tract. The first surge in the levels of these hormones (occurred between weeks 10 and 12) coincided with the increase in the diameters of the seminiferous tubules, the epididymis, ductus deferens and the penis. The first appearance of secondary spermatocytes and initiation of penile separation occurred during this period. The second surge was associated with the first appearance of spermatids, spermatozoa and completion of penile separation, which occurred between 20 and 24 weeks.

Key words: Nubian bucks, spermatogenesis, body measurements.

INTRODUCTION

Sudan is predominantly an agricultural country with the largest livestock population in the Arab World and ranks second to Ethiopia in Africa. Despite this large population, there is a critical shortage in milk supply and other dairy products. This is mainly due to the poor feeding, poor management and prevalence of diseases. Goats play an important economic role in the livelihood of many Sudanese families.

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The local breeds of goats in Sudan embrace the Nubian, Desert, Nilotic dwarf and Taagari. Among these breeds the Nubian goat is recognized as the only specialized milk breed (Hassan and El Derani, 1990).

Goats are used as a representative of large animals for certain experimental purposes like studies on reproduction as the reproductive tracts of the male goat, ram and bull are essentially similar (Goyal, 1985). Among these three species, male goats receive preference because, unlike rams, and bulls, are inexpensive and easier to handle for surgical manoeuvres (Goyal et al., 1999).

The reproductive tract of the male goat consists of testes, epididymis, ductus deferens, penis and the accessory sex glands (seminal vesicles, prostate and bulbo-urethral (Cowper's) gland). The male reproductive tract has been investigated histologically, ultrastructurally and histochemically in several species including bull (Abdel- Raouf, 1960; Mohammed, 2005), camel (Ali et al., 1978; Tingari and Moniem, 1979; Tingari et al., 1984), rat (Pogach et al., 1993) and domestic fowl (Tingari 1972). The goat in general received little or no attention. In spite of the importance of the Nubian goat, there is no reference in the literature dealing with the characteristics pertaining to the morphological and physiological changes of the reproductive tract prior to the age of puberty.

Studies on puberty have been reported for the bull (Abdel Raouf, 1960; Renaville et al., 1993), goat (Nasir et al., 2013), sheep and goat (Louw and Joubert, 1964; Lord et al., 1991), ram (Dun, 1955), camel (Abdel Rahim, 1997), rhesus macaques (Bercovitch, 1993) and man (Martha and Reiter, 1991). Puberty, the culmination of a multitude of developmental processes at the hypothalamic, pituitary and gonadal levels, is essentially manifested by the episodic release of testosterone (Renaville et al., 1983; Schams, Winkler et al., 1988) which serves as a primary regulator for other major physiological changes during this period (Martha and Reiter, 1991). Associated with this increase in plasma testosterone concentrations, a growth hormone (GH) discharge may precede the onset of puberty (Thompson et al., 1972).

Puberty is reached when sexual organs have become fully developed (Abdel-Raouf, 1960), the sexual instincts are prominent and reproduction is possible. The objective of this study is to examine the changes in the morphological parameters in the male reproductive tract of the Nubian bucks prior to the age of puberty.

MATERIALS AND METHODS

This research work was conducted in the period between May, 2001 and May 2002. Samples were obtained from different parts of the male reproductive tract including the testis, epididymis, ductus deferens and penis of 32 Nubian male kids, from birth up to six months of age. Samples were taken at 15 days interval for investigation. The different groups were represented by at least two animals each. The animals were used initially for data collection including; body weight (BW), scrotal circumference (SC), Heart Girth (HG), testicular descent into the scrotum and penile separation from prepuce.

Statistical analysis

A computer package for statistical analysis was used (SPSS version, 11). The data obtained were computed to find correlations between body weight (BW), scrotal circumference (SC), Heart Girth (HG) in association with penile separation and appearance of spermatozoa in the seminiference tubules.

RESULTS

Body weight (BW)

The result showed that body weight in Nubian male kids increased with age in a linear pattern starting with 2.3 kg at week one and ending with 13.5 kg at 24 weeks of age (Figure 1).

Heart girth circumference (HG)

Heart girth measurements increased with age in a linear pattern, reaching higher values at 22 weeks of age. HG showed a strong correlation ($P< 0.1$) with age (Figure 2).

Scrotal circumference (SC)

SC measurement increased with age in a linear pattern reaching the maximum at 22 weeks of age (Figure 3). There were strong correlations between SC and BW ($P< 0.01$) and between SC and HG ($P< 0.01$).

Correlation between the body weight (BW), heart girth circumference (HG), scrotal circumference (SC)

Very strong positive correlations were found between the BW, heart girth circumference (HG) and scrotal circumference (SC) (Tables 1 and 2).

Penile separation from the prepuce

The diameter of the penis was 6988 µm wide at week one. The skin was closely adherent to the underlying tissue in which Meissner's corpuscles were seen. An inner folded band encircled the corpus spongiosum penis and corpus cavernosum penis and consisted of about ten layers, mainly cuboidal cells in the center, covered on either side by columnar cells and overlying layer of connective tissue containing band of smooth muscle fibers and collagen fibers. Penile separation started slightly at 12 weeks of age and continued with age till it

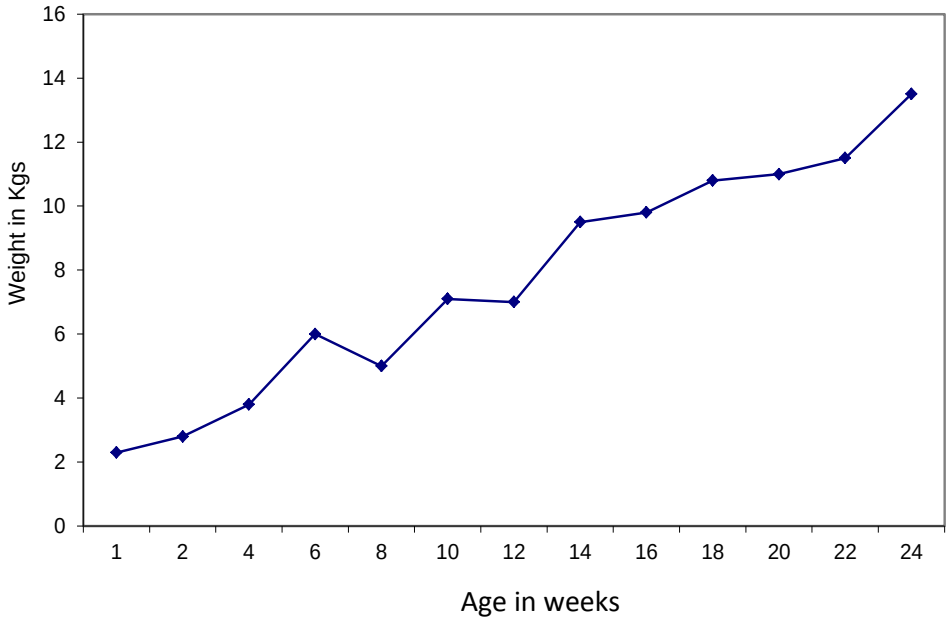

Figure 1. Body weight changes (Kg) with age (weeks) in Nubian male kids.

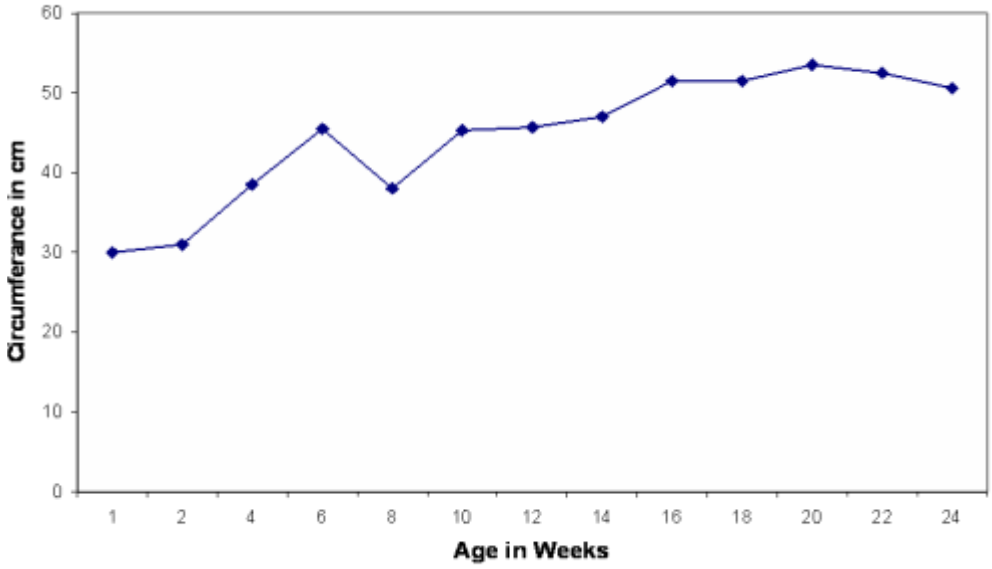

Figure 2. Heart-girth measurements (cm) with age (weeks) in Nubian male kids.

was completely achieved between 22 and 24 weeks of age (Figures 4 and 5).

Puberty

Based on the first appearance of spermatozoa in the seminiferous tubules, puberty was reached in Nubain male kids at the age of 22 weeks. At this age penile separation was completed (Figure 4), body weight was11.5 kg, heart girth was 52.5 cm and scrotal circumference was 13.5 cm.

DISCUSSION

This study was conducted in different seasons and the results were not affected by seasonal changes, since the Nubian goat is a tropical breed and has no pattern of seasonal breeding, (Kurohmaru and Nishida, 1987; Ritar,

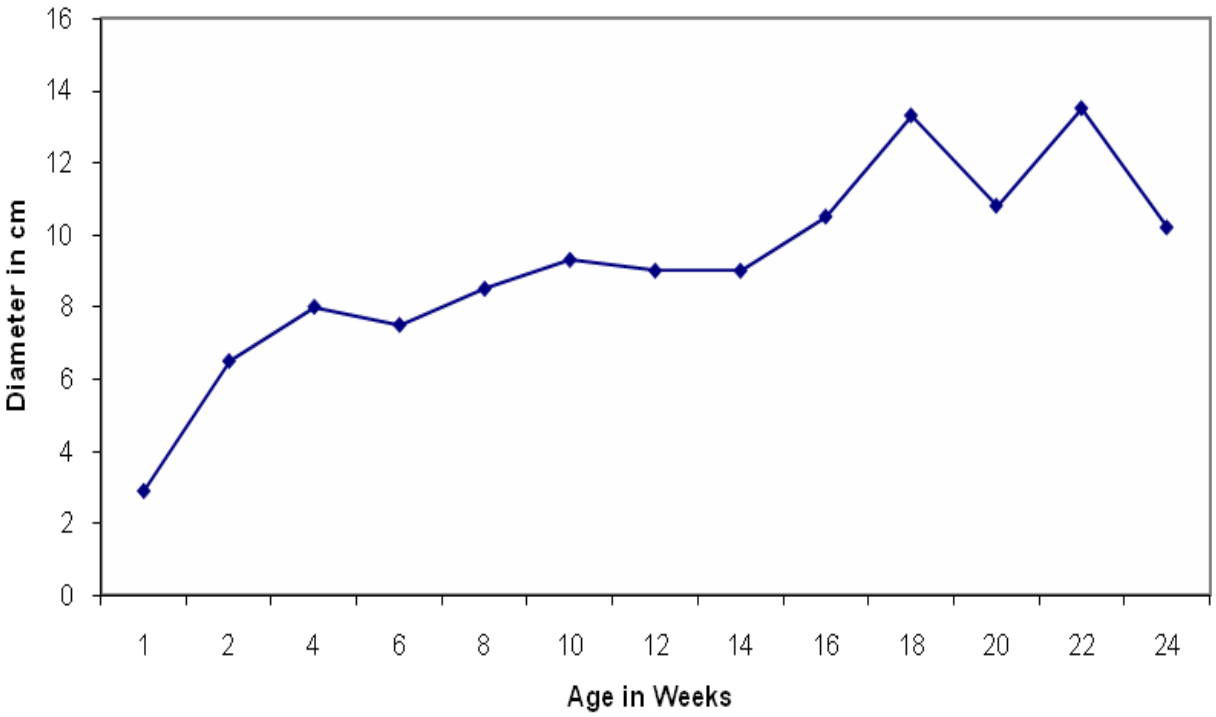

Figure 3. Scrotal circumference (cm) with Age (weeks) in Nubian male kids.

Table 1. Correlations between body weight (kg) heart girth (cm) and scrotal circumference (cm) in Nubian male kids.

	BW	HG	SC
BW	1		
HG	0.962**	1	
SC	0.828**	0.840**	1

** Significant at p<0.01 level (2-tailed).

Table 2. Body weight (kg), heart-girth (cm) and scrotal circumference of nubian male kids.

Age (weeks)	Body weight (kg)	Heart-girth (cm)	Scortal circumference (cm)
1	2.3	30.0	2.9
2	2.8	31.0	6.5
4	3.8	38.5	8.0
6	6.0	45.5	7.5
8	5.0	38.0	8.5
10	7.1	45.3	9.3
12	7.0	45.7	9.0
14	9.5	47.0	9.0
16	9.8	51.5	10.5
18	10.8	51.5	13.3
20	11.0	53.5	10.8
22	11.5	52.5	13.5
24	13.5	56.0	10.2

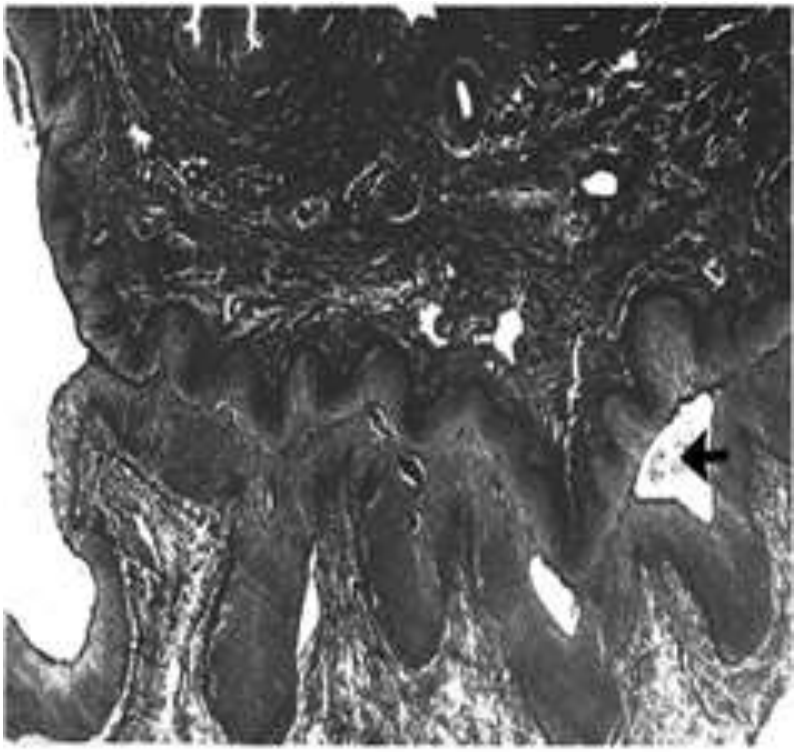

Figure 4. Division into two layers of stratified squamous epithelium has started (arrow) 40000X.

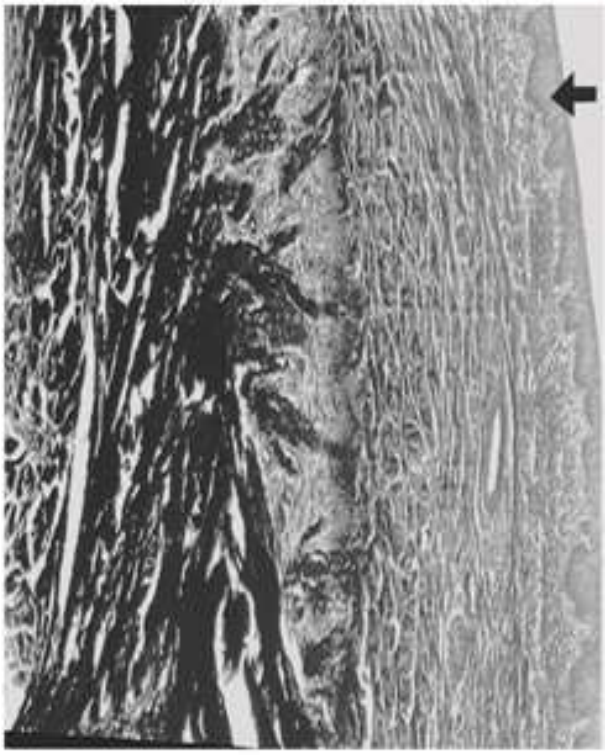

Figure 5. Complete separation of epithelium band has been completed (arrow) 640X.

1991). With regard to data on measurements of scrotal circumference, heart-girth and body weight, good correlations were found between these parameters and age. These body measurements reached their maximum at the age of puberty (22 - 24 weeks). Similar findings were also reported in man (Forest et al., 1976), monkeys (Mann et al., 1994; Lunn et al., 1997), ram (Dun, 1955), and sheep (Louw and Joubert, 1964).

The environment for the bucks used in this study was the same in relation to feeding, management and housing. Thus nutrition was not considered as a variable. However, some researchers focused on nutrition to be the most important factor that can affect body measurements in small domestic animals (Setchel et al., 1965; Martin et al., 1994; Thwaites, 1995a).

For the determination of age of puberty, evidence for commencement of spermatogenesis was considered in this study. Thus, puberty in Nubian bucks was reached at 22 weeks of age (Shaaeldin, 2006). Moreover, penile separation was also completed at the same age. Similar findings have been reported on measurement of scrotal circumference, heart girth, and body weight in other breeds of goat and sheep which were indicative of puberty to be at the age between 18 and 22 Weeks. The maximal levels of plasma protein (PRL), testosterone, LH, FSH was reached between 18-20 weeks (Shaaeldin, 2015), which give further support to pubertal characteristic of goat.

However, other breeds of goat and sheep reach puberty between 16 and 21 Weeks (Louw and Joubert, 1964) and 30 weeks (Nasir et al., 2013). Dyrmundsson (1973) noticed that there were great differences in age of puberty and body weight between ram lambs of various breeds of sheep. Large animals are said to reach puberty at the age between 23-26 weeks (Abdel Rahim, 1997). The present study confirms earlier observations that signs of puberty in the Nubian bucks appeared around 22-24 weeks of age. Maturity would be achieved a few weeks later reaching up to one year of age (Renaville et al., 1993; Adil and Nasir, 2015).

Conclusion

The results obtained revealed the age at puberty for the first time in male kids of Nubian goat depending on the first appearance of spermatozoa in the seminiference tubules. The associated body measurements could be used as simple guide for selection of breeding males at puberty. Nevertheless, age at sexual maturity still needs more time to accomplished, it will be a subject for future research.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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