Indian Journal of Animal Sciences **91** (4): 294–298, April 2021/Article
https://doi.org/10.56093/ijans.v91i4.114335

Effect of genetic and non-genetic factors on morphometric traits of indigenous cattle breeds used for sporting event in Tamil Nadu

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Received: 31 March 2020; Accepted: 18 July 2021

ABSTRACT

A total of 310 sporting bulls belonging to Pulikulam, Kangayam, Umblachery and non-descript cattle were used to assess the morphometric traits such as body weight (kg) and body length (cm), height at withers and chest girth (cm), face length and face width (cm), horn length and horn circumference and skin thickness (mm). The body measurements were analyzed to study the effect of different factors such as place of event, genetic and age groups by the general linear model. From this analyses, body weight and chest girth did not vary among different genetic groups, but, numerically higher body weight values were observed at more than six years of age. Kangayam bulls had significantly higher height at withers, when compared to other genetic groups. Pulikulam breed had higher face length (46.79±1.52 cm), maximum horn length (31.38±3.05 cm) and face width (20.53±1.04 cm), when compared to other genetic groups. Age of the bull, genetic groups and place of event did not show any significant effect on skin thickness. Overall, Pulikulam breed had optimum parameters with respect to body length, body weight, horn length and horn circumference and these attributes would confer *jallikattu* breed when compared to other recognized breeds.

Keywords: Body measurements, Indigenous breeds, Morphometric traits, Sporting event

Animal sports are sporting events that make use of animals and such animals could be trained or sometimes specially bred to participate in an age-old tradition sporting events. India too has a tradition of animal sports that are held in different parts of the country such as bull fighting, buffalo races, bullock cart race, cock fights, horse racing, etc. *Jallikattu* or bull taming sport is one of the traditional sporting events held in Tamil Nadu annually along with Pongal celebrations. This age-old traditional event was associated with participation of indigenous cattle breeds' native to Tamil Nadu to exhibit aggression towards bull tamers (Littlewood 1936). The bulls were given training prior to sporting event such as swimming and running; and specialized protein rich diets to improve the phenotypic appearance. They were uncastrated and highly ferocious in nature since it has been reared by one or two persons in the family (Ezhilvendan 2013). But, no proper scientific study was conducted to assess the morphometric attributes of those indigenous bulls participating in the sporting event. Hence, the study was planned to document and assess the morphometric traits of sporting bulls.

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MATERIALS AND METHODS

The indigenous breeds/ genetic groups of cattle such as Pulikulam, Kangayam, Umblachery and non-descript were identified based on the morphological characters. Among these breeds, only the bulls were used for sporting events and their age was ascertained by dentition, as described by Shortt (1889). A total of 310 bulls were measured, but, due to their aggressiveness, complete phenotypic measurements for each bull could not be taken. Irrespective of genetic groups, measurements were taken as per the descriptions given by Sasimowski (1987). Single fold skin thickness was taken at neck and at the 13th rib in millimeter with the help of vernier caliper with an accuracy of 0.05 mm and then average was taken from both measurements (Pan 1963). From the collected information, the body weight (kg) was estimated by using Agarwal's modified Shaeffer's formula (Wangchuk *et al.* 2018).

All the collected information pertaining to body measurements were computerized and analyzed to study the effect of different factors such as place of event (I = Madurai, II = Trichy and III = Dindigul districts), genetic groups (I = Pulikulam, II = Kangayam, III = Umblachery and IV = Non-descript bulls) and age groups (I = one to two years, II = two to three years, III = three to four years, IV = four to five years, V = five to six years, VI = more than six years) by the univariate statistical analyses under general linear model (SPSS version 20).

$$Y_{ijkl} = \mu + F_i + E_j + S_k + e_{ijkl}$$

where Y_{ijkl}, the dependent variable or the body measurements; μ, overall mean; F_i, effect of i^{th} place of event (i =1 to 3); E_j, effect of j^{th} genetic group (j = 1 to 4); S_k, effect of k^{th} age group (k = 1 to 6); e_{ijkl}, random error, normally and independently distributed with a mean of '0' and variance of σ^2_e.

Duncan's Multiple Range Test as modified by Kramer (1957) was employed to make pair-wise comparisons of least-squares means.

RESULTS AND DISCUSSION

The least-squares means of morphometric traits such as body weight (kg) and body length (cm), height at withers and chest girth (cm), face length and face width (cm), horn length and horn circumference and skin thickness (mm) are furnished in Tables 1, 2, 3, 4 and 5, respectively.

Body weight and body length: The overall least-squares means of body weight estimated in sporting bulls at different ages of 1–2, 2–3, 3–4, 4–5, 5–6 and more than 6 years were 207.45±16.56, 274.64±11.99, 323.19±8.16, 358.61±15.85, 380.80±14.43 and 388.19±23.02 kg respectively. Body weight did not vary, stochastically among different genetic groups with respect to all age groups. But, numerically higher body weight values were observed for more than six years of age in all genetic groups. Among various districts, only bulls of 3–4 years of sporting age differed significantly (P<0.01) on body weight and bulls native to Madurai district had the highest body weight (354.25±11.16 kg) in 3–4 years of age.

In sporting bulls, the overall least-squares means of body length were 104.72±4.16, 119.35±2.98, 127.80±3.62, 134.47±2.19, 138.35±2.13 and 142.73±4.57 cm at different ages 1–2, 2–3, 3–4, 4–5, 5–6 and more than 6 years, respectively. In 4–5 years of age, the body length differed significantly (P<0.05) among genetic groups as well among the districts. In 4–5 years of age, Kangayam bulls had significantly (P<0.05) higher body length (140.85±3.68 cm) when compared to Pulikulam (132.64±2.53 cm) and non-descript bulls (129.91±2.74 cm). The body length differed significantly (P<0.05) among genetic groups and highly significant (P<0.01) among the districts of various events, at 5–6 years of age. Body length of sporting bulls in Madurai and Dindigul districts did not differ significantly, because in these districts the main breed for sporting events was Pulikulam; but Trichy district had significantly lower values of body length since this area's prime breed for sporting event was Umblachery, which are smaller in size when compared to Pulikulam breed used in Madurai and Dindigul districts.

Height at withers and chest girth: The average height at withers at 4–5 and 5–6 years of age were 126.01±1.66 and 127.95±1.41 cm respectively and age of the bull (4–5 and 5–6 years) was found to have significant (P<0.05) effect on height at withers; but did not show any significant effect on bulls among different districts. Among genetic groups,

Table 1. Least-squares means (±S.E.) for body weight (kg) and body length (cm) at different ages in sporting bulls

Age (in years)	Overall mean	Sig.	Genetic group				Sig.	Place of event (districts)		
			Pulikulam	Kangayam	Umblachery	Non-descript		Dindigul	Madurai	Trichy
Body weight (kg)										
1–2	207.45±16.56 (31)	NS	202.72±23.22 (13)	200.70±33.86 (3)	–	218.92±19.59 (15)	NS	183.90±20.75 (10)	204.69±17.35 (19)	233.75±42.43 (2)
2–3	274.64±11.99 (50)	NS	264.65±14.24 (10)	285.22±13.43 (10)	257.07±38.05 (1)	291.61±8.14 (29)	NS	281.96±22.09 (4)	282.80±11.52 (18)	259.14±12.66 (28)
3–4	323.19±8.16 (48)	NS	330.67±11.47 (15)	308.29±17.12 (6)	344.92±24.93 (3)	308.89±8.56 (24)	**	–	354.25±11.16 (28)	292.13±9.95 (20)
4–5	358.61±15.85 (56)	NS	363.14±19.32 (25)	369.26±20.54 (6)	–	343.43±19.32 (25)	NS	358.62±47.90 (1)	368.03±10.27 (35)	349.18±10.61 (20)
5–6	380.80±14.43 (67)	NS	364.16±15.08 (35)	393.57±23.05 (6)	383.10±29.41 (4)	352.37±17.36 (22)	NS	359.90±38.26 (2)	405.24±12.68 (37)	377.26±10.92 (28)
> 6	388.19±23.02 (22)	NS	380.01±21.61 (15)	399.86±49.98 (1)	409.12±49.98 (1)	363.78±22.01 (5)	NS	369.22±51.82 (1)	418.44±24.78 (11)	376.92±18.26 (10)
Body length (cm)										
1–2	104.72±4.16 (32)	NS	103.94±5.70 (14)	103.00±8.58 (3)	–	107.20±4.97 (15)	NS	100.08±5.07 (11)	102.45±4.39 (19)	111.61±10.74 (2)
2–3	119.35±2.98 (53)	NS	117.89±3.48 (11)	123.48±3.36 (10)	113.65±9.71 (1)	122.37±1.95 (31)	NS	119.98±5.24 (5)	120.70±2.93 (19)	117.36±3.23 (29)
3–4	127.80±3.62 (54)	NS	128.19±4.06 (17)	124.65±4.84 (7)	133.24±6.56 (3)	125.13±3.41 (27)	NS	125.67±9.77 (1)	134.84±2.39 (33)	122.89±2.27 (20)
4–5	134.47±2.19 (60)	*	132.64b±2.53 (28)	140.85a±3.68 (6)	–	129.91b±2.74 (26)	*	131.72ab±6.09 (2)	131.90a±1.84 (38)	131.78b±1.98 (20)
5–6	138.35±2.13 (72)	*	136.26b±2.10 (38)	147.43a±3.81 (6)	136.61b±4.76 (4)	133.08b±2.54 (24)	**	135.36b±5.25 (3)	144.05a±2.07 (40)	135.63b±1.81 (29)
> 6	142.73±4.57 (28)	NS	138.80±4.41 (18)	149.83±8.00 (2)	146.83±10.60 (1)	135.48±4.35 (7)	NS	145.26±10.74 (1)	149.04±4.79 (13)	133.90±3.36 (14)

Figures in parentheses are the number of observations; **, Highly significant (P<0.01); *, Significant (P<0.05); NS, non-significant and Sig., Level of significance. Row means with different superscripts differ significantly.

Table 2. Least-squares means (±S.E.) for height at withers and chest girth (cm) at different ages in sporting bulls

Age (in years)	Overall mean	Sig.	Genetic group				Sig.	Place of event (districts)		
			Pulikulam	Kangayam	Umblachery	Non-descript		Dindigul	Madurai	Trichy
Height at withers (cm)										
1–2	105.91±3.49 (36)	NS	105.64±4.94 (13)	101.33±7.21 (3)	–	110.75±3.96 (20)	NS	103.01±4.01 (15)	103.34±3.69 (19)	111.37±9.04 (2)
2–3	119.74±2.17 (54)	NS	114.70±2.54 (11)	124.27±2.37 (11)	118.88±7.09 (1)	121.10±1.43 (31)	*	123.04^{a}±3.82 (5)	120.86^{ab}±2.14 (19)	115.32^{b}±2.34 (30)
3–4	122.85±1.40 (58)	NS	122.85±1.60 (19)	125.25±2.19 (8)	121.49±3.42 (3)	121.84±1.33 (28)	**	122.35^{ab}±3.30 (3)	126.85^{a}±1.32 (34)	119.37^{b}±1.27 (21)
4–5	126.01±1.66 (65)	*	124.11^{ab}±1.93 (29)	130.51^{a}±2.58 (8)	–	123.42^{b}±2.07 (28)	NS	123.70±4.67 (2)	128.74±1.32 (41)	125.59±1.40 (22)
5–6	127.95±1.41 (72)	*	125.98^{b}±1.46 (39)	132.45^{a}±2.39 (5)	122.14b±2.87 (4)	124.23^{b}±1.67 (24)	NS	128.23±3.73 (2)	129.80±1.23 (41)	125.81±1.08 (29)
> 6	125.51±2.68 (25)	NS	125.89±2.48 (16)	129.61±5.80 (1)	121.61±5.80 (1)	124.92±2.38 (7)	NS	126.59±5.95 (1)	125.03±2.87 (12)	124.90±2.08 (12)
Chest girth (cm)										
1–2	121.99±5.76 (31)	NS	119.00±8.08 (13)	121.67±11.78 (3)	–	125.31±6.82 (15)	NS	113.54±7.22 (10)	122.93±6.04 (19)	129.50±14.76 (2)
2–3	144.68±3.40 (51)	NS	141.34±4.05 (10)	147.12±3.70 (11)	142.11±10.83 (1)	148.14±2.32 (29)	NS	148.04^{a}±6.28 (4)	146.57^{a}±3.28 (18)	139.43^{b}±3.57 (29)
3–4	154.30±1.66 (48)	NS	155.54±2.33 (15)	151.85±3.48 (6)	159.21±5.07 (3)	150.62±1.74 (24)	**	–	160.85±2.27 (28)	147.76±2.02 (20)
4–5	160.64±3.47 (57)	NS	162.64±4.19 (25)	159.63±4.33 (7)	–	159.64±4.19 (25)	NS	160.01±10.40 (1)	160.63±2.18 (35)	161.29±2.21 (21)
5–6	167.30±3.23(68)	NS	164.77±3.35 (36)	171.83±5.15 (6)	171.12±6.57 (4)	161.50±3.88 (22)	NS	165.51±8.55 (2)	168.74±2.83 (37)	167.67±2.42 (29)
> 6	165.29±3.76 (22)	NS	164.35±3.53 (15)	168.08±8.16 (1)	167.08±8.16 (1)	161.63±3.59 (5)	NS	159.65±8.46 (1)	168.00±4.05 (11)	168.21±2.98 (10)

Figures in parentheses are the number of observations; **, Highly significant (P<0.01); *, Significant (P<0.05); NS, Non-significant and Sig., level of significance. Row means with different superscripts differ significantly.

Kangayam bulls had significantly (P<0.05) higher height at withers (132.45±2.39 cm) and had numerically higher mean value when compared to other recognized breeds. Among three districts, 2–3 and 3–4 years of age groups were found to differ significantly (P<0.05) and highly significantly (P<0.01) on height at withers, respectively. In pair-wise comparison, there was no significant difference in mean values between Dindigul and Madurai districts, but, Trichy district differed significantly (P<0.05) from rest of the two.

The overall least-squares means of chest girth recorded in sporting bulls were 121.99±5.76, 144.68±3.40, 154.30±1.66, 160.64±3.47, 167.30±3.23 and 165.29±3.76 cm for 1–2, 2–3, 3–4, 4–5, 5–6 and more than 6 years, respectively. Chest girth did not vary, stochastically, among different genetic groups in all the age groups. But, numerically higher chest girth values were observed for more than six years of age in all genetic groups. Kangayam bulls had higher chest girth (168.08±8.16 cm) when compared to Pulikulam and non-descript bulls. In different districts, only bulls of 3–4 years of sporting age differed significantly (P<0.01) on chest girth. Madurai district recorded the highest chest girth (160.85±2.27 cm) in 3–4 years of sporting age.

Face length and face width: The traits, viz. face length and face width of sporting bulls belonging to different genetic groups were not different in all ages (Table 3). Higher values were observed for more than six years of age in all genetic groups. Pulikulam breed of cattle had higher face length (46.79±1.52 cm) and face width (20.53±1.04 cm), when compared to Kangayam, Umblachery and non-descript bulls. Regional (district) differences were noticed significantly (P<0.05) in face length of sporting bulls in 2–3 years of age; whereas in face width, differences were significant (P<0.05) or highly significant (P<0.01) alternatively on face width in different districts from 1–5 years of age. In general, sporting bulls participated in the events held at Madurai district had significantly (P<0.05) higher face length (45.77±1.53 cm) and highly significant (P<0.01) higher face width (21.66±6.89 cm) at 2–3 years of age, when compared to other districts.

Horn length and horn circumference: The genetic group did not show any significant influence on horn length in the sporting bulls of all ages. Horn length approached the highest at adult stages and the maximum horn length (31.38±3.05 cm) was recorded in Pulikulam bulls at more than six years of age and it was observed that the per cent increment in horn length was higher after six years of age. Different districts influenced the horn length highly significantly (P<0.01) in the age group of 4–5 years. Bulls in Madurai district recorded the highest horn length of 28.13±1.52 cm, when compared to Dindigul (25.28±5.47 cm) and Trichy (20.39±1.60 cm) districts. Both the genetic groups and districts were not found to exert influence on horn circumference. However, the higher values were observed in Pulikulam bulls at more than six years of age

Table 3. Least-squares means (±S.E.) for face length and face width (cm) at different ages in sporting bulls

Age (in years)	Overall mean	Sig.	Genetic group				Sig.	Place of event (districts)		
			Pulikulam	Kangayam	Umblachery	Non-descript		Dindigul	Madurai	Trichy
					Face length					
1–2	43.43±1.50 (37)	NS	41.28±2.07 (14)	46.33±3.12 (3)	–	42.68±1.71 (20)	NS	41.75±1.68 (16)	43.61±1.59 (19)	44.92±3.90 (2)
2–3	41.98±1.55 (54)	NS	38.22±1.82 (11)	44.06±1.70 (11)	43.21±5.07 (1)	42.44±1.02 (31)	*	36.94^{b}±2.73 (5)	45.77^{a}±1.53 (19)	43.23^{a}±1.67 (30)
3–4	45.39±0.90 (59)	NS	43.94±1.02 (19)	44.01±1.40 (8)	49.23±2.19 (3)	44.39±0.84 (29)	NS	46.15±2.11 (3)	45.52±0.84 (35)	44.50±0.81 (21)
4–5	44.78±1.01 (67)	NS	45.30±1.18 (30)	45.35±1.53 (9)	–	43.69±1.27 (28)	NS	44.45±2.85 (2)	45.29±0.79 (42)	44.59±0.84 (23)
5–6	45.13±1.00 (76)	NS	43.10±0.97 (41)	46.45±1.78 (6)	45.10±2.23 (4)	44.97±1.18 (25)	NS	43.65±2.46 (3)	46.05±0.96 (43)	45.69±0.84 (30)
> 6	42.52±1.58 (27)	NS	46.79±1.52 (17)	41.39±2.75 (2)	38.39±3.65 (1)	43.51±1.50 (7)	NS	43.01±3.69 (1)	41.42±1.67 (12)	43.13±1.16 (14)
					Face width					
1–2	18.27±0.84 (36)	NS	17.86±1.16 (14)	18.67±1.15 (3)	–	18.29±0.97 (19)	*	16.07^{b}±0.96 (15)	18.45^{ab}±0.90 (19)	20.29^{a}±2.20 (2)
2–3	18.92±0.70 (54)	NS	17.29±0.82 (11)	18.93±0.76 (11)	22.26±2.28 (1)	17.20±0.46 (31)	**	15.12^{b}±1.23 (5)	21.66^{a}±6.89 (19)	19.98^{a}±0.75 (30)
3–4	19.87±0.75 (58)	NS	19.50±0.81 (19)	19.02±1.10 (8)	21.04±1.66 (3)	19.92±0.73 (28)	*	21.16^{a}±1.88 (2)	20.29^{ab}±0.62 (35)	18.16^{b}±0.60 (21)
4–5	18.73±0.51 (65)	NS	18.68±0.60 (28)	19.55±0.77 (9)	–	17.96±0.64 (28)	**	16.62^{b}±1.44 (2)	20.66^{a}±0.40 (40)	18.91^{ab}±0.42 (23)
5–6	18.87±0.63 (76)	NS	18.67±0.61 (41)	19.12±1.12 (6)	18.34±1.40 (4)	19.35±0.74 (25)	NS	17.05±1.54 (3)	20.28±0.60 (43)	19.29±0.53 (30)
> 6	18.95±1.16 (26)	NS	20.53±1.04 (17)	18.88±2.50 (1)	17.88±2.50 (1)	18.51±1.03 (7)	NS	19.45±2.56 (1)	18.34±1.21 (12)	19.07±0.89 (13)

Figures in parentheses are the number of observations; **, Highly significant (P<0.01); *, Significant (P<0.05); NS, non-significant and Sig., Level of significance. Row means with different superscripts differ significantly.

Table 4. Least-squares means (±S.E.) for horn length and ear length (cm) at different ages in sporting bulls

Age (in years)	Overall mean	Sig.	Genetic group				Sig.	Place of event (districts)		
			Pulikulam	Kangayam	Umblachery	Non-descript		Dindigul	Madurai	Trichy
					Horn length					
1–2	24.01±2.32 (31)	NS	25.08±3.36 (11)	26.67±4.74 (3)	–	20.28±2.67 (17)	NS	20.75±2.77 (12)	23.24±2.48 (17)	28.04±5.95 (2)
2–3	21.37±3.07 (52)	NS	24.83±3.53 (11)	26.35±3.32 (11)	26.61±9.43 (1)	20.56±2.18 (29)	NS	23.97±6.03 (3)	25.76±2.82 (19)	24.37±3.09 (30)
3–4	24.73±2.37 (56)	NS	24.95±2.57 (18)	26.57±3.32 (7)	22.30±5.24 (3)	25.09±2.31 (28)	NS	29.71±5.92 (2)	23.71±1.97 (34)	20.76±1.95 (20)
4–5	24.62±1.94 (66)	NS	24.07±2.26 (29)	25.60±2.93 (9)	–	24.18±2.43 (28)	**	25.28^{b}±5.47 (2)	28.13^{a}±1.52 (41)	20.39^{c}±1.60 (23)
5–6	25.12±2.28 (17)	NS	23.50±2.38 (38)	26.39±3.89 (5)	24.27±4.66 (4)	26.34±2.74 (23)	NS	21.18±6.06 (2)	26.07±2.01 (41)	28.12±1.78 (27)
> 6	24.05±3.08 (26)	NS	31.38±3.05 (16)	25.12±5.39 (2)	23.62±7.14 (1)	24.07±2.93 (7)	NS	30.98±7.22 (1)	27.74±3.33 (12)	22.43±2.28 (!3)
					Horn circumference at base					
1–2	19.26±1.20 (23)	NS	19.34±1.86 (7)	20.33±2.33 (3)	–	18.11±1.48 (13)	NS	16.34±1.86 (15)	20.33±2.33 (6)	18.11±1.48 (2)
2–3	19.36±1.42 (43)	NS	19.64±1.87 (8)	20.21±1.65 (9)	19.53±4.08 (1)	18.05±1.13 (25)	NS	17.31±3.04 (2)	19.83±1.38 (12)	20.94±1.44 (29)
3–4	21.05±1.08 (40)	NS	21.14±1.18 (14)	21.31±1.97 (4)	20.54±2.28 (3)	21.20±1.08 (19)	NS	22.88±2.58 (2)	20.43±1.11 (18)	19.84±0.86 (20)
4–5	19.99±0.98 (42)	NS	19.57±1.21 (19)	21.38±1.24 (7)	–	19.01±1.24 (16)	NS	18.61±2.93 (1)	22.07±0.77 (20)	19.28±0.61 (21)
5–6	21.29±1.06 (53)	NS	20.70±1.12 (27)	21.63±1.67 (6)	21.67±2.13 (4)	21.17±1.34 (16)	NS	20.13±2.77 (2)	21.39±1.03 (23)	22.37±0.79 (28)
> 6	18.93±1.96 (21)	NS	22.06±1.84 (13)	19.99±4.23 (1)	13.99±4.23 (1)	19.66±1.79 (6)	NS	19.26±4.35 (1)	17.58±2.16 (9)	19.93±1.53 (11)

Figures in parentheses are the number of observations; **, Highly significant (P<0.01); NS, Non-significant and Sig., Level of significance. Row means with different superscripts differ significantly.

Table 5. Least-squares means (±S.E.) for skin thickness (mm) at different ages in sporting bulls

Age (in years)	Overall mean	Sig.	Genetic group				Sig.	Place of event (districts)		
			Pulikulam	Kangayam	Umblachery	Non-descript		Dindigul	Madurai	Trichy
					Skin thickness					
1–2	2.24±0.45 (18)	NS	3.44±0.60 (10)	–	–	3.45±0.51 (7)	NS	1.22±0.77 (5)	1.46±0.71 (11)	4.04±0.90 (2)
2–3	4.05±0.46 (44)	NS	3.29±0.55 (10)	3.80±0.53 (9)	4.84±1.44 (1)	4.27±0.33 (24)	NS	3.00±0.85 (4)	4.46±0.45 (16)	4.69±0.50 (24)
3–4	5.68±0.54 (44)	NS	5.77±0.51 (16)	5.23±0.84 (5)	6.78±1.89 (1)	4.94±0.40 (22)	NS	–	5.59±0.63 (28)	5.77±0.60 (16)
4–5	4.16±0.36 (45)	NS	4.52±0.45 (18)	3.26±0.92 (4)	–	4.69±0.41 (23)	NS	–	4.12±0.44 (31)	4.20±0.50 (14)
5–6	4.72±0.48 (57)	NS	4.55±0.52 (29)	3.77±0.98 (3)	5.81±1.06 (3)	4.75±0.57 (22)	NS	4.18±1.24 (2)	5.20±0.46 (37)	4.77±0.45 (18)
> 6	4.70±0.63 (16)	NS	5.28±0.56 (12)	–	4.62±1.63 (1)	4.21±0.91 (3)	NS	–	4.19±0.87 (11)	5.21±0.73 (5)

Figures in parentheses are the number of observations; NS, non-significant and Sig., Level of significance.

for horn circumference at base (22.06±1.84 cm), when compared to other genetic groups. Bulls at Trichy and Madurai districts had higher horn circumference at base (19.93±1.53 cm).

In sporting bulls, many of morphometric traits at different age groups were not influenced by the genetic groups and districts, because, those bulls selected for sporting event had received uniform feeding and management practices to keep the physic fit, which is in close proximity with the findings of Ezhilvendan (2013). This could be one of the reasons that the true genetic potential to attain respective body weight of that breed was controlled by severe physical training at various age groups.

Skin thickness: Across different ages of the bull, different genetic groups and districts did not show any significant effect on skin thickness. On measured observations at more than six years of age, the Pulikulam breed and bulls at Trichy district had highest skin thickness of 5.28±0.56 and 5.21±0.73 mm, respectively.

No literature was available to compare the effect of different genetic groups of sporting bulls and sporting bulls belonging to different districts on morphometric traits in various ages.

Kangayam bulls had significantly (P<0.05) higher height at withers and body length; and had higher mean values for body weight numerically, when compared to Pulikulam breed. But, kangayam bulls could be used if they are less than five years of age. As age progressed, it gets bigger in size; there might be a chance to get tamed by the bull tamers. The number of Umblachery bulls was very less at sporting event due to their smaller size, short horn length and short legs, which could attributes as easy restraint for bull tamers. The non-descript bulls had numerically lowest morphometric traits such as body weight, body length and height at withers, when compared to Kangayam and Pulikulam bulls. Pulikulam bulls had optimum morphometric traits with respect to body length, body weight, higher horn length and horn circumference and these morphometric attributes would confer them as *jallikattu* breed, when compared to other genetic groups.

REFERENCES

Ezhilvendan P. 2013. Valour in *Jellicut*. 1st edn, Ezhilvendan pathipagam, Tuticorin.

Littlewood R W. 1936. Livestock of Southern India, Government of Madras. pp. 95–99.

Kramer C Y. 1957. Extension of multiple range tests of group correlated adjusted means. *Biometrics* **13**: 13–18.

Pan Y S. 1963. Quantitative and morphological variation of sweat glands, skin thickness, and skin shrinkage over various body regions of Sahiwal zebu and Jersey cattle. *Australian Journal of Agricultural Research* **14**: 424.

Sasimowski E. 1987. *Animal Breeding and Production on Outline*. Elsevier, Amsterdam.

Shortt J. 1889. *A Manual of Indian Cattle and Sheep, their Breeds, Management and Diseases*, 3rd edn, pp. 27–29. Higginbotham and Co, Madras, India.

Wangchuk K, Wangdi J and Mindu M. 2018. Comparison and reliability of techniques to estimate live cattle body weight. *Journal of Applied Animal Research* **46**(1): 349–52.