**AATCC Review**

**Original Research Article**  **Open Access**

# Regression model and correlation analysis of different heart parameters of non-descript goats of Jammu region

Shalini Suri[1], Jasvinder Singh Sasan[1*], Kamal Sarma[1] and Vikas Mahajan[2]

[1]Division of Veterinary Anatomy, F. V. Sc & A.H, SKUAST-Jammu, R. S Pura-181102, India
[2]Division of Livestock Farm Complex, R. S. Pura, J & K, India

## ABSTRACT

*The heart was triangular with convex anterior border and concave posterior border. The average weight of the heart was 182.58 ± 15.59 gm. Circumference of the heart was 18.87 ± 0.78 cm. The distance between right and left longitudinal grooves was 10.40 ± 0.36 cm anteriorly and 7.70 ± 0.33 cm posteriorly. Right and left longitudinal grooves did not reach the apex of the heart. The latero-medial width of the heart was 5.08 ± 0.12 cm whereas the antero-posterior width at coronary groove was 6.29 ± 0.41cm. The wall thickness was 0.33 ± 0.03 cm for left atrium and 0.38 ± 0.09 cm for the right atrium. Inter-ventricular septum was 1.31 ± 0.08 cm thick. Diameter of cranial vena cava (1.58 ± 0.06 cm) was slightly greater than the caudal vena cava (1.40 ± 0.06 cm). The circumference of pulmonary artery was 4.65 ± 0.51 cm with wall thickness of 0.30 ± 0.02 cm. Aorta had a circumference of 5.85 ± 0.14 cm, diameter of 1.88 ± 0.10 cm and wall thickness of 0.40 ± 0.03 cm. Descending part of aorta had a larger diameter than the ascending part. The circumference of ascending part and descending part was in approximation. Various biometrical parameters of the heart were analyzed statistically to observe the correlation between these parameters. The parameters that showed significant correlation (P<0.01 and 0.05) (both positive as well as negative) were analyzed for regression which was used to predict the value of dependent variable (unknown) from independent (known) variables.*

*Keywords: Analysis, Aorta, Correlation, Goat, Heart, Regression*

## Introduction

Our country has 148.88 millions goats contributes about 27.8% of total livestock [1]. In our country, goat rearing is predominantly practiced by small and marginal farmers and landless labours. This poor and economically weaker section of our society earns livelihood by sale of goats, kids and their products viz. meat, milk, hide, wool, manure. Goat rearing has advantages when compared to other farm animals as they do not require expensive buildings and equipments. Moreover, goats are resistant to various diseases as compared to other exotic breeds of cattle [2]. Goats have high dry matter and fiber digestibility and thus can subsit on poor woody vegetation which no other animal will consume. Hence, the people below the poverty line are also able to rear the goat. Hence, goat is popularly known as 'Poor Man's Cow'.

Heart along with vessels constitutes cardiovascular system. Heart acts as central pumping organ which continuously pumps blood by rhythmic contractions [3]. The size of heart varies among species. Literature is available on the gross morphology of heart of Murrah buffalo [4], pig [5] and domestic animals [3]. Regarding biometrical aspect, literature is available on non-descript buffaloes of Madhya Pradesh [6], deer [7], Nili-Ravi buffalo [8], adult sheep of Jammu region [9], adult sheep [10, 11, 12], chital (*Axis axis*) [13] and fowl [14].

The complete knowledge of gross anatomy and biometry of goat heart helps in better understanding of its physiological function which is important in disease diagnosis and corrective treatment. Due to meager literature on the biometrical aspect of goat's heart, the present study has been planned.

## Materials and Methods

The present study was carried out on six hearts of healthy adult non-descript goats irrespective of sex. Samples were collected from the local slaughter houses of Jammu region. After collection, hearts were properly cleaned and washed in running tap water. Various biometrical parameters were recorded with help of a non-stretchable thread, metric scale and Vernier caliper. After recording, these parameters were subjected to statistical analysis [15]. The descriptive statistics includes mean, standard error, minimum value, maximum value and co-efficient of variation (Table 1). Pearson Correlation was used to determine the association between different parameters (Table 2). Regression analysis was done to establish an equation to predict the value of a dependent variable (unknown) from independent (known) variable (Table 3). The below-mentioned regression model was adopted:

$X = Intercept + b_1x_1 + b_2x_2 + \ldots b_nx_n + SE$ (b = Regression Coefficient)

## Results and Discussion

The heart was triangular in shape with wide base and blunt apex which was directed downwards and backward. This observation was similar to earlier reports in sheep [12]. It was cone-shaped in cattle [16], typical valentine in pigs [5] and globe-shaped in Western Grey kangaroo [17].

Externally, the heart presented two borders. The anterior border was convex whereas the posterior border was concave.

*Corresponding Author: **Jasvinder Singh Sasan***

However, in sheep, the posterior border was vertical [12]. The right and left surfaces were convex. These surfaces presented four grooves namely one coronary, two longitudinal (right and left) and one intermediate groove to lodge corresponding coronary vessels. Coronary groove separated auricles and ventricles. Similar observations were made in sheep [11] and buffalo [18]. Right longitudinal groove was posterior in position and met left longitudinal groove above the apex of the heart as also observed in sheep [10].

The weight of the heart ranged from 114.10-225.30 gm with mean of 182.58 ± 15.59 gm. In sheep, the average weight was 70.32 ± 9.10 gm [9]. The length of anterior border from the base to the apex was 9.10 ± 0.22 cm in non-descript goat of Jammu region. In deer, the rostral border was 10.87 ± 0.427 cm long[7]. In sheep, the same was 8.12 ± 0.27 cm in males and 7.28 ± 0.39 cm in females indicating longer male hearts as compared to females[10]. In young male buffalo, anterior border was 13.90 ± 0.22 cm long whereas it was 13.30 ± 0.33 cm in young female buffalo [19]. As compared to the anterior border, posterior border was shorter (6.87 ± 0.21 cm) which was in accordance to the findings in sheep where posterior border was 6.37 ± 0.19 cm in males and 5.72 ± 0.25 cm in females [10]. In deer, the caudal border was 8.00 ± 0.816 cm[7].

Circumference of the heart was taken at the level of coronary groove which was found to be 18.87 ± 0.78 cm. In non-descript deer, it was 21 ± 1.225 cm [7]. In sheep, it was 17.66 ± 1.53 cm[9]. However, circumference of sheep heart at coronary groove as 7.81 ± 0.17 cm in males and 7.25 ± 0.17 cm in females [10].

Distance between right and left longitudinal grooves was taken at the level of coronary groove. The distance was 10.40 ± 0.36 cm anteriorly whereas the grooves were 7.70 ± 0.33 cm apart posteriorly indicating more caudal position of these grooves. The right and left longitudinal grooves did not reach the apex of the heart. The termination of the right groove was 2.39 ± 0.18 cm above the apex whereas the left groove terminated 2.09 ± 0.15 cm above the apex. These were in corroboration to the findings in sheep where the distance of the right groove from apex was 2.72 ± 0.18 cm in males and 2.40 ± 0.14 cm in females [10]. For left groove, it was 2.21 ± 0.12 cm in males and 2.14 ± 0.11 cm in females [10]. The intermediate groove was more towards the right longitudinal groove as the distance between intermediate and left groove was 4.58 ± 0.26 cm whereas the distance between intermediate and right groove was 3.38 ± 0.24 cm. Intermediate groove also did not reach up to the apex and terminated well above the apex (3.45 ± 0.36 cm) which was in accordance to the findings in deer where the distance between apex and termination of intermediate groove was 3.45 ± 0.21 cm [7].

The latero-medial width of heart was 5.08 ± 0.12 cm whereas the antero-posterior width at coronary groove was 6.29 ± 0.41cm. In sheep's heart, the antero-posterior width was 7.8 ±0.70 cm[9].

The wall thickness of right atrium of non-descript goat of Jammu was 0.33 ± 0.03 cm whereas in sheep, the same was 0.44 ± 0.09 cm in males and 0.58 ± 0.07 cm in females [10]. In Nili-Ravi buffalo, the thickness was 1.33 ± 0.051 cm in young and 1.65 ± 0.03 cm in adults[8]. The wall thickness of left atrium was 0.38 ± 0.09 cm. Suresh[10] in sheep's heart reported more thick wall of left atrium (0.81 ± 0.05 cm in males and 0.80 ± 0.04 cm in females). The wall of left ventricle (1.51 ± 0.09 cm) was almost 2.25 times the right ventricle (0.67 ± 0.06 cm) which was in accordance to the findings in sheep [9]. In sheep, the wall thickness of left ventricle was twice that of the thickness of right ventricle in both males and females [10].

Inter-ventricular septum was 1.31 ± 0.08 cm thick. In sheep, the same was 1.29 ± 0.04 cm [9]. However, the inter-ventricular septum was 1.5 cm thick in deer [7]. Diameter of cranial vena cava (1.58 ± 0.06 cm) was slightly greater than caudal vena cava (1.40 ± 0.06 cm).

The circumference of pulmonary artery was 4.65 ± 0.51 cm with wall thickness of 0.30 ± 0.02 cm. Pulmonary artery of sheep had circumference of 3.45 ± 0.11 cm and wall thickness of 0.27 ± 0.02 cm [9]. The diameter of large, medium and small pulmonary veins was 1.73 ± 0.13 cm, 1.30 ± 0.11 cm and 0.98 ± 0.08 cm, respectively. Aorta had a circumference of 5.85 ± 0.14 cm, diameter of 1.88 ± 0.10 cm and wall thickness of 0.40 ± 0.03 cm. In sheep, the circumference was 3.65 ± 0.29 cm and wall thickness was 0.34 ± 0.01 cm [9]. The descending part of aorta had larger diameter (1.37 ±0.07 cm) than the ascending part (1.27 ± 0.05 cm). The circumference of ascending part (4.05 ± 0.31 cm) and descending part (4.08 ± 0.19 cm) was in approximation. Similarly, the wall thickness of both the parts was also in approximation. The moderator band was 2.01 ± 0.10 cm long and 0.28 ± 0.03 cm thick. In sheep, the length was 2.28 ± 0.23 cm with thickness of 0.30 ± 0.06 cm[9].

The various biometrical parameters of heart were analyzed statistically to observe the correlation between these parameters (Table 2). The derived regression equations between various correlated parameters are tabulated in Table 3. Heart parameters having significant correlation (P<0.01 and 0.05) have been presented in Table 2. Positive and negative correlation indicated that both parameters change in similar and opposite direction, respectively. The weight of heart showed positive correlation with circumference at coronary groove, distance between right and left coronary groove (posteriorly) and diameter of caudal vena cava but was negatively correlated with wall thickness of descending aorta. Length of the posterior border of heart from base to apex was negatively correlated with distance between IM groove and apex of the heart (0.816) but positively correlated with the circumference of aorta (0.893). In buffalo, positive correlation (0.79) was reported between total length of heart and circumference of aorta [16]. Circumference at coronary groove showed positive correlation with distance between right and left coronary groove (posteriorly), antero-posterior width at coronary groove and diameter of caudal vena cava. Distance between right and left coronary grooves (anteriorly) was positively correlated with the diameter of the heart and negatively correlated with the wall thickness of aorta. Distance between right and left coronary grooves (posteriorly) was positively correlated with distance from caudal vena cava to apex, diameter of caudal vena cava and diameter of ascending aorta but negative correlation was seen with diameter of descending aorta. Distance from right coronary groove to apex showed positive correlation with latero-medial width, diameter of medium pulmonary vein and length of moderator band. Similarly, distance from left coronary groove to apex also showed positive correlation with the length of the moderator band but was negatively correlated with the wall thickness of left ventricle. Distance between IM groove and right coronary groove showed highly significant positive correlation with distance from caudal vena cava to apex (0.959) and diameter of ascending aorta (0.927). However, distance between IM groove and apex of heart showed a negative correlation with wall thickness of right atrium. Latero-medial width of heart and length of moderator band showed positive correlation with diameter of both medium and small sized pulmonary veins. Thickness of inter-ventricular septum showed highly significant positive correlation with diameter of cranial vena cava.

Diameter of cranial vena cava was positively correlated with distance between IM groove and left coronary groove but negatively correlated with the wall thickness of aorta. Diameter of descending aorta showed negative correlation with distance from caudal vena cava to apex as well as diameter of ascending aorta. However, it was positively correlated with the circumference of descending aorta. Circumference of ascending aorta showed positive correlation with distance between caudal vena cava to apex. Wall thickness of descending aorta showed positive correlation with wall thickness of left atrium and negative correlation with circumference of ascending aorta. Thickness of moderator ban was positively correlated with the wall thickness of ascending aorta. In sheep, circumference of aorta was positively correlated with both length of moderator band as well as thickness of right ventricle [9]. Circumference of heart showed positive correlation with thickness of wall of left ventricle. However, length of heart showed positive correlation with thickness of wall of right ventricle. Circumference of pulmonary artery showed positive correlation with thickness of moderator band.

The parameters that showed significant correlation (P<0.01 and 0.05) (both positive as well as negative) were analyzed for regression. Regression analysis was used to predict the value of dependent variable (unknown) from independent (known) variables. The regression models resulted from regression analysis between different heart parameters are presented in Table 3. The diameter of caudal vena cava was the best predictor for weight of heart (r = 0.975 and $R^2$ = 0.955) when using single heart parameter measurements. It indicated that the diameter of caudal vena cava influenced 95.5 % variation of the weight of heart while the rest was affected by other factors. Circumference of aorta ($R^2$ = 0.799) was the better indicator for determining the length of the posterior border from base to the apex of heart than the distance between IM groove and apex of the heart ($R^2$ = 0.665). To determine the circumference of the heart at coronary groove, the best parameter was distance between right and left coronary grooves (posteriorly) ($R^2$ = 0.845). However, the diameter of heart influenced 93.1 % variation of distance between right and left coronary grooves (anteriorly) ($R^2$ = 0.931). For distance between right and left coronary grooves (posteriorly), the best indicator was diameter of caudal vena cava with highest $R^2$ value of 0.780. Distance from right coronary groove to apex was best indicated by diameter of medium pulmonary vein ($R^2$ = 0.941) whereas distance from left coronary groove to apex was best indicated by wall thickness of left ventricle ($R^2$ = 0.727). Diameter of cranial vena cava ($R^2$ = 0.845) was better indicator than thickness of inter-ventricular septum ($R^2$ = 0.756) to determine distance between IM and left coronary groove. For distance between IM and right coronary groove, the best indicator was distance between caudal vena cava and apex of heart ($R^2$ = 0.915). Diameter of medium pulmonary vein influenced 85 % variation of latero-medial width of heart ($R^2$ = 0.850) whereas circumference of descending aorta influenced 93.8 % variation of diameter of descending aorta ($R^2$ = 0.938).

*Table 1 Gross biometrical parameters of heart of non-descript goats of Jammu region*

| Parameters (cm) | Mean ± SE | Minimum | Maximum | Coefficient of variation |
|---|---|---|---|---|
| Weight of heart (gm) | 182.58 ± 15.59 | 114.10 | 225.30 | 20.91 |
| Length of anterior border from base to apex | 9.10 ± 0.22 | 8.60 | 10.10 | 5.94 |
| Length of posterior border from base to apex | 6.87 ± 0.21 | 6.40 | 7.60 | 7.35 |
| Circumference at the coronary groove | 18.87 ± 0.78 | 15.80 | 21.60 | 10.18 |
| Distance between right and left coronary groove (Anteriorly) | 10.40 ± 0.36 | 9.10 | 11.30 | 8.58 |
| Distance between right and left coronary groove (Posteriorly) | 7.70 ± 0.33 | 6.50 | 9.00 | 10.52 |
| Distance from right coronary groove to apex | 2.39 ± 0.18 | 2.05 | 3.10 | 18.63 |
| Distance from left coronary groove to apex | 2.09 ± 0.15 | 1.60 | 2.50 | 17.37 |
| Distance between IM and left coronary groove | 4.58 ± 0.26 | 4.10 | 5.80 | 14.10 |
| Distance between IM and right coronary groove | 3.38 ± 0.24 | 2.80 | 4.30 | 17.28 |
| Distance between IM groove and apex of heart | 3.45 ± 0.36 | 2.10 | 4.70 | 25.91 |
| Latero-medial width | 5.08 ± 0.12 | 4.75 | 5.55 | 5.70 |
| Anterio-posterior width (at coronary groove) | 6.29 ± 0.41 | 5.34 | 7.97 | 15.90 |
| Wall thickness of right atrium | 0.33 ± 0.03 | 0.23 | 0.41 | 20.60 |
| Wall thickness of left atrium | 0.38 ± 0.09 | 0.23 | 0.78 | 55.20 |
| Wall thickness of right ventricle | 0.67 ± 0.06 | 0.45 | 0.88 | 23.26 |
| Wall thickness of left ventricle | 1.51 ± 0.09 | 1.25 | 1.92 | 15.88 |
| Thickness of interventricular septum | 1.31 ± 0.08 | 1.07 | 1.65 | 15.76 |
| Diameter of cranial vena cava | 1.58 ± 0.06 | 1.41 | 1.82 | 9.44 |
| Diameter of caudal vena cava | 1.41 ± 0.06 | 1.15 | 1.55 | 10.79 |
| Circumference of pulmonary artery | 4.65 ± 0.51 | 3.20 | 6.50 | 27.06 |
| Wall thickness of pulmonary artery | 0.30 ± 0.02 | 0.23 | 0.37 | 20.08 |
| Diameter of large pulmonary vein | 1.73 ± 0.13 | 1.41 | 2.08 | 17.68 |
| Diameter of medium pulmonary vein | 1.30 ± 0.11 | 1.05 | 1.76 | 20.50 |
| Diameter of small pulmonary vein | 0.98 ± 0.08 | 0.64 | 1.27 | 20.70 |
| Circumference of aorta | 5.85 ± 0.14 | 5.50 | 6.40 | 5.99 |
| Diameter of aorta | 1.88 ± 0.10 | 1.63 | 2.31 | 13.44 |
| Diameter descending aorta | 1.37 ± 0.07 | 1.01 | 1.55 | 13.64 |
| Diameter ascending aorta | 1.27 ± 0.05 | 1.11 | 1.42 | 9.47 |
| Circumference descending aorta | 4.08 ± 0.19 | 3.30 | 4.70 | 11.32 |
| Circumference ascending aorta | 4.05 ± 0.31 | 3.00 | 4.80 | 18.66 |
| Wall thickness of aorta | 0.40 ± 0.03 | 0.34 | 0.51 | 18.46 |
| Wall thickness descending aorta | 0.27 ± 0.02 | 0.24 | 0.36 | 16.06 |
| Wall thickness ascending | 0.24 ± 0.03 | 0.14 | 0.6 | 26.058 |
| Length of moderator band | 2.01 ± 0.10 | 1.68 | 2.42 | 12.35 |
| Thickness of moderator band | 0.28 ± 0.03 | 0.14 | 0.35 | 28.61 |

*Table 2 Showing correlation between different heart parameters*

| Parameter 1 | Parameter 2 | Pearson Correlation | Sig. (2 - tailed) |
|---|---|---|---|
| Weight of heart | Circumference at the coronary groove | 0.907* | 0.013 |
| | Distance between right and left coronary groove (P) | 0.944** | 0.005 |
| | Diameter of caudal vena cava | 0.975** | 0.001 |
| | Wall thickness descending aorta | -0.872* | 0.024 |
| Length of posterior border from base to apex | Distance between IM groove and apex of heart | -0.816* | 0.048 |
| | Circumference of aorta | 0.893* | 0.017 |
| Circumference at coronary groove | Weight of heart | 0.907* | 0.013 |
| | Distance between right and left coronary groove (P) | 0.920** | 0.009 |
| | Anterio-posterior width (at coronary groove) | 0.907* | 0.013 |
| | Diameter of caudal vena cava | 0.856* | 0.030 |
| Distance between right and left coronary grooves (anteriorly) | Diameter of heart | 0.968** | 0.002 |
| | Wall thickness of aorta | -0.874* | 0.023 |
| Distance between right and left coronary grooves (posteriorly) | Weight of heart | 0.944** | 0.005 |
| | Distance between right and left coronary groove (P) | 0.920** | 0.009 |
| | Distance from caudal vena cava to apex | 0.866* | 0.026 |
| | Diameter of caudal vena cava | 0.888* | 0.018 |
| | Diameter descending aorta | -0.824* | 0.044 |
| | Diameter ascending aorta | 0.860* | 0.028 |
| Distance from right coronary groove to apex | Latero-medial width | 0.847* | 0.033 |
| | Diameter of medium pulmonary vein | 0.971** | 0.001 |
| | Length of moderator band | 0.846* | 0.034 |
| Distance from left coronary groove to apex | Wall thickness of left ventricle | -0.851* | 0.032 |
| | Length of moderator band | 0.821* | 0.045 |
| Distance between IM and left coronary groove | Diameter of cranial vena cava | 0.918** | 0.010 |
| Distance between IM and right coronary groove | Distance from caudal vena cava to apex | 0.959** | 0.002 |
| | Diameter ascending aorta | 0.927** | 0.008 |
| | Circumference ascending aorta | 0.867* | 0.025 |
| Distance between IM groove and apex of heart | Length of posterior border from base to apex | -0.816* | 0.048 |
| | Wall thickness of right atrium | -0.835* | 0.039 |
| Latero-medial width | Distance from right coronary groove to apex | 0.847* | 0.033 |
| | Diameter of medium pulmonary vein | 0.927** | 0.008 |
| | Diameter of small pulmonary vein | 0.816* | 0.048 |
| Anterio-posterior width (at coronary groove) | Circumference at the coronary groove | 0.907* | 0.013 |
| Wall thickness of right atrium | Distance between IM groove and apex of heart | -0.835* | 0.039 |
| Wall thickness of left atrium | Wall thickness descending aorta | 0.918** | 0.010 |
| Wall thickness of left ventricle | Distance from left coronary groove to apex | -0.851* | 0.032 |
| | Thickness of interventricular septum | 0.855* | 0.030 |
| Thickness of interventricular septum | Distance between IM and left coronary groove | 0.870* | 0.024 |
| | Wall thickness of left ventricle | 0.855* | 0.030 |
| | Diameter of cranial vena cava | 0.918** | 0.010 |
| Diameter of cranial vena cava | Distance between IM and left coronary groove | 0.918** | 0.010 |
| | Thickness of interventricular septum | 0.918** | 0.010 |
| | The wall thickness of aorta | -0.840* | 0.036 |
| Diameter of caudal vena cava | Weight of heart | 0.975** | 0.001 |
| | Circumference at the coronary groove | 0.856* | 0.030 |
| | Distance between right and left coronary groove (Posteriorly) | 0.888* | 0.018 |
| Diameter of medium pulmonary vein | Distance from right coronary groove to apex | 0.971** | 0.001 |
| | Latero-medial width | 0.927** | 0.008 |
| | Length of moderator band | 0.912* | 0.011 |
| Diameter of small pulmonary vein | Latero-medial width | 0.816* | 0.048 |
| | Length of moderator band | 0.878* | 0.021 |
| Circumference of aorta | Length of posterior border from base to apex | 0.893* | 0.017 |
| Diameter of descending aorta | Distance between right and left coronary groove (Posteriorly) | -0.824* | 0.044 |
| | Distance from caudal vena cava to apex | -0.823* | 0.044 |
| | Diameter ascending aorta | -0.918** | 0.010 |
| | Circumference descending aorta | 0.969** | 0.001 |
| Diameter of ascending aorta | Distance between right and left coronary groove (P) | 0.860* | 0.028 |
| | Distance between IM and right coronary groove | 0.927** | 0.008 |
| | Distance from caudal vena cava to apex | 0.925** | 0.008 |
| | Diameter descending aorta | -0.918** | 0.010 |
| Circumference of descending aorta | Diameter descending aorta | 0.969** | 0.001 |

| | | | |
|---|---|---|---|
| Circumference of ascending aorta | Distance between IM and right coronary groove | 0.867* | 0.025 |
| | Distance from caudal vena cava to apex | 0.827* | 0.042 |
| | Wall thickness descending aorta | -0.878* | 0.021 |
| The wall thickness of aorta | Distance between right and left coronary groove (Anteriorly) | -0.874* | 0.023 |
| | Distance between caudal vena cava and the origin of pulmonary artery (Anteriorly) | -0.935** | 0.006 |
| | Diameter of cranial vena cava | -0.840* | 0.036 |
| Wall thickness descending aorta | Weight of heart | -0.872* | 0.024 |
| | The wall thickness of the left atrium | 0.918** | 0.010 |
| | Circumference ascending aorta | -0.878* | 0.021 |
| Wall thickness ascending aorta | Thickness of moderator band | 0.878* | 0.021 |
| Length of the moderator band | Distance from right coronary groove to apex | 0.846* | 0.034 |
| | Distance from left coronary groove to apex | 0.821* | 0.045 |
| | Diameter of medium pulmonary vein | 0.912* | 0.011 |
| | Diameter of small pulmonary vein | 0.878* | 0.021 |
| Thickness of the moderator band | Wall thickness ascending | 0.878* | 0.021 |

*Correlation is significant at the 0.05 level (2-tailed)*
*** Correlation is significant at the 0.01 level (2-tailed)*

**Table 2 Showing correlation between different heart parameters**

| Independent variable | Dependent variable | Coefficient of determination (R Square) | Regression model $(X = Intercept + b_1x_1 + b_2x_2 + ..... b_nx_n + SE)$ |
|---|---|---|---|
| Weight of heart (Var 1) | Circumference at the coronary groove (Var 2) | 0.821 | Var1= -157.520 + (18.029)x Var2 + 18.001 |
| | Distance between right and left coronary groove (P) (Var 3) | 0.898 | Var1= -159.942 + (44.487)x Var3 + 14.106 |
| | Diameter of caudal vena cava (Var 4) | 0.955 | var1 = -162.301 + (245.180) x var4+ 9.398 |
| | Wall thickness descending aorta (Var 5) | 0.757 | var1 = 389.793 + (-753.481) x var5+ 20.923 |
| | Var 2, Var 3, Var 4 and Var 5 | 0.994 Multiple Correlation Coefficient (R) =0.999 | var1 = -71.445 +(2.554) x var2+ (9.813) x var3+ (128.371) x var4+ (-183.422) x var5 + 5.057 |
| Length of posterior border from base to the apex of heart (Var 1) | Distance between IM groove and apex of the heart (Var 2) | 0.665 | var1 = 8.456 + (-0.465) x var2+ 0.322 |
| | Circumference of aorta (Var 3) | 0.799 | var1 = -0.649 +(1.285) x var3+0.252 |
| | Var 2, Var 3 | 0.855 Multiple Correlation Coefficient (R) =0.926 | var1 = 2.165 +(-0.191) x var2+ (0.910) x var3+ 0.259 |
| Circumference at the coronary groove (Var 1) | Distance between right and left coronary groove (P) (Var 2) | 0.845 | var1 = 2.086 +(2.178) x var2+0.846 |
| | Anterio-posterior width (at coronary groove) (Var 3) | 0.826 | var1 = 7.918 +(1.748) x var3+0.909 |
| | Diameter of caudal vena cava (Var 4) | 0.739 | var1 = 3.643 +(10.826) x var4+1.102 |
| | Var 2, Var 3, Var 4 | 0.961 Multiple Correlation Coefficient (R) =0.983 | var1 = 2.705 +(0.343) x var2+(1.064) x var3+(4.806) x var4+ 0.566 |
| Distance between right and left coronary groove (A) (Var 1) | Diameter of heart (Var 2) | 0.931 | var1 = 3.243 +(1.217) x var2+0.250 |
| | Wall thickness of aorta (Var 3) | 0.765 | var1 = 14.627 +(-10.514) x var3+0.480 |
| | Var 2, Var 3 | 0.971 Multiple Correlation Coefficient (R) =0.983 | var1 = 6.550 +(0.916) x var2+(-3.776) x var3+0.172 |
| Distance between right and left coronary groove (P) (Var 1) | Distance from caudal vena cava to apex (Var 2) | 0.743 | var1 = 2.572 +(0.580) x var2+0.453 |
| | Diameter of caudal vena cava (Var 3) | 0.780 | var1 = 1.046 +(4.731) x var3+0.418 |
| | Diameter descending aorta (Var 4) | 0.679 | var1 = 12.599 +(-3.581) x var4+0.511 |
| | Diameter ascending aorta (Var 5) | 0.740 | var1 = 0.349 +(6.130) x var5+0.466 |
| | Var 2, Var 3, Var 4, Var 5 | 0.991 Multiple Correlation Coefficient (R)=0.994 | var1 = -2.771 +(-0.094) x var2+(3.361) x var3+ (0.320) x var4+(5.078) x var5+0.123 |

| | | | |
|---|---|---|---|
| | Latero-medial width (Var 2) | 0.712 | var1 = -4.235 +(1.308) **x** var2+0.268 |
| Distance from right coronary groove to apex (Var 1) | Diameter of medium pulmonary vein (Var 3) | 0.941 | var1 = 0.287 +(1.620) **x** var3+0.117 |
| | Length of moderator band (Var 4) | 0.713 | var1 = -0.665 +(1.514) **x** var4+0.262 |
| | Var 2, Var 3, Var 4 | 0.982 Multiple Correlation Coefficient (R)=0.999 | var1 = 4.182 +(-0.851) **x** var2+(3.122) **x** var3+(-0.763) **x** var4+0.070 |
| | The wall thickness of left ventricle (Var 2) | 0.727 | var1 = 4.034 +(-1.287) **x** var2+0.217 |
| Distance from left coronary groove to apex (Var 1) | Length of moderator band (Var 3) | 0.672 | var1 = -0.324 +(1.198) **x** var3+0.235 |
| | Var 2, Var 3 | 0.883 Multiple Correlation Coefficient (R)=0.936 | var1 = 1.938 +(-0.853) **x** var2+(0.728) **x** var3+0.159 |
| | Thickness of interventricular septum (Var 2) | 0.756 | var1 = 1.010 +(2.728) **x** var2+0.356 |
| Distance between IM and left coronary groove (Var 1) | Diameter of cranial vena cava (Var 3) | 0.845 | var1 = -1.700 +(3.971) **x** var3+0.287 |
| | Var 2, Var 3 | 0.842 Multiple Correlation Coefficient (R)=0.916 | var1 = -1.325 +(0.549) **x** var2+(3.282) **x** var3+ 0.329 |
| | Distance from caudal vena cava to apex (Var 2) | 0.915 | var1 = -0.714 +(0.471) **x** var2+0.183 |
| Distance between IM and right coronary groove (Var1) | Diameter ascending aorta (Var 3) | 0.855 | var1 = -2.330 +(4.768) **x** var3+0.248 |
| | Circumference ascending aorta (Var 4) | 0.758 | var1 = 0.667 +(0.677) **x** var4+0.325 |
| | Var 2, Var 3, Var 4 | 0.963 Multiple Correlation Coefficient (R)=0.983 | var1 = -1.541 +(0.135) **x** var2+(2.239) **x** var3+ (0.256) **x** var4+0.187 |
| Distance between IM groove and apex of heart (Var 1) | Wall thickness of right atrium (Var 2) | 0.694 | var1 = 7.079 +(-11.032) **x** var2+0.547 |
| | Diameter of medium pulmonary vein (Var 2) | 0.850 | var1 = 3.767 +(1.003) **x** var2+0.123 |
| Latero-medial width (Var 1) | Diameter of small pulmonary vein (Var 3) | 0.664 | var1 = 3.933 +(1.165) **x** var3+0.189 |
| | Var 2, Var 3 | 0.871 Multiple Correlation Coefficient (R)=0.932 | var1 = 3.710 +(0.815) **x** var2+(0.307) **x** var3+ 0.133 |
| The wall thickness of left atrium (Var 1) | Wall thickness descending aorta (Var 2) | 0.840 | var1 = -0.817 +(4.359) **x** var2+0.091 |
| Wall thickness of left ventricle (Var 1) | Thickness of interventricular septum (Var 2) | 0.731 | var1 = 0.209 +(0.999) **x** var2+0.133 |
| Thickness of interventricular septum (Var 1) | Diameter of cranial vena cava (Var 2) | 0.840 | var1 = -0.695 +(1.266) **x** var2+0.093 |
| Diameter of cranial vena cava (Var 1) | Wall thickness of aorta (Var 2) | 0.702 | var1 = 2.265 +(-1.695) **x** var2+0.094 |
| Diameter of medium pulmonary vein (Var 1) | Length of moderator band (Var 2) | 0.834 | var1 = -0.666 +(0.979) **x** var2+0.123 |
| Diameter of small pulmonary vein (Var 1) | Length of moderator band (Var 2) | 0.779 | var1 = -0.468 +(0.716) **x** var2+0.107 |
| | Diameter ascending aorta (Var 2) | 0.848 | var1 = 3.172 +(-1.506) **x** var2+0.088 |
| Diameter descending aorta (Var 1) | Circumference descending aorta (Var 3) | 0.938 | var1 = -0.227 +(0.399) **x** var3+0.051 |
| | Var 2, Var 3 | 0.993 Multiple Correlation Coefficient (R)=0.994 | var1 = 1.036 +(-0.622) **x** var2+(0.264) **x** var3+0.026 |
| Circumference ascending aorta (Var 1) | Wall thickness descending aorta (Var 2) | 0.770 | var1 = 8.180 +(-15.026) **x** var2+0.402 |
| Wall thickness ascending aorta (Var 1) | Thickness of moderator band (Var 2) | 0.778 | var1 = 0.040 +(0.683) **x** var2+0.037 |

## REFERENCES

1. 20th Livestock Census-All India Report. (2019). Ministry of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying, New Delhi

2. Modekar, S. S. (2001). Gross anatomy, histology and histochemistry of the liver in goat (*Capra hircus*). M.V.Sc thesis submitted to College of Veterinary and Animal Sciences, Marathwada Agricultural University, Parbhani.

3. Dyce, K. M., Sack, W. O., & Wensing, C. J. G. (2010). Textbook of Veterinary Anatomy. 4th Edn. Saunders Elsevier.

4. Dhingra, L. D., & Sharma, D. N. (1978). Topographic anatomy of the heart of adult female Murrah buffalo (*Bubalus bubalis*). Indian Journal of Animal Sciences, *48*, 729-736.

5. Crick, C. J., Sheppard, M. N., Ho, S. Y., Gebstein, L., & Anderson, R. H. (1998). Anatomy of the pig heart: comparison with normal human cardiac structure. Journal of Anatomy, *193*, 105-119.

6. Malik, M. R., Tiwari, G. P., Singh, A. P., & Kapoor, P. N. (1972). Biometry of the heart of the buffalo (*Bubalus bubalis*). Indian Journal of Animal Sciences, *42*, 1004-1006.

7. Malik, M. R., Jain, N. K., Parmar, M. L., & Taluja, J. S. (1999). Morphometry of the heart of deer. Indian Journal of Animal Sciences, *69*(5), 318-319.

8. Hussain, R., & Qureshi, A. S. (2016). Age related changes in the morphometric parameters of the Heart, Kidneys and Adrenal glands of Nili-Ravi buffalo (*Bubalus bubalis*). Italian Journal of Animal Science, *6*(2), 995 – 998.

9. Archana, Kumar, P., & Kumar, P. (2010). Anatomy and biometry of heart of sheep (*Ovis aries*) of Jammu region. Indian Journal of Veterinary Anatomy, *22*(1), 12-14.

10. Suresh, B. U. (2013). Gross anatomical and biometrical study of the heart of adult sheep (*Ovis aries*). M.V.Sc thesis submitted to Bombay Veterinary College.

11. Panditrao, K. V. (2014). Gross anatomical and histomorphological studies on ventricles of heart in sheep (*Ovis aries*). M.V.Sc. thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur, India.

12. Sandhu, D., Gupta, A., Bansal, N., Uppal, V., & Mohindroo, J. (2021). Gross anatomical and histomorphological studies on heart of sheep. The Haryana Veterinarian, *60*(1), 69-73.

13. Gupta, N., Vaish, R., Gupta, D. K., & Pandey, Y. (2015). Gross morphological and Morphometrical studies on heart of chital (*Axis axis*). Journal of Animal Research, *5*(3), 641-644.

14. Sasan, J. S., Prakash, P., Singh, A. D., John, M. A., & Malik, M. R. (2015). Biometry of the heart of the fowl (*Gallus gallus domesticus*). Indian Journal of Animal Research, *49*(4), 556-558.

15. Snedecor, C. W., & Cochran, W. G. (1994). Statistical methods. 9th Edn., Lowa State University press, Ames, Lowa.

16. Gupta, V., Pathak, A., Prakash, A., & Farooqui, M. M. (2012). Gross anatomical and biometrical studies on the heart and its associated blood vessels in buffalo (*Bubalus bubalis*) of Mathura region. Indian Journal of Veterinary Anatomy, *24*(2), 80-81.

17. Martin, L., Virginia, M., & William, P. (2009). Gross anatomy of the heart in the Western Grey kangaroo (*Macropus fuliginosus*). International Journal of Morphology, *27*(4), 1099-1104.

18. Bhasin, H., Gupta, A., Mohindroo, J., Bansal, N., & Uppal, V. (2012). Gross biometric and ultrasonographic studies on the buffalo heart. Ruminant Science, *6*(1), 47-50.

19. Shahida, P. P., Rind, M., Khan, H., Tufail, M., Rind, B., & Rindi, R. (2007). Gross anatomical studies on normal heart of buffalo (*Bubalus bubalis*). International Journal of Agriculture & Biology, *9*(1),162 – 166.