Sex Dimorphism in the One Hump-Camel (*Camelus dromedarius*) from Selected Populations in Nigeria

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Authors' contributions

Article Information

Original Research Article

ABSTRACT

Data on body weights and linear measurements were obtained from 159 camels in selected Local Government Areas of Katsina state (Daura, Mani and Mashi), Nigeria. The aim of this study was to determine factors affecting body measurements of Katsina camels and regroup these camels for selection and genetic improvement. Camels were grouped into groups of 1-3, 4-6, 7-9, 10-12 and 13-15 years. Sex demonstrated significance ($P < 0.05$) at 1-3 years on thoracic girth, body length and body weight. At 4-6 years, all body linear measurements and body weights significant were ($P < 0.05$) except ear length, tail length and foot pad circumference. Body weights and most body linear measurements were significant ($P < 0.05$), except for distance between the eyes, width at shoulders, hump length and tail length which were not significant ($P > 0.05$) at 7-9 years. At 10-12 years, body length, posterior limb length and body weight were significant ($P < 0.05$); there was no significant ($P > 0.05$) in body linear measurement and body weight at 13-15 years. Age was significant ($P < 0.05$) across all body linear measurements and body weights for both camel bull and camel cow in all age groupings. Camel bull had higher mean values for body linear measurements and body weights which shows the existence of sexual dimorphism. Between 7-9

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and 10-12 years was the peak of growth in camels, at 13- 15 years camels body weight decline. The study shows that body linear measurement and body weight in camels is influenced by sex and age.

1. INTRODUCTION

According to FAOSTAT [1], the total population of dromedary in Nigeria is 20,500 heads of camels. These animals are found in the northern states of Nigeria. Camels play important role in the economy of these states. The northern states of Nigeria where *Camelus dromedarius* (one hump camel) are found include: Borno, Yobe, Jigawa, Kano, Katsina, Kebbi, Sokoto and Zamfara (James-Rugu and Jidayi, [2]; Mohammed and Hoffman, [3]. According to Timothy et al. [4] 80% of the total populations of the camels in Nigeria are found in Sokoto state, Katsina state, Kano state, and Borno state which cover a combine area of 70, 714 km^2 and are desert gate ways with important camel trade. They are capable of surviving without drinking water for more than two weeks. They can loss up to about 30% of their body weight by loss of water and they can replenish this loss rapidly by drinking large volume of water quickly at the next opportunity Portal et al. [5]. During drought periods, they are able to utilize thorny and spine plants for feeding that other animals will not be able to utilize and they can continue to produce milk and meat for human consumption under drought circumstances that would lead to the death of other livestock breeds Portal et al. [5].

Raymod [6] reported that camels, horses, mules and donkey belong to domestic animals referred to as beast of burden among which camel are capable of doing many functions competently. Camels are important livestock specie that contributes significantly to the livelihood of the pastoralists and agro-pastoralists in the fragile environments of the desert and semi-desert of Africa and Asia Ishag, [7]. Abdussamad et al. [8] reported that the functions of camels around the Nigerian-Niger corridor include milk for household consumption, meat, and cash from sale of camels, transport, culture, and draught power, hump fat for cooking, social security, and skin for leather.

Camels contribute significantly to the livelihood of the pastoralists and agro-pastoralists in the fragile environments of the desert and semi-desert of Asia and Africa Ishag, [7]. Kamal, [9]; Meiloud et al. [10] reported that, camel is one of the best adapted animal of the desert; they are also a source of milk, meat, wool and transportation for the livelihood of the desert areas. Given camel's considerable contribution to food security in semi arid and arid regions as compared to other domestic animals, study on camel production system, phenotypic and genetic characterization is scanty Yohannes et al. [11] and there is dearth of information on camel production potential and production systems for genetic improvement in Nigeria. These informations are required for the design of appropriate selection and breeding strategy for utilization and improvement of the potential of camel genetic resources for exploration and introduction into other zones to mitigate climate change impact.

The present study is designed to identify the variation in body linear measurements of camel bulls and camel cows in order to apply selection for improvement of body size and body weight in selected populations of camels in Katsina state, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Katsina state situated within North western region of Nigeria, which lies on the tropics on latitude 12°59′N/ longitude 7°36′ E and latitude 12.983° N and 7.600° E of the Greenwich Meridian (GMT) with latitude of 182.82 to 457 meters above sea level. Most of the camels in Katsina state are owned by the nomads residing in three Local Government Areas located in Northern Katsina State, they include: Daura (Sharawar Labo and Sharawar Gerchi), Mashi (Gana Jigawa) and Mani (Shirinya). Daura lies on latitude 13°3N and longitude 8°32E; Mashi lies on latitude 12°98N and longitude 7°94E; Mani lies on latitude 12°98N and longitude 7°87E Google Map, [12]. However, there are migrant camel owners within Dutsi Local Government Area but they stay there only during rainy season grazing on thorny shrubs.

2.2 Data Collection

A total number of 159 camels (about 54 camel bulls and 105 camel cows) were sampled through stratified random sampling from camel farms in the three Local Government Areas for body linear measurements. Camels were grouped into the following age categories: 1-3, 4-6, 7-9, 10-12 and 13-15 years.

Body weight and body linear measurements were taken using a specially designed tape (WE-BO MALEBAND®). This tape is design to take care of linear measurements in centimeters (cm), meters (m) and approximate live body weight equivalent of farm animals. It is graduated from 0 meters to 2.26 meters (0-226 cm) for linear measurements and 30 kg to 880 kg for weight estimation. Body weights were measured by taking readings round the circumference of the thoracic girth or chest girth.

Body measurements evaluated were: face length (fl), distance between the eyes (de), ear length (el), neck length (nl), width at shoulders (ws), height at withers (hw), anterior limb length (all), thoracic girth (tg), height at hump (hh), hump length (hl), hump circumference (hc), hump height (hh), body length (bl), abdomen circumference (ac), posterior limb length (pll), foot pad circumference (cpf), tail length (tl) and

body weight (bw). Camels were measured in a standing position. Fig. 1 shows a summary of how measurements were taken.

2.3 Statistical Analysis

Single measurement for each quantitative variable was made and data collected were proof read against any mistake. Data's were subjected to analysis of variance (ANOVA) and descriptive statistics using SPSS 21. Analysis was carried out separately for male and female camels. The existence of significant differences among means was separated using Duncan's Multiple Range Test by Duncan [13].

The model employed for estimation of body weights and linear body measurements (LBM) is:

$$Y_{ijk} = \mu + A_i + S_j + e_{ijk}$$

Where:

Y_{ijk} = body weight of the individual in the ith age group of the jth sex measured at the kth location
μ = overall mean
A_i = the effect of ith age group (i=1, 2…15)
S_j = the effect of jth sex (j=1, 2)
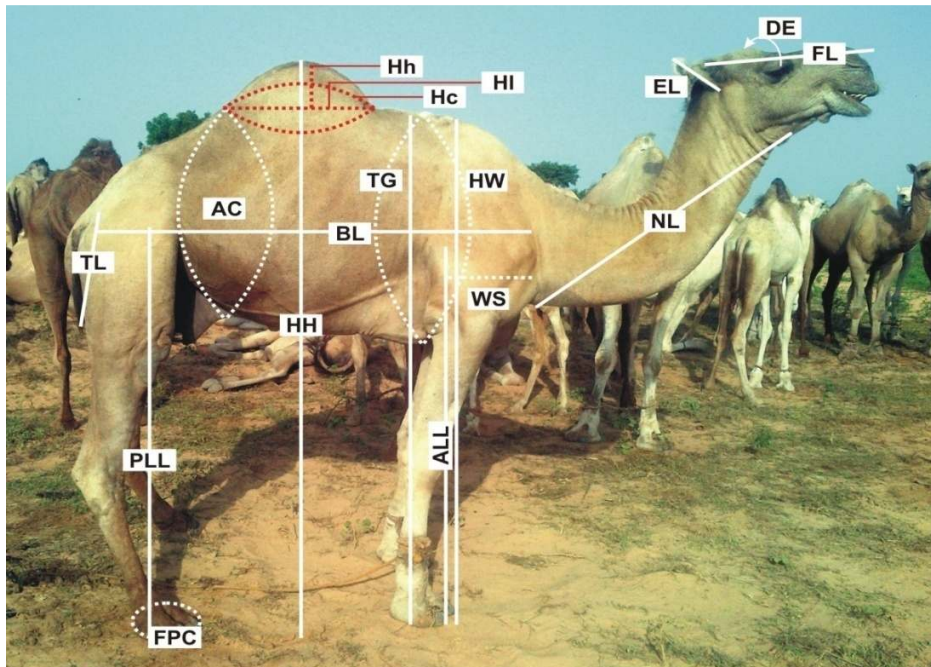e_{ijk} = random residual error

Fig. 1. Description of body linear measurements

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3. RESULTS

3.1 Effect of Sex on Body Weights and Body Linear Measurements of Camels

At 1-3 years, sex was effect was significant ($P < 0.05$) on thoracic girth, body length and body weight Table 1. In the second age group 4-6 years, sex was significant ($P < 0.05$) on almost all body linear measurement and body weight except ear length, tail length and foot pad circumference which were not significant ($P > 0.05$) Table 2. At 7-9 years, body weights and most body linear measurements were significant ($P < 0.05$) due to sex effect, except for distance between the eyes, width at shoulders, hump length and tail length that were not significant ($P > 0.05$) Table 3. At 10-12 years, body length, posterior limb length and body weight were significant ($P < 0.05$) due to sex effect Table 4. At 13-15 years, there was no significant ($P > 0.05$) in both body linear measurement and body weight Table 5.

Table 1. Mean values of body weight and body linear measurements of camels at 1-3 years by sex in Katsina state

Parameters	Mean ± SEM		P-value
Sex	Camel bull	Camel cow	
N	9	17	
BLM			
FL (cm)	42.44 ± 0.78[a]	41.88 ± 0.53[a]	0.55
DE (cm)	23.67 ± 0.94[a]	23.00 ± 0.49[a]	0.49
EL (cm)	10.89 ± 0.59[a]	11.06 ± 0.25[a]	0.76
NL (cm)	97.56 ± 1.25[a]	97.71 ± 1.06[a]	0.93
WS (cm)	29.56 ± 1.73[a]	29.82 ± 0.89[a]	0.88
HW (cm)	165.1 ± 3.20[a]	163.3 ± 2.30[a]	0.65
ALL (cm)	139.6 ± 1.67[a]	135.8 ± 1.81[a]	0.19
TG (cm)	169.0 ± 0.99[a]	165.3 ± 1.10[b]	0.01
HH (cm)	181.6 ± 1.88[a]	179.4 ± 1.77[a]	0.45
Hl (cm)	32.56 ± 1.23[a]	32.94 ± 1.27[a]	0.85
Hc (cm)	89.33 ± 3.33[a]	86.41 ± 2.56[a]	0.50
Hh (cm)	17.22 ± 1.75[a]	15.12 ± 0.73[a]	0.20
BL (cm)	140.4 ± 3.14[a]	135.9 ± 2.07[b]	0.02
AC (cm)	141.1 ± 2.34[a]	140.1 ± 1.12[a]	0.67
PLL (cm)	153.4 ± 2.32[a]	151.2 ± 2.03[a]	0.50
FPC (cm)	47.78 ± 0.83[a]	49.65 ± 0.76[a]	0.92
TL (cm)	45.89 ± 0.94[a]	47.29 ± 0.58[a]	0.19
BW (kg)	403.1 ± 7.41[a]	390.7 ± 7.97[b]	0.03

"Means with different superscript are significantly different ($P < 0.05$), means with the same superscript are not significantly different ($P > 0.05$)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, Hl=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weigh

Table 2. Mean values of body weight and body linear measurements of camels at 4-6 years by sex in Katsina state

Parameters	Mean ± SEM		P-value
Sex	Camel bull	Camel cow	
N	18	37	
BLM			
FL (cm)	46.78 ± 0.69[a]	44.30 ± 0.53[b]	0.01
DE (cm)	26.50 ± 0.45[a]	24.35 ± 0.35[b]	0.00
EL (cm)	11.28 ± 0.34[a]	11.14 ± 0.17[a]	0.69
NL (cm)	106.94 ± 1.14[a]	102.8 ± 0.72[b]	0.04
WS (cm)	37.00 ± 0.76[a]	33.84 ± 0.56[b]	0.00

Parameters	Mean ± SEM		P-value
Sex	Camel bull	Camel cow	
N	18	37	
HW (cm)	175.3± 1.54[a]	168.3 ± 2.53[b]	0.02
ALL(cm)	147.9 ± 1.33[a]	143.4 ± 1.51[b]	0.05
TG (cm)	188.4 ± 2.68[a]	181.7 ± 1.63[b]	0.03
HH (cm)	194.8 ± 1.79[a]	186.9 ± 1.65[b]	0.01
Hl (cm)	42.78 ± 1.63[a]	38.12 ± 1.22[b]	0.03
Hc (cm)	105.0 ± 2.95[a]	95.19 ± 2.29[b]	0.01
Hh (cm)	19.83 ± 1.45[a]	16.70 ± 0.79[b]	0.03
BL (cm)	151.8 ± 1.52[a]	147.4 ± 1.38[b]	0.04
AC (cm)	161.4 ± 2.49[b]	181.2 ± 27.2[a]	0.01
PLL (cm)	161.7 ± 1.41[a]	156.1 ± 1.56[b]	0.03
FPC (cm)	55.11 ± 0.91[a]	52.12 ± 0.79[a]	0.13
TL (cm)	49.72 ± 1.11[a]	48.14 ± 0.81[a]	0.26
BW (kg)	555.3 ± 21.6[a]	501.5 ± 12.9[b]	0.03

"Means with different superscript are significantly different (P < 0.05), means with the same superscript are not significantly different (P > 0.05)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, Hl=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weight

Table 3. Mean values of body weight and body linear measurements of camels at 7-9 years by sex in Katsina state

Parameters	Mean ± SEM		P-value
Sex	Camel bull	Camel cow	
N	21	33	
BLM			
FL (cm)	49.38 ± 0.39[a]	46.82 ± 0.38[b]	0.03
DE (cm)	29.24 ± 0.53[a]	28.61 ± 0.29[a]	0.26
EL (cm)	12.28 ± 0.26[a]	11.73 ± 0.17[b]	0.03
NL (cm)	110.5 ± 0.86[a]	108.5 ± 0.48[b]	0.01
WS (cm)	41.24 ± 0.65[a]	40.00 ± 0.42[a]	0.75
HW (cm)	182.9 ± 1.65[a]	180.3 ± 1.33[b]	0.02
ALL(cm)	154.0 ± 1.36[a]	148.7 ± 4.25[b]	0.03
TG (cm)	209.1 ± 1.62[a]	205.3 ± 1.02[b]	0.04
HH (cm)	205.8 ± 1.83[a]	199.4 ± 1.63[b]	0.05
Hl (cm)	46.38 ± 2.14[a]	44.24 ± 1.50[a]	0.40
Hc (cm)	113.6 ± 3.85[a]	109.8 ± 2.67[b]	0.01
Hh (cm)	22.67 ± 1.34[a]	19.58 ± 0.97[b]	0.02
BL (cm)	160.6 ± 2.22[a]	158.1 ± 1.42[b]	0.05
AC (cm)	178.1 ± 1.61[a]	173.7 ± 1.07[b]	0.02
PLL (cm)	170.9 ± 1.52[a]	167.7 ± 0.97[b]	0.05
FPC (cm)	59.71 ± 0.69[a]	56.21 ± 0.63[b]	0.03
TL (cm)	54.05 ± 1.24[a]	53.76 ± 0.91[a]	0.85
BW (kg)	715.2 ± 15.3[a]	697.5 ± 9.56[b]	0.03

"Means with different superscript are significantly different (P < 0.05), means with the same superscript are not significantly different (P > 0.05)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, Hl=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weight

Table 4. Mean values of body weight and body linear measurements of camels at 10-12 years by sex in Katsina state

Parameters	Mean ± SEM		P-value
Sex	Camel bull	Camel cow	
N	4	20	
BLM			
FL (cm)	51.50 ± 1.50[a]	50.80 ± 0.45[a]	0.56
DE (cm)	32.00 ± 1.15[a]	30.60 ± 0.26[a]	0.07
EL (cm)	13.00 ± 0.58[a]	12.80 ± 0.25[a]	0.74
NL (cm)	114.5 ± 0.29[a]	112.2 ± 0.52[a]	0.06
WS (cm)	43.75 ± 0.95[a]	43.65 ± 0.23[a]	0.88
HW (cm)	185.8 ± 4.01[a]	184.3 ± 1.64[a]	0.73
ALL(cm)	155.5 ± 2.06[a]	154.2 ± 1.50[a]	0.72
TG (cm)	215.8 ± 2.17[a]	210.2 ± 1.03[a]	0.07
HH (cm)	207.8 ± 3.82[a]	204.2 ± 1.39[a]	0.38
HI (cm)	50.75 ± 4.80[a]	47.90 ± 1.34[a]	0.44
Hc (cm)	119.5 ± 6.33[a]	113.9 ± 2.99[a]	0.06
Hh (cm)	22.50 ± 1.65[a]	21.30 ± 1.08[a]	0.64
BL (cm)	168.5 ± 4.79[a]	159.8 ± 2.01[b]	0.01
AC (cm)	185.5 ± 2.25[a]	180.3 ± 1.18[a]	0.07
PLL (cm)	169.8 ± 2.06[a]	164.0 ± 1.56[b]	0.02
FPC (cm)	62.00 ± 1.35[a]	61.65 ± 0.49[a]	0.78
TL (cm)	55.50 ± 3.57[a]	55.80 ± 0.86[a]	0.90
BW (kg)	762.8 ± 21.9[a]	754.8 ± 9.96[b]	0.04

"Means with different superscript are significantly different ($P < 0.05$), means with the same superscript are not significantly different ($P > 0.05$)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, HI=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weight

3.2 Effect of Age on Body Weights and Body Linear Measurements of Camels

Age grouping had significance ($P < 0.05$) across all body linear measurements and body weights for both camel bull and camel cow Tables 6 and 7.

4. DISCUSSION

4.1 Effect of Sex on Body Weights of Camels

The findings of this study revealed the variation due to sex on body weight of camels at 1-3, 4-6, 7-9, 10-12 years, this concur with the findings of Berhanu, [14] who reported higher body weights of camel bulls over camel cows in Yabello and Melka Soda districts. Mehari et al. [15], also reported similar trend from Somali region, Ethiopia who stated that camel bulls were quite heavier than camel cows. On the other hand,

camel bulls and cows at 13-15 years showed no variation in body weights. Average body weights of camel bulls and camel cows at 4-6, 7-9, 10-12 and 13-15 years were higher than the values reported by Berhanu [14] in Melka soda and Yabello district of Ethiopia (Yohannes et al. [11]; Yosef et al. [16]).

4.2 Effect of Sex on Body Linear Measurements of Camels

At 1-3 years, sex had effect on thoracic girth and body length where camel bulls had higher values than camel cows; at 4-6 years, sex had effect on all body linear measurements except ear length, abdomen circumference, foot pad circumference and tail length. Camel bulls at 7-9 years had higher body linear traits than camel cows except distance between the eyes, width at shoulders; hump length and tail length with both sexes having similar mean valves; at 10-12 years camel bulls had higher mean

values for body lenght and posterior limb length whereas all other body linear measurements were similar. This finding corroborates with Berhanu, [14] who reported significant difference of mean values in 13 out of 18 body linear measurements, between camel bull and camel cows. The present study also agrees with Abdallah and Bernard, [17] who reported that on the average, measurements were higher in camel bull for all the parameters compared to camel cows in their study on Arabian camel.

Table 5. Mean values of body weight and body linear measurements of camels at 13-15 years by sex in Katsina state

Parameters	Mean ± SEM		P-value
Sex	Camel bull	Camel cow	
N	2	3	
BLM			
FL (cm)	51.50 ± 0.50[a]	51.33 ± 1.20[a]	0.92
DE (cm)	33.00 ± 0.00[a]	30.67 ± 0.88[a]	0.13
EL (cm)	13.50 ± 0.50[a]	12.33 ± 0.33[a]	0.13
NL (cm)	116.0 ± 1.00[a]	112.7 ± 1.33[a]	0.17
WS (cm)	44.50 ± 0.50[a]	43.33 ± 0.88[a]	0.40
HW (cm)	189.0 ± 1.00[a]	187.0 ± 0.58[a]	0.15
ALL(cm)	163.0 ± 1.00[a]	152.7 ± 5.33[a]	0.23
TG (cm)	209.5 ± 3.50[a]	208.0 ± 1.53[a]	0.67
HH (cm)	214.5 ± 2.50[a]	210.3 ± 2.67[a]	0.36
HI (cm)	53.50 ± 6.50[a]	55.33 ± 5.84[a]	0.85
Hc (cm)	120.5 ± 12.5[a]	124.0 ± 8.98[a]	0.82
Hh (cm)	25.00 ± 7.00[a]	24.00 ± 2.00[a]	0.87
BL (cm)	170.0 ± 3.00[a]	166.3 ± 0.88[a]	0.24
AC (cm)	180.5 ± 3.50[a]	178.0 ± 3.21[a]	0.64
PLL (cm)	173.5 ± 2.50[a]	164.0 ± 5.51[a]	0.28
FPC (cm)	65.00 ± 0.00[a]	62.33 ± 1.20[a]	0.18
TL (cm)	58.50 ± 1.50[a]	56.67 ± 2.60[a]	0.64
BW (kg)	737.5 ± 34.5[a]	722.3 ± 15.1[a]	0.67

"Means with different superscript are significantly different (P < 0.05), means with the same superscript are not significantly different (P > 0.05)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, Hl=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weight

Table 6. Mean values of body weight and body linear measurements of camel bull in Katsina state

Parameters	Mean ± SEM					P-value
	1-3 years	4-6 years	7-9 years	10-12 years	13-15 years	
N	9	18	21	4	2	
BLM						
FL (cm)	42.44±0.78[a]	46.78±0.69[b]	49.38±0.39[c]	51.50±1.50[d]	51.50±0.50[e]	0.00
DE (cm)	23.67±0.94[a]	26.50±0.45[b]	29.23±0.52[c]	32.00±1.16[d]	33.00±0.00[e]	0.00
EL (cm)	10.89±0.59[a]	11.29±0.34[b]	12.38±0.26[c]	13.00±0.58[d]	13.50±0.50[e]	0.01
NL (cm)	97.56±1.25[c]	109.4±4.58[b]	109.5±0.86[b]	114.5±0.29[a]	116.0±1.00[a]	0.05
WS (cm)	29.56±1.73[a]	37.00±0.76[b]	41.42±0.65[c]	43.75±0.95[d]	44.50±0.50[e]	0.00
HW (cm)	165.1±3.20[a]	175.5±1.54[b]	182.9±1.64[c]	185.8±1.01[d]	189.0±1.00[e]	0.00
ALL(cm)	139.6±1.67[a]	147.9±1.33[b]	154.0±1.36[c]	155.5±2.06[d]	163.0±1.00[e]	0.00
TG (cm)	169.0±0.99[a]	188.4±2.68[b]	207.1±1.62[c]	211.8±2.17[d]	209.5±3.50[e]	0.00
HH (cm)	181.6±1.87[a]	194.8±1.78[b]	203.8±1.83[c]	207.8±3.82[d]	214.5±2.50[e]	0.00
HI (cm)	32.56±1.23[a]	40.78±1.63[b]	46.38±2.14[c]	50.75±4.80[d]	53.50±6.50[e]	0.00
Hc (cm)	89.33±3.34[a]	105.0±2.95[b]	111.6±3.85[c]	119.5±6.33[d]	120.5±12.5[e]	0.00

Parameters	Mean ± SEM					P-value
	1-3 years	4-6 years	7-9 years	10-12 years	13-15 years	
N	9	18	21	4	2	
Hh (cm)	17.22±1.75[d]	19.83±1.15[c]	21.67±1.34[b]	21.50±1.66[b]	25.00±7.00[a]	0.02
BL (cm)	140.4±3.14[a]	150.8±1.52[b]	159.6±2.22[c]	167.5±4.78[d]	170.0±3.00[e]	0.00
AC (cm)	141.1±2.34[a]	161.4±2.45[b]	178.1±1.61[c]	184.5±2.25[d]	180.5±3.50[e]	0.00
PLL (cm)	153.4±2.32[a]	161.7±1.41[b]	168.9±2.06[c]	168.8±2.06[d]	173.5±2.50[e]	0.00
FPC (cm)	49.78±0.23[a]	55.11±0.91[b]	59.71±0.69[c]	62.00±1.35[d]	65.00±0.00[e]	0.00
TL (cm)	45.89±0.93[a]	40.72±1.11[b]	54.05±1.24[c]	55.50±3.57[d]	58.50±1.50[e]	0.00
BW (kg)	403.1±7.41[a]	555.3±21.6[b]	715.2±15.3[c]	759.8±21.9[d]	737.5±34.5[e]	0.00

"Means with different superscript are significantly different (P < 0.05), means with the same superscript are not significantly different (P > 0.05)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, HI=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weight

Table 7. Mean values of body weight and body linear measurements of camel cow in Katsina state

Parameters	Mean ± SEM					P-value
	1-3 years	4-6 years	7-9 years	10-12 years	13-15 years	
N	12	37	33	20	3	
BLM						
FL(cm)	41.58±0.68[a]	44.30±0.53[b]	48.82±0.38[c]	50.80±0.45[d]	51.33±1.20[e]	0.00
DE(cm)	23.00±0.64[a]	24.35±0.35[b]	28.61±0.29[c]	30.60±0.26[d]	30.67±0.88[e]	0.00
EL(cm)	10.92±0.29[a]	11.14±0.19[b]	11.13±0.17[c]	12.80±0.25[d]	12.33±0.33[e]	0.00
NL(cm)	98.25±1.43[a]	103.8±0.72[b]	110.5±0.47[c]	112.2±0.52[d]	112.7±1.33[e]	0.00
WS(cm)	30.17±1.19[a]	33.84±0.56[b]	41.00±0.42[c]	43.65±0.23[d]	43.33±0.88[e]	0.00
HW(cm)	164.1±2.51[a]	168.3±2.53[b]	180.6±1.33[c]	184.3±1.64[d]	187.0±0.58[e]	0.00
ALL(cm)	136.7±2.20[a]	143.4±1.51[b]	148.7±4.25[c]	154.2±1.50[d]	152.7±5.33[e]	0.02
TG(cm)	167.5±1.25[a]	181.7±1.63[b]	205.3±1.02[c]	211.2±1.03[d]	208.0±1.53[e]	0.00
HH(cm)	179.9±1.96[a]	186.9±1.65[b]	199.4±1.63[c]	204.7±1.39[d]	210.3±2.67[e]	0.00
HI(cm)	33.58±1.46[a]	38.12±1.21[b]	44.24±1.49[c]	47.90±1.34[d]	55.33±5.84[e]	0.00
Hc(cm)	87.17±3.12[a]	95.19±2.29[b]	109.8±2.67[c]	115.8±2.99[d]	124.0±8.96[e]	0.00
Hh(cm)	15.17±0.83[a]	16.70±0.70[b]	19.58±0.97[c]	21.30±1.08[d]	24.00±2.00[e]	0.00
BL(cm)	138.6±2.77[a]	147.4±1.38[b]	159.1±1.42[c]	159.8±2.01[d]	166.3±0.88[e]	0.00
AC(cm)	140.2±1.36[d]	181.2±27.2[a]	175.7±1.07[c]	181.3±1.18[a]	178.0±3.21[b]	0.05
PLL(cm)	151.6±2.32[a]	156.1±1.56[b]	167.7±0.97[c]	167.0±1.56[d]	164.0±5.51[e]	0.00
FPC(cm)	49.83±0.93[a]	53.11±0.79[b]	58.21±0.63[c]	61.65±0.49[d]	62.33±1.20[e]	0.00
TL(cm)	47.25±0.69[a]	48.14±0.81[b]	53.76±0.91[c]	55.80±0.86[d]	56.67±2.60[e]	0.00
BW(kg)	392.1±9.32[a]	501.1±12.9[b]	698.5±9.56[c]	754.8±9.96[d]	722.3±15.1[e]	0.00

"Means with different superscript are significantly different (P < 0.05), means with the same superscript are not significantly different (P > 0.05)"; BLM = Body linear measurement, FL=Face length, DE=Distance between the eyes, EL=Ear length, NL=Neck length, WS=Width at shoulders, HW=Height at withers, ALL=Anterior limb length, TG=Thoracic girth, HH=Height at hump, HI=Hump length, Hc=Hump circumference, Hh=Hump height, BL=Body length, AC=Abdomen, circumference, PLL=Posterior limb length, FPC=Foot pad circumference, TL=Tail length and BW=Body Weight

4.3 Effect of Age on Body Weights of Camels

Age varied with body weight of camels across all age grouping in both camel bulls and camel cows, as camels advance in age: 1-3, 4-6, 7-9 and 10-12 years, there was a corresponding increase in body weights and variation in some phenotypic traits; however, at 13-15 years there was a declined in body weights in both sexes of camel. Camel bulls had higher mean values of body weight than camel cows across all ages.

4.4 Effect of Age on Body Linear Measurements of Camels

All body linear measurements varied significantly across all age groups in both camel bull and

camel cow. However, at 4-6 and 7-9 years camel bulls neck length are similar, 7-9 and 10-12 years hump height were also similar; in camel cow at 7-9 and 10-12 years, abdomen circumference were similar. This finding agrees with the findings of Berhanu, [14] who reported the existence of significance in all body linear measurements and body weights affected by age group (< 5 years as younger camels and > 5 years as older camels); Ishag et al. [18] who worked on Sudanese camel with age groupings 4-6, 7-9, 10-12, and ≥ 13 years.

At 1-3 and 4-6 years, effect of age group had lower mean values for body linear measurement and body weight, 7-9 and 10-12 years demonstrated higher mean values for body linear measurements and body weights, there was a decline at in body weight at 13-15 years. Therefore between 7-9 and 10-12 years is the peak of growth. The result is slightly above the finding of Ishag et al. [18] who reported that age group 7 to 9 years had significantly higher mean values on body linear measurements and body weights, followed by those of the age group 10 to 12 years, than those of the age group >13 years. They concluded that the camels reach growth peak within 7 to 9 years; after which the different measurements decline.

5. CONCLUSION

The higher values in body weights and body linear measurements exhibited by camel bulls over camel cows across all age groups show the existence of sexual dimorphism in camels which may be attributed to physiological induces (hormonal secretion) activities in the different sexes as suggested by the aforementioned authors.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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