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A Biometric Study of the Lower Respiratory Tract of One-Humped Camel (*Camelus Dromedarius*) Fetuses

Bello A[1]*, JE Onu[1], BI Onyeanusi[2], MA Umaru[3], AI Deneji[4] and ML Sonfada[1]

[1]*Department of Veterinary Anatomy, Usmanu Danfodiyo University, Sokoto, Nigeria*
[2]*Department of Veterinary Anatomy, Ahmadu Bello University, Zaria, Nigeria*
[3]*Department of Theriogenology and Animal production, Usmanu Danfodiyo University, Sokoto, Nigeria*
[4]*Department of Veterinary Medicine, Surgery and Theriogenology, Usmanu Danfodiyo University, Sokoto, Nigeria*

Abstract

A Biometrical study was conducted on the lower respiratory tract of 52 foetuses of the one-humped camel collected from the Sokoto metropolitan abattoir, over a period of three months at different gestational ages. The approximate age of the foetuses was estimated from the crown vertebral rump length (CVRL) and samples were categorised into early, middle and late of first, second and third trimester. The mean body weight, mean weights of the entire lower respiratory system of the foetus, mean weights of the various segment of lower respiratory system (trachea, bronchus and lungs) and individual segments of the lungs at early, middle and late of first, second third trimester were observed. It was observed that, there was increase in body weight; organ weight and individual segment of the lower respiratory system of the foetuses with advancement in gestation period. The number of tracheal rings was observed in all the stages of development and was found to be increasing progressively with advancement in gestational age. The mean volume of the segment of lower respiratory system (trachea, left lungs and right lungs) were observed and shown a progressive increase in body weight, weights of the entire lower respiratory system of the foetus and weights of the various segment of lower respiratory system of the various segments of the trachea showed a significant difference [$P \leq 0.05$] with advancement in gestational period. The mean length, width and diameter of the various segment of lower respiratory system [trachea, bronchus and lungs] were observed in all the stages of development. Result shown that, a geometrical increase in length, width and diameter of the various segments of the trachea and bronchus was significant [$P \leq 0.05$] with advancement in gestational period.

Keywords: Biometry; Camel; Trachea; Foetus; Lungs; Prenatal development

Introduction

The respiratory organs play crucial role in the adaptive features of animal [1]. The changes in respiratory organs over a period of time lead to the correlative changes of the whole organism in respect to its environment. The lower respiratory tract consists of the larynx, the tracheobronchial system, the right and left lungs. The two parts of the lung are divided from each other by the content of the mediastinum [2]. Embryologically, in mammals, the first indication of the future lower respiratory system appears in the 4 mm embryo, in the primitive pharyngeal floor just behind the pharyngeal pouches, early in week 4 of embryonic life, as a longitudinal groove called the laryngotracheal groove [3].

The entodermal lining of the laryngotracheal groove forms the epithelium and glands of the larynx, trachea, bronchi, and pulmonary lining [2]. The splanchnic mesoderm ventral to the foregut gives rise to the connective tissue, the cartilage, and smooth muscle accompanying these structures [4].

There have been many studies involving the gross morphology and histology of the various systems and organs at various stages of development in different animals including sheep [3,5]; goat [6]; cattle [7]; dog [8,9]; rat [10]; llama [11-13]; horse [14]; but detailed studies have not been conducted on the morphometric changes of the lower respiratory tract of the camel foetus. Though much work appears to have been done on the histology and morphology of the brain [6,8,11,14], on the heart [3,15,16], on salivary glands [17]; on the digestive tract [18-20], on female reproductive organ [21], on foot disorder [18], on hump attachment [7], and on anatomy of reproductive tract [14], there is dearth of information on the foetal changes of the lower respiratory tract of the one-humped camel.

Materials and Methods

Study area

The research was conducted in Sokoto state which is located to the northwest of Nigeria between latitudes 12° 0N and 130° 54N and between longitudes 40° 8E and 60° 54E. The State ranks second in the nation's livestock population with an estimated livestock population of 43,960 camels, 3 million cattle, 3 million sheep and 5 million goats [22].

Source of samples

Complete respiratory systems of camel foetuses were used for the study. Samples were sourced from Sokoto metropolitan abattoir, and transported to the Anatomy Research Laboratory of the Department of Veterinary Anatomy, Usmanu Danfodiyo University, Sokoto (UDUS).

Experimental design: The study involves an evaluation of the dromedary lower respiratory tract using foetuses at various gestational

***Corresponding author:** Bello A, Department of Veterinary Anatomy, Usmanu Danfodiyo University, Sokoto, Nigeria, Tel: +234(0)8039687589; E-mail: abccrcfge28@yahoo.com.com

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ages. Camel foetal wastages were collected from Sokoto metropolitan abattoir and used for the research. The recovered foetuses were taken to the Veterinary Anatomy Laboratory, Usmanu Danfodiyo University Sokoto and aged by the method adopted by El-Wishy et al. [14]. The entire gross study focus on five (5) different parameters as adopted by Sukon [23].

Gross observation: Shape, weight, length, width, volume.

Ageing of the foetus: The ages of the foetuses were estimated biometrically using the formula (GA ± (CVRL + 23.99/0.366) as described by El-Wishy et al. [14], where GA is the gestational age (in days). This was conducted by taking the weights of the foetuses using a beam balance. With the aid of a rule (butterfly), the crown vertebral-rump length (CVRL) was measured from the caudal fontanel to the base of the tail, following the vertebral curvature. The foetuses were categorized into definite trimesters using the calculated gestational ages and other gross features (developmental horizon) as described by Khalafalla et al. [24] and Sonfada et al. [22] (Table 1).

Sample size: The sample size was based on the accidental findings of the wasted foetuses. A total of fifty-four foetuses were used for the research and categorized in Table 2.

Dissection of the foetuses: The method of Chibuzor [25] was adopted for the dissection of the foetuses. This was done by placing the foetuses on dorsal recumbency and making a mid-ventral skin incision (Linea Alba) at abdomino-pelvic region, through the thoracic region and up to the neck at the inter-mandibular space. The entire trachea was dissected out, identified and the morphometric values were recorded.

Morphometric studies of the lower respiratory tract: Weight of the lower respiratory tract was taken using a Metler balance P1210 (Metler Instruments AG, Switzerland) with a sensitivity of 0.1 kg for the large foetuses. Each segment of the tract was weighed using the same instrument too. Linear measurement of the various segments of the tract involving the length, width and thickness was done using Vanier calliper, micro-meter screw gauge, metric ruler and measuring tape.

First trimester (1-130 days)	Days	Weeks
Early first trimester (EFT)	1 - 42 days	6 weeks
Middle first trimester (MFT)	43 - 85 days	6 weeks
Late first trimester (LFT)	86 - 130 days	6 weeks
Second trimester (131-270 days)		
Early second trimester (EST)	131 - 175 days	6 weeks
Middle second trimester (MST)	176 - 220 days	6 weeks
Late second trimester (LST)	221 - 270 days	6 weeks
Third trimester (271-390 days)		
Early third trimester (ETT)	271 - 310 days	6 weeks
Middle third trimester (MTT)	311 - 350 days	6 weeks
Late third trimester (LTT)	350 - 390 days	6 weeks

Table 1: Ageing of the foetus.

First trimester	18 foetuses
Early first trimester	6 foetuses
Middle first trimester	6 foetuses
Late first trimester	6 foetuses
Second trimester	**18 foetuses**
Early second trimester	6 foetuses
Middle second trimester	6 foetuses
Late second trimester	6 foetuses
Third trimester	**18 foetuses**
Early third trimester	6 foetuses
Middle third trimester	6 foetuses
Late third trimester	6 foetuses

Table 2: Sample size.

The morph metrical procedures that were employed in this study involved dividing the segment of the lower respiratory tract into three components, namely: trachea, bronchi and lungs [26]. The length and diameter of the trachea and bronchi were measured at all stages of development. The weight, length, width and volume of the left and right lungs were measured too.

Measuring the weights of the foetuses (FBW), weighing the entire lower respiratory tract (WLRT), and weighing the various segments of the lower respiratory tract: trachea (TW), left bronchus (LBW), right bronchus (RBW), left lung (LLW) and right lung (RLW) at all stages of development, will be made. Measuring the length and diameter of the various segments of the lower respiratory tract of each foetus at all stages of development, using divider (for smaller segments) and meter ruler (for bigger segments) in centimetre will be made. The volume of the left lung (LLV) and right lung (RLV) were measured in all stages of development, using water displacement technique (Archimedes' principle) in cubic centimetre [27].

Presentation of data: All the recorded weights, lengths and diameters of the various segments were expressed as mean ± standard error of mean (mean ± SEM) using the computer software package Microsoft Excel (Microsoft Office 2007).

Result

Foetal study

The weight, thickness or diameter of various segment of the lower respiratory tract was observed. The weight index of the segment of the lower respiratory tract were found to be 72%, 62.5% and 56.5% at early, middle and late first trimester. At early, middle and late second trimester, the weight index of the lower respiratory tract was 30%, 27.3% and 21.6%. The weight index at early, middle and late third trimester was 23.7%, 25.1% and 23.4%. The mean body weight of the foetus ranges from 0.92 ± 0.03 kg to 4.81 ± 0.13 kg, 8.08 ± 0.65 kg to 16.24 ± 0.55 kg and 17.18 ± 0.80 kg to 22.00 ± 0.60 at first, second third trimester respectively (Tables 1-3). The mean weights of the entire lower respiratory tract at first, second and third trimester ranges from 0.50 ± 0.05 g to 67.80 ± 0.05 g, 84.10 ± 0.04 g to 129.30 ± 0.02 g and 171.60 ± 0.05 kg to 303.50 ± 0.05 g respectively. The mean weights of the trachea, left lung and right lungs in all three phases of gestation (first, second and third trimesters) were observed to increase as the animal advanced in age as shown in Tables 1-3. Statistical observation shown that there was no significant difference in mean across the column [$P \leq 0.05$].

The mean crown vertebrate-rump length (CVRL) ranges from 8.50 ± 1.25 cm to 25.40 ± 2.67 cm for foetuses of first trimester, 46.30 ± 3.00 cm to 65.00 ± 2.85 cm for foetuses of second trimester and 75.20 ± 3.35 cm to 88.20 ± 4.55 cm for foetuses of third trimester as shown in Table 1. The weight of the camel foetus at all three phases of gestation [first, second and third trimesters] were observed to increase as the animal advanced in age as shown in Tables 1 and 2.

Trachea

The Tracheal rings were observed to be semi-circular (c-shaped and incomplete dorsally) in cross section as shown in (Plate 1) with the ends of the tracheal cartilages joined by smooth muscle at second and third trimesters of age. Result have shown that the tracheal cartilages begin to

appear at late second trimester and keep on increasing with advanced in age as shown in Tables 4 and 5. The observed tracheal ring ranges from 42.00 ± 2.00 at late first trimester to 68 ± 4.00 cartilages at late third trimester of age. The measurements of weight, diameter and length of trachea shown that the mean diameter of the trachea ranges from (0.05 + 0.01 cm) at early first trimester and the diameters of the tracheal region (cranial, middle, and caudal) was shown to be increasing with advanced in age as shown in Table 5. There was no observed significant difference between tracheal regions with advancement in age ($P \leq 0.05$) as shown in Table 5. The lumen of the trachea were observed to be narrow in caudally region with relatively small and bounded by bone such as first pair of ribs, vertebra (thoracic vertebra) and sternum at second and third trimesters of age. The mean of the tracheal length was shown to be increasing with advance in age (Tables 3-8).

Lungs

The total weight of right lung ranges from 0.06 ± 0.01 g at early first trimester to 156.50 ± 0.65 g at late third trimester. The total weight of left lung ranges from 0.04 ± 0.01 g at early first trimester to 116.00 ± 0.80 g at late third trimester. The mean weight of right and left lung was observed. The mean weight of the left lung was observed to increase as the animal advanced in age as shown in Tables 3 and 6. The weight of right apical, middle lobe and caudal lobe were observed as shown in Table 7. The mean weight of the left apical lobe and mean weight of caudal lobe in all the stages of development were observed as in Table 6. Statistical observation shown that, there was no significant difference in means across the column ($P \leq 0.05$).

Trimester	Sample (n)	Age of fetus (days)	Weight of fetus (kg)	CVRL(cm)
First				
Early	4	38.00 ± 2.50 [a]	0.92 ± 0.03 [a]	8.50 ± 1.25
Middle	8	62.00 ± 3.50 [b]	2.02 ± 0.05 [b]	16.30 ± 3.50
Late	7	102.00 ± 2.50 [c]	4.81 ± 0.13 [c]	25.40 ± 2.65
Second				
Early	6	152.00 ± 2.85 [d]	8.08 ± 0.65 [d]	46.30 ± 3.00
Middle	5	198.00 ± 3.00 [e]	10.12 ± 0.80 [e]	52.10 ± 3.15
Late	8	249.00 ± 3.65 [f]	16.24 ± 0.55 [f]	65.00 ± 2.85
Third				
Early	4	294.00 ± 4.00 [g]	17.18 ± 0.80 [g]	75.20 ± 3.35
Middle	3	338.00 ± 3.50 [h]	17.70 ± 0.75 [h]	83.50 ± 3.40
Late	2	376.00 ± 5.00 [i]	22.00 ± 0.60 [i]	88.20 ± 4.55

Note: a, b, c, d, e, f, g, h, i: means on the same column with different superscripts are significantly different ($P < 0.05$)

Table 3: Show relationship between (Mean ± SEM) age, weight and CVRL of camel fetus.

Trimester	Weight of fetus (kg)	Weight of LRT (g)	Weight of trachea (g)	Weight Right lung (g)	Weight left lung (g)
First					
Early	0.92 ± 0.03 [a]	0.50 ± 0.05 [a]	0.40 ± 0.02 [a]	0.06 ± 0.01 [a]	0.04 ± 0.03 [a]
Middle	2.02 ± 0.05 [b]	5.14 ± 0.08 [b]	0.72 ± 0.07 [b]	2.42 ± 0.04 [b]	2.00 ± 0.07 [b]
Late	4.81 ± 0.13 [c]	67.80 ± 0.05 [c]	5.30 ± 0.04 [c]	36.50 ± 0.02 [c]	26.00 ± 0.33 [c]
Second					
Early	8.08 ± 0.65 [d]	84.10 ± 0.04 [d]	11.20 ± 0.05 [d]	42.40 ± 0.30 [d]	30.50 ± 0.45 [d]
Middle	10.12 ± 0.80 [e]	111.45 ± 0.05 [e]	15.05 ± 0.03 [e]	50.20 ± 0.25 [e]	46.20 ± 0.75 [e]
Late	16.24 ± 0.55 [f]	129.30 ± 0.02 [f]	18.30 ± 0.03 [f]	60.50 ± 0.20 [f]	50.50 ± 0.35 [f]
Third					
Early	17.18 ± 0.80 [g]	171.60 ± 0.05 [g]	26.40 ± 0.08 [g]	81.30 ± 0.45 [g]	62.90 ± 0.87 [g]
Middle	17.70 ± 0.75 [h]	214.40 ± 0.07 [h]	30.20 ± 0.06 [h]	104.70 ± 0.82 [h]	79.50 ± 0.65 [h]
Late	22.00 ± 0.60 [i]	303.50 ± 0.05 [i]	31.00 ± 0.03 [i]	156.50 ± 0.65 [i]	116.00 ± 0.80 [i]

Note: a,b,c,d,e,f,g,h,i: means on the same column with different superscripts are significantly different ($P<0.05$)

Table 4: Show relationship between (Mean ± SEM) weight of the fetus, weight of LRT, weight of trachea, weight of right lungs and weight of the left lungs.

The mean total volume of the lung and trachea were observed in all the stages of development. The mean volumes of the right lung and the left lung were observed to increase as the animal advanced in age as shown in Table 7. The mean volumes of each lobe of the lung were observed too, with an exception of the early first trimester due to the absence of clear demarcation of the lobation. The right lung (apical, middle and caudal lobes) were observed as shown in Tables 6 and 7. The mean volumes of left apical lobe and caudal lobe were observed to increase as the animal advanced in age (Tables 9-11).

Discussion

The observed increase in weight, length and diameter of various segments of the lower respiratory tract in the study is in line with the findings of bovine, porcine and caprine specie by Bock et al. [11]; Georgieva and Gerov [7] and Kalache et al. [5] respectively. The lower respiratory tract indices observed in the study showed significant difference in relation to the age [$P \leq 0.05$] and the indices were decreasing with advancement in gestation (body development) and similar developments were seen in the study of Georgieva and Gerov [7] and Kalache et al. [5] in porcine specie.

The progressive increase in weight, length, width and diameter of the trachea and lungs based on gestation period is in line with the observations of Kalache et al. [5] and Kumar et al. [28] on the trachea of human and showed to have significant difference in relation to the age ($P \leq 0.05$). The observed increase in lengths and widths of the trachea and lungs in this study showed to have significant difference in relation to the age ($P \leq 0.05$) and is in line with the observations of Kalache et al. [5], Kumar et al. [28] and Coyne and Fingland et al. [9] who studies the developmental anatomy of red deer trachea based on gestational period. Choi [29] suggested that, the variation in numbers of tracheal rings between specimens was due to individual anatomical variations.

A geometrical increase in volume of the various segments of trachea, left lungs and right lungs as observed in this study showed to have significant difference ($P \leq 0.05$) with advancement in gestation and was in line with the findings of porcine, bovine [21,28], buffalo [3] and Llama [30].

The observed CRVL was found to have related to the weight of the foetus. CRVL was proportional to the weight of the foetus in all the stages of the development. The CRVL at first trimester ranges from 8.50 ± 1.25 cm at early first trimester to 25.40 ± 2.65 cm at late first trimester with an average of 16.95 ± 1.25 cm. This is in close proximity with the findings of Bello et al. [19], Hena et al. [20] and Sonfada et al. [22]. These variations may as a result of breed variations as those in close proximity are from the same geographical regions. The weight of the foetuses were found to be within the range of 0.92 ± 0.03 kg to 4.81 ± 0.13 kg with an average of 2.55 ± 0.08 kg at first trimester this findings is in close proximity with that of Hena et al. [20] and Mortola and Fischer et al. [31] on Nigerian camel but lower than that of Peshin and Prakash [32] and Morgan et al. [6] on Sudanese camel. The variation may be as

Trimester	Weight of trachea (g)	Weight of Left lungs (g) cranial	caudal	Weight of Right lungs (g) Cranial	Caudal	Accessory
First						
Early	0.40 ± 0.01 [a]	--------	----------	------	--------	--------
Middle	0.72 ± 0.03 [b]	0.81 ±0.03 [a]	1.19 ± 0.05 [a]	0.62 ± 0.03 [a]	1.06 ± 0.03 [a]	0.74 ± 0.02 [a]
Late	5.30 ± 0.50 [c]	5.80 ± 0.04 [b]	20.20 ± 0.03 [b]	4.30 ± 0.05 [b]	28.80 ± 0.02 [b]	2.90 ± 0.05 [b]
Second						
Early	11.20 ± 0.85 [d]	7.90 ± 0.55 [c]	22.60 ± 0.55 [c]	6.00 ± 0.65 [c]	33.10 ± 0.55 [c]	3.50 ± 0.40 [c]
Middle	15.05 ± 0.70 [e]	8.20 ± 0.85 [d]	38.00 ± 0.60 [d]	6.40 ± 0.75 [d]	40.00 ± 0.65 [d]	3.80 ± 0.50 [d]
Late	18.30 ± 0.85 [f]	10.00 ± 0.55 [e]	40.50 ± 0.50 [e]	7.00 ± 0.55 [e]	48.40 ± 0.45 [e]	5.10 ±0.45 [e]
Third						
Early	26.40 ± 0.90 [g]	15.00 ± 0.50 [f]	48.90 ± 0.65 [f]	10.20 ± 0.95 [f]	64.10 ± 0.50 [f]	7.00 ± 0.75 [f]
Middle	30.20 ± 0.45 [h]	18.50 ± 0.85 [g]	61.00 ± 0.35 [g]	14.00 ± 0.55 [g]	79.65 ± 0.40 [g]	11.05 ± 0.50 [g]
Late	31.00 ± 0.50 [i]	26.00 ± 0.65 [h]	90.00 ±0.85 [h]	15.30 ± 0.70 [h]	127.50 ± 0.80 [h]	13.40 ± 0.75 [h]

Note: a,b,c,d,e,f,g,h,i: means on the same column with different superscripts are significantly different (P<0.05)

Table 5: Show relationship between (Mean ±SEM) weight of the various segment of trachea, left and right lungs of camel fetus.

Trimester	No of sample	Age of fetus (days)	CVRL(cm)	Length of trachea (cm)	No of tracheal rings
First					
Early	4	38.00 ± 2.50 [a]	8.50 ± 1.25	2.52 ± 0.50	----
Middle	8	62.00 ± 3.50 [b]	16.30 ± 3.50	7.20 ± 0.85	-----
Late	7	102.00 ± 2.50 [c]	25.40 ± 2.65	13.00 ± 0.80	42.00 ± 2.00[a]
Second					
Early	6	152.00 ± 2.85 [d]	46.30 ± 3.00	20.30 ±1.25	46 ± 3.00 [b]
Middle	5	198.00 ± 3.00 [e]	52.10 ± 3.15	21.40 ±1.50	50 ± 2.50 [c]
Late	8	249.00 ± 3.65 [f]	65.00 ± 2.85	25.50 ±2.00	56 ± 3.00 [d]
Third					
Early	4	294.00 ± 4.00 [g]	75.20 ± 3.35	26.40 ±2.00	60 ± 4.50 [e]
Middle	3	338.00 ± 3.50 [h]	83.50 ± 3.40	32.50 ±2.15	66 ± 3.00 [f]
Late	2	376.00 ± 5.00 [i]	88.20 ± 4.55	43.00 ±1.50	68 ± 4.00 [g]

Note: a,b,c,d,e,f,g,h,i: means on the same column with different superscripts are significantly different (P<0.05)

Table 6: Show relationship between (Mean± SEM) age, CVRL, length of trachea and number of tracheal rings in all the stage of fetal development.

Trimester	No of sample	Diameter of the trachea(cm) cranial	Middle	Caudal	Diameter of the principal bronchus (cm) Left	Right
First						
Early	4	0.05 ± 0.01 [a]	0.05 ± 0.01 [a]	0.05 ± 0.01 [a]	0.05 ± 0.01 [a]	0.05 ± 0.01 [a]
Middle	8	0.10 ± 0.01 [b]	0.10 ± 0.01 [b]	0.10 ± 0.01 [b]	0.05 ± 0.01 [b]	0.05 ± 0.01 [b]
Late	7	0.30 ± 0.02 [c]	0.25 ± 0.01 [c]	0.35 ± 0.02 [c]	0.20 ± 0.01 [c]	0.20 ± 0.01 [c]
Second						
Early	6	0.65 ± 0.03 [d]	0.60 ± 0.02 [d]	0.65 ± 0.01 [d]	0.50 ± 0.02 [d]	0.50 ± 0.01 [d]
Middle	5	1.00 ± 0.03 [e]	0.90 ± 0.01 [e]	1.20 ± 0.02 [e]	0.80 ± 0.01 [e]	0.80 ± 0.01 [e]
Late	8	1.30 ± 0.01 [f]	1.20 ± 0.01 [f]	1.40 ± 0.02 [f]	1.00 ± 0.02 [f]	1.00 ± 0.02 [f]
Third						
Early	4.	1.50 ± 0.03 [g]	1.40 ± 0.02 [g]	1.60 ± 0.01 [g]	1.20 ± 0.01 [g]	1.20 ± 0.01 [g]
Middle	3	2.00 ± 0.03 [h]	1.80 ± 0.01 [h]	2.20 ± 0.02 [h]	1.50 ± 0.01 [h]	1.50 ± 0.01 [h]
Late	2	2.55 ± 0.02 [i]	2.40 ± 0.02 [i]	2.40 ± 0.02 [i]	1.50 ± 0.02 [i]	1.50 ± 0.01 [i]

Note: a, b, c, d, e, f, g, h, i: means on the same column with different superscripts are significantly different (P < 0.05)

Table 7: Show relationship between (Mean ± SEM) age, CVRL, diameter of the trachea and principle bronchus of fetuses at different developmental stage.

a result of nutritional status and regional variation.

The observed CRVL at second trimester ranges from 46.30 ± 3.00 cm at early second trimester to 65.00 ± 2.85 cm at late second trimester with an average of 55.65 ± 2.93 cm. This is in close proximity with the findings of Sonfada et al. [22], Bello et al. [19], Hena et al. [20].

At second trimester, the weight of the foetus was within the range of 8.08 ± 0.65 kg at early second trimester to 16.24 ± 0.55 kg at late second trimester with an average of 12.16 ± 0.60 kg. This shown a drastic programmed increase in weight from first trimester to second trimester of age. This is in agreement with the finding of Choi [29]. The above findings had shown that there will be increase in foetal weight with progressive maturity of the various organ system developments.

The observed CRVL at third trimester ranges from 75.20 ± 3.35 cm at early third trimester to 88.20 ± 4.55 cm at late third trimester with an average of 81.70 ± 7.90 cm. The above finding shows a progressive geometric increase in CRVL from first trimester (16.95 ± 1.95 cm). Second trimester (55.65 ± 2.93 cm) to third trimester (81.70 ± 7.90 cm); is in line with the findings of Choi [29], Hena et al. [20], Malie et al. [21], Luciano et al. [12] on camel and contrary to that of Scava et al. [33] on goat Plopper et al. [34] on dog and cat. The above variation may be

Trimester	No of sample	CVRL (cm)	Volume of LRT (ml)	Volume of trachea (ml)	Volume of Left lungs(ml)	Volume of Right lungs (ml)
First						
Early	4	8.50 ± 1.25	5.30 ± 0.85 [a]	1.00 ± 0.25 [a]	2.00 ± 0.22 [a]	2.30 ± 0.50 [a]
Middle	3	16.30 ± 3.50	41.80 ± 0.65 [b]	3.50 ± 0.85 [b]	17.50 ± 0.35 [b]	20.80 ± 2.15 [b]
Late	7	25.40 ± 2.65	87.00 ± 1.25 [c]	10.00 ± 1.00 [c]	35.00 ± 0.85 [c]	42.00 ± 2.00 [c]
Second						
Early	6	46.30 ± 3.00	121.00 ± 3.25 [d]	16.00 ± 0.95 [d]	45.00 ± 2.35 [d]	60.00 ± 3.15 [d]
Middle	5	52.10 ± 3.15	149.00 ± 4.00 [e]	18.00 ± 1.00 [e]	49.00 ± 3.00 [e]	82.00 ± 3.00 [e]
Late	8	65.00 ± 2.85	204.00 ± 2.35 [f]	26.00 ± 1.25 [f]	75.00 ± 3.50 [f]	103.00 ± 2.25 [f]
Third						
Early	4	75.20 ± 3.35	255.00 ± 5.55 [g]	30.00 ± 2.35 [g]	100.00 ± 5.35 [g]	125.00± 4.25 [g]
Middle	3	83.50 ± 3.40	318.00 ± 4.75 [h]	35.00 ± 2.00 [h]	121.00 ± 4.00 [h]	162.00 ± 4.00 [h]
Late	2	88.20 ± 4.55	388.00 ± 3.25 [i]	52.00 ± 2.25 [i]	156.00 ± 6.00 [i]	180.00 ± 5.35 [i]

Note: a,b,c,d,e,f,g,h,i: means on the same column with different superscripts are significantly different (P<0.05)

Table 8: Show relationship between (Mean ± SEM) sample size, CVRL, Volume of LRT, Trachea, left lung and right lung at different development stage.

Trimester	No of sample	CVRL (cm)	Volume of Left lungs (ml)		Volume of right lungs(ml)		
			Cranial	Caudal	Cranial	Caudal	Accessory
First							
Early	4	8.50 ± 1.25	--------	----------	-------	----------	----------
Middle	3	16.30 ± 3.50	6.50 ± 0.50[a]	11.00 ± 0.65 [a]	5.20 ± 0.50 [a]	10.80 ± 0.80 [a]	4.80 ± 0.35 [a]
Late	7	25.40 ± 2.65	12.00 ± 0.35 [b]	23.00 ± 0.50 [b]	10.00 ± 0.50 [b]	25.20 ± 0.95 [b]	6.80 ± 0.65 [b]
Second							
Early	6	46.30 ± 3.00	15.00 ± 0.65 [c]	30.00 ± 0.85 [c]	12.00 ± 0.65 [c]	40.00 ± 2.25 [c]	8.00 ± 0.75 [c]
Middle	5	52.10 ± 3.15	16.50 ± 1.15 [d]	32.00 ± 0.90 [d]	15.00 ± 0.50 [d]	56.50 ± 2.00 [d]	10.50 ± 0.65 [d]
Late	8	65.00 ± 2.85	20.00 ± 0.95 [e]	55.00 ± 1.25 [e]	25.00 ± 1.15 [e]	65.00± 2.15 [e]	13.00± 0.80 [e]
Third							
Early	4	75.20 ± 3.35	30.00 ± 1.00 [f]	70.00 ± 0.50 [f]	30.00 ± 1.00 [f]	80.00 ± 3.00 [f]	15.00 ± 1.25 [f]
Middle	3	83.50 ± 3.40	36.00 ± 1.50 [g]	85.00 ± 2.25 [g]	35.00 ± 1.00 [g]	109.00 ± 2.50 [g]	18.00 ± 1.15 [g]
Late	2	88.20 ± 4.55	50.00 ± 1.15 [h]	106.00 ± 3.00 [h]	47.00 ± 1.10 [h]	113.00 ± 1.85 [h]	20.00 ± 1.00 [h]

Note: a,b,c,d,e,f,g,h,i: means on the same column with different superscripts are significantly different (P<0.05)

Table 9: Show relationship between (Mean ± SEM) sample size, CVRL, Volume of Various segment of left and right lungs in all the stages of development

Trimester	No of sample	Density of LRT	Density of Trachea	Density of Left Lungs	Density of Right Lungs
First					
Early	4	0.09	0.40	0.22	0.03
Middle	3	0.12	0.20	0.11	0.12
Late	7	0.77	0.53	0.74	0.87
Second					
Early	6	0.70	0.70	0.67	0.71
Middle	5	0.75	0.80	0.94	0.61
Late	8	0.63	0.70	0.67	0.59
Third					
Early	4	0.67	0.88	0.64	0.65
Middle	3	0.67	0.86	0.66	0.62
Late	2	0.78	0.60	1.06	0.87

Table 10: Show relationship between (Mean ± SEM) no of sample Density of LRT, Trachea, left Lung and right Lungs in all the stages of development.

as a result of the natural size of the specie in conformity with the long neck of the camel. The observed increase in weight of the camel foetus observed in the third trimester foetuses was within the range of 17.18 ± 0.80 kg at early third trimester to 22.00 ± 0.60 kg at late third trimester with an average of 19.59 ± 0.70 kg. The observed result shown that, there is more increase in the foetal weight at the age of second trimester from first trimester than from third trimester to second trimester of age. This finding is contrary to the findings of Luciano et al. [12] in Cattle, Scava et al. [35] in Goat who observed progressive increase at third trimester from second trimester of age [36-38].

Conclusion

The morphometrical parameters of the developing lower respiratory tract at prenatal stage were established. The mean values obtained in this study were essentially in agreement with a considerable number of similar studies. However, a number of differences have also been observed and was attributed to specie and ecotype difference. Peculiar measurements can be seen with the ecotypes of camels slaughtered in the Sokoto basin area. The mean volumes of the right lung and the left lung were observed to increase as the animal advanced in age. The tracheal cartilage begins to appear in the late first trimester (25.40

Trimester	No of sample	Density of left lungs		Density of right lungs		
		Cranial	Caudal	Cranial	Caudal	Accessory
First						
Early	4	-	-	-	-	-
Middle	3	0.12	0.12	0.12	0.10	0.15
Late	7	0.48	0.88	0.43	1.14	0.43
Second						
Early	6	0.52	0.75	0.50	0.83	0.44
Middle	5	0.50	1.19	0.43	0.71	0.36
Late	8	0.50	0.74	0.28	0.75	0.39
Third						
Early	4	0.50	0.70	0.34	0.80	0.47
Middle	3	0.51	0.72	0.40	0.73	0.61
Late	2	0.52	0.85	0.33	1.13	0.67

Table 11: Show relationship between (Mean ± SEM) number of samples and density of various segments of left and right lungs in all the stages of development.

± 2.65 cm CRVL). In the study, the tracheal rings were found to be increasing with advancement in age. This shows that there is continues increase in the tracheal rings at post natal age.

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