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# Variations in Morphometric Traits of Local Chicken in Gomoa West District, Southern Ghana

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**ABSTRACT**

The study was undertaken to identify the variations among morphometric traits of local chicken in the Gomoa West district of Ghana. Thirteen body measurements namely Weight (WT), Body Length (BDL), Chest Circumference (CC), Thigh Circumference (TC), Shank Length (SL), Neck Length (NL), Wing Length (WGL), Head Length (HDL), Hip Length (HL), Wattle Length (WAL), Beak Length (BKL), Drumstick Length (DL) and Comb Length (CL) were taken on 500 birds and analyzed under general linear model to determine the fixed effects of sex, comb type, feather distribution and skin colour on variabilities in the traits. The male birds had significantly ($P<0.001$) larger heads (NL=9.11 cm, HDL=6.59 cm, CL=5.23 cm etc.) and bodies (WT=1.19 kg, BDL=24.64 cm, CC=14.32 cm etc.) than their female counterparts. Cushion comb-type chickens were significantly ($P<0.001$) superior to all other comb-type chickens in all head and body measurements. Feather distribution had significant ($P<0.05$) influence on WT and BDL, as naked neck birds appeared superior. Birds with grey skin colour had significantly ($P<0.001$) larger chest circumference than all other birds. These findings could be useful as selection criterion, thereby providing a basis for genetic manipulation and improvements of the local chicken in Ghana.

**Key words**: Comb type, Measurement, Naked neck, Poultry, Skin colour

## INTRODUCTION

The domestic local chicken (*Gallus gallus domesticus*) is the populous genetic resources among poultry that can be found in virtually every community in Ghana. These local breeds of domestic chicken are kept mainly by smallholder farmers under traditional management practices, and have adapted to a wide range of ecological settings. They are characterized by nondescript and hyper-variable phenotypic landscape (Dana et al., 2010; Egahi et al., 2010; Melesse and Negesse, 2011). Local chicken show striking morphological variations in plumage colour and pattern, comb shape, ear lobe colour, shank colour, etc. Other characteristics such as naked neck, frizzled feathers, single, pea, rose and cushion combs are common within the flock of local chicken (Hassabellah et al., 2014; Negesa et al., 2014 and Liyanage et al., 2015). It has been verified that single comb (the wild type) is recessive to all comb types, except the comb-less variant whiles the causative genetic variants for some morphological traits were mapped to their respective genomic region (Wragg et al., 2012). Smallholder farmers usually have broad breeding objectives to fulfill their versatile needs (Moges et al., 2010), hence they keep flock of diverse phenotypes. However, there is some sort of selection on visual traits by smallholder farmers who keep chickens not only for eggs and meat production but also to satisfy their visual appeal and to meet their cultural and religious needs (Dana et al., 2010; Melesse and Negesse, 2011).

The future improvement and sustainability of local chicken production systems is dependent on the availability of genetic variation (Benitez, 2002), which can be ascertained through characterization studies. Since morphological traits constitute major components of phenotypes in animal genetic resources, knowing the variations of morphological traits is fundamental to characterization of local genetic resources. Morphometric measurements have been found useful in contrasting size and shape of animals (Latshaw and Bishop, 2001; Ajayi et al., 2008). Phenotypic characteristics are very important in describing the uniqueness of animal genetic resources, and providing data for conservation of poultry genetic resources. However, not much is known about the morphometric description of the local chicken in Gomoa West district in Ghana. Hence this study was undertaken with the aim of describing variabilities in the body dimensions and size of local chicken in the district.

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## MATERIALS AND METHODS

### Study area

This study was carried out in the Gomoa West district of Central Region of Ghana. The district lies within latitudes $5^0$ $14^1$N and $5^0$ $35^1$N and longitudes $0^0$ $22^1$ W and $0^0$ $54^1$W (Getamap.net, 2016). The area experiences two rainfall patterns thus major rainy season (April to July) and minor rainy season (September to November) with mean annual rainfall ranging between 700 and 900 mm in the southern coastal belt and 900 to 1100 mm in the northern and northwestern semi-deciduous forest areas. The mean annual temperature ranges between $26^0$C and $29^0$C.

### Ethical approval

Not applicable. This research did not involve the introduction of any intervention in/on birds, or direct collection of cells, tissues or any material from birds.

### Sources of study birds and data collection

Within the period of July to August 2014, simple random sampling was used to select 10 communities within the district, and six farmers each from each district. A total of 500 (370 females and 130 males) local chickens aged four months or above were selected from the flock of smallholder farmers for measurements. Ages of birds were obtained from farmers' records or estimates (where records were unavailable) (Figure 1).The comb type (cushion, pea, rose and single) (Figure 2), skin colour (brown, grey, red, violet, white and yellow) and feather distribution (frizzled, naked neck and normal) (Figure 3) of each bird were noted. The following morphometric traits were measured on each bird. Weight (WT): The overall mass of a live bird measured with a kitchen scale; Body Length (BDL): The distance between the tip of the rostrum maxillare (beak) and the tip of the caudal (tail, without feathers) end; Chest Circumference (CC): The distance around the chest, taken behind the wings, through the anterior border of breast-bone crest and the central thoracic vertebra; Thigh Circumference (TC): It is the distance around the widest point of the thigh; Shank Length (SL): The distance along the metatarsus, measured from the shank joint to the extremity of the digituspedis; Neck Length (NL): The distance between the occipital condyle and the cephalic borders of the coracoids; Wing Length (WGL): It is the distance measured from the shoulder joint to the extremity of the terminal phalanx; Head Length (HDL): It is the distance measured between the occipital bone to the point of insertion of the beak to the skull; Hip Length (HL): This measurement was taken as the distance from the right to the left pelvic bone; Wattle Length (WAL): Vertical distance from the beginning to the end of the wattle; Beak Length (BKL): The distance from the rectal apterium to the maxillary nail; Drumstick Length (DL): The distance from the hip joint to the attachment of the shank; Comb Length (CL): It is the distance from the base to the tip end of the comb. Body weight was measured in kg while all linear traits were measured in cm.

### Data analysis

The Statistical Package for Social Science (SPSS, version 17) was used to analyze the data. The multivariate command under general linear model was used to analyze the fixed effects of sex, age, comb type, skin colour and feather distribution on the quantitative traits and mean differences separated using LSD pair-wise comparison under the post hoc multiple comparisons at 5% level of significance.

## RESULTS

### Morphometric traits of the head of local chicken

The results clearly indicate a highly significant ($P<0.001$) difference on all traits of the head across sex (Table 1). Males were generally superior to females in all measurements. For wattles in particular, males had much longer wattles than their female counterparts. Age had significant ($P<0.001$) influence on all the head measurements and as expected, the sizes of the traits increased with increasing age (Table 1). Birds aged 25 months or more had the longest neck, head, wattle, comb and beak while birds within ages of 4 to 12 months had similar comb and beak lengths (Figure 1).

All the measurements on the head were significantly ($P<0.05$) affected by comb type (Table 2). Birds with cushion combs were generally superior in all measurements even though their neck length, head length, comb length and beak length were similar to those of birds with rose type combs. Skin colour had no significant ($P>0.05$) effect on all traits except for head length ($P<0.001$). In numerical values, local chickens with red skin colour had the longest neck whiles those with white skin colour had the longest head, comb and wattle (Table 2).

### Morphometric traits of the general body of local chicken

There were highly significant ($P<0.001$) variations on all traits of the general body across sex (Table 3). The males were notably superior, recording the highest weight, longest body, drumstick, wing, shank and biggest chest, thigh and hip as compared to the females. Age was also a highly significant ($P<0.001$) source of variation on all traits of the general body (Table 3). Expectedly, local fowls with the ages ranging from 25 or more months had the highest weight and all body measurements. Clearly, feather distribution had no significant ($P>0.05$) effect on all traits of the body except for weight, body length and thigh circumference (Table 4). Naked neck chickens though appearing superior, had similar weight with frizzled feathered and similar body length with normal feathered chicken. The comb type had significant ($P<0.01$) effects on all traits on the body of local chickens (Table 4). Birds with cushion type combs were particularly superior to all other birds in all the body traits measured. Body measurements were generally similar among all other comb types. Skin colour had significant effect on only chest circumference and hip width. Chicken having grey skin were significantly ($P<0.001$) larger at the chest and had significantly ($P=0.001$) longer hips

**Table 1.** Effects of sex and age on quantitative traits (Means ± SE) of the head of local chicken in Gomoa West district, Ghana

| Variable | Trait | | | | |
|---|---|---|---|---|---|
| **Sex** | **NL** | **HDL** | **CL** | **WAL** | **BKL** |
| Female | 8.37±0.05[b] | 5.90±0.05[b] | 2.52±0.07[b] | 0.84±0.06[b] | 3.00±0.02[b] |
| Male | 9.11±0.10[a] | 6.59±0.08[a] | 5.23±0.13[a] | 2.71±0.10[a] | 3.23±0.03[a] |
| P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| **Age (months)** | | | | | |
| 4 – 6 (n=72) | 8.03±0.10[e] | 5.71±0.09[c] | 2.33±0.17[b] | 0.55±0.13[e] | 3.00±0.03[d] |
| 7 – 12 (n=277) | 8.53±0.05[d] | 5.97±0.04[b] | 2.98±0.09[b] | 1.24±0.07[d] | 3.02±0.02[d] |
| 13 – 18 (n=107) | 8.76±0.08[c] | 6.08±0.07[b] | 3.65±0.14[a] | 1.80±0.11[c] | 3.11±0.02[c] |
| 19 – 24 (n=42) | 9.12±0.13[b] | 6.60±0.11[a] | 4.62±0.22[a] | 2.34±0.17[b] | 3.24±0.04[b] |
| 25 – 30 (n=2) | 12.50±0.59[a] | 7.50±0.51[a] | 5.00±1.02[a] | 5.50±0.78[a] | 4.00±0.17[a] |
| P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

[a,b,c,d,e] Means with different superscript in a column are significantly different by sex and age; SE: Standard Error; NL: Neck Length; HDL: Head Length; CL: Comb Length; WAL: Wattle Length; BKL: Beak Length; n: number of birds

**Table 2.** Effects of comb type and skin colour on quantitative traits (Means ± SE) of the head of local chicken in Gomoa West district, Ghana

| Traits | Comb types | | | | | Skin colour | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Cushion** | **Pea** | **Rose** | **Single** | **P-values** | **Brown** | **Grey** | **Red** | **Violet** | **White** | **Yellow** | **P-values** |
| NL | 9.58±0.25[ab] | 8.55±0.28[b] | 8.63±0.48[ab] | 8.41±0.12[b] | 0.007 | 8.20±0.45 | 8.50±0.61 | 9.35±0.22 | 8.74±0.18 | 8.00±0,86 | 8.62±0.23 | 0.217 |
| HDL | 6.89±0.20[a] | 6.04±0.23[bc] | 5.63±0.39[c] | 6.13±0.10[b] | 0.006 | 7.60±0.37[a] | 7.00±0.49[ab] | 6.09±0.17[bc] | 6.27±0.14[a] | 8.00±0.70[a] | 5.81±0.19[c] | <0.001 |
| CL | 4.18±0.43[a] | 2.20±0.50[c] | 4.00±0.85[a] | 3.17±0.22[b] | 0.018 | 3.00±0.80 | 5.00±1.07 | 3.28±0.38 | 3.23±0.31 | 5.00±1.52 | 3.08±0.40 | 0.637 |
| WAL | 4.23±0.29[a] | 0.67±0.33[c] | 1.63±0.57[b] | 1.25±0.15[bc] | <0.001 | 1.23±0.53 | 2.00±0.72 | 2.63±0.25 | 1.91±0.21 | 4.00±1.02 | 1.46±0.27 | 0.896 |
| BKL | 3.40±0.07[a] | 3.00±0.08[b] | 3.13±0.13[ab] | 3.06±0.03[b] | <0.001 | 2.98±0.13 | 3.50±0.17 | 3.31±0.06 | 3.07±0.05 | 3.00±0.24 | 3.11±0.06 | 0.163 |

[a,b,c] Means with different superscript in a row are significantly different by comb types and skin colour; SE: Standard Error; NL: Neck Length; HDL: Head Length; CL: Comb Length; WAL: Wattle Length; BKL: Beak Length

**Table 3.** Effects of sex and age on quantitative traits (Means ± SE) of the general body of local chicken in Gomoa West district of Ghana

| Traits | Sex | | | Age (months) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Female | Male | P-values | 4-6 | 7-12 | 13-18 | 19-24 | 25-30 | P-value |
| WT | 0.94±0.01[b] | 1.19±0.02[a] | <0.001 | 0.69±0.03[e] | 0.95±0.02[d] | 1.08±0.02[c] | 1.30±0.03[b] | 2.10±0.11[a] | <0.001 |
| BDL | 22.31±0.13[b] | 24.64±0.23[a] | <0.001 | 21.17±0.29[e] | 23.07±0.16[d] | 23.69±0.22[c] | 24.88±0.31[b] | 29.00±1.11[a] | <0.001 |
| CC | 13.27±0.11[b] | 14.32±0.19[a] | <0.001 | 12.32±0.25[e] | 13.67±0.14[d] | 13.76±0.19[c] | 14.52±0.26[b] | 18.00±0.94[a] | <0.001 |
| DL | 12.23±0.07[b] | 13.75±0.12[a] | <0.001 | 12.49±0.15[d] | 12.75±0.08[d] | 12.82±0.11[c] | 13.48±0.16[b] | 15.50±0.57[a] | <0.001 |
| WGL | 17.30±0.09[b] | 19.46±0.16[a] | <0.001 | 17.47±0.20[d] | 18.05±0.11[d] | 18.18±0.15[c] | 19.051±0.21[b] | 22.50±0.78[a] | <0.001 |
| TC | 7.28±0.06[b] | 8.02±0.11[a] | <0.001 | 6.72±0.14[e] | 7.41±0.08[d] | 7.81±0.11[c] | 8.15±0.15[b] | 10.00±0.55[a] | <0.001 |
| SL | 8.55±0.07[b] | 10.04±0.13[a] | <0.001 | 8.57±0.17[e] | 9.18±0.09[d] | 9.32±0.12[c] | 9.75±0.17[b] | 11.50±0.63[a] | <0.001 |
| HL | 9.29±0.06[b] | 10.25±0.10[a] | <0.001 | 8.98±0.13[e] | 9.51±0.07[d] | 9.66±0.10[c] | 10.25±0.13[b] | 13.00±0.49[a] | <0.001 |

[a, b c, d, e] Means with different superscript in a row are significantly different by sex and age; WT: Weight; BDL: Body length; CC: Chest Circumference; DL: Drumstick Length; WGL: Wing Length; TC: Thigh Circumference; SL: Shank Length; HL: Hip length

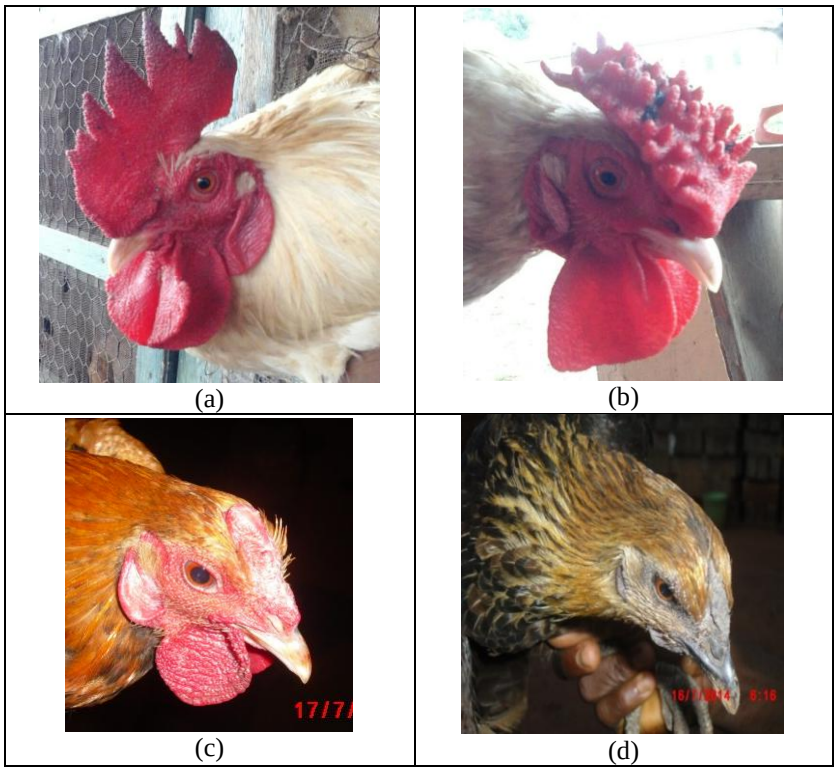
**Table 4.** Effects of feather distribution and comb type on quantitative traits (Means ± SE) of the general body of local chicken in Gomoa West district of Ghana

| Variable | Traits | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Feather distribution** | **WT** | **BDL** | **CC** | **DL** | **WGL** | **TC** | **SL** | **HL** |
| Frizzled | 0.97±0.05[ab] | 21.79±0.43[b] | 13.63±0.31 | 12.08±0.21 | 17.25±0.30 | 7.42±0.19[ab] | 8.50±0.23 | 9.33±0.17 |
| Naked neck | 1.10±0.0 [a] | 23.55±0.65[a] | 14.09±0.45 | 12.91±0.31 | 18.36±0.44 | 7.91±0.28[a] | 9.36±0.34 | 9.64±0.25 |
| Normal | 0.92±0.07 [b] | 23.02±0.10[a] | 13.37±0.07 | 12.36±0.05 | 17.44±0.07 | 7.26±0.04[b] | 8.84±0.05 | 9.34±0.04 |
| P-values | 0.035 | 0.013 | 0.222 | 0.094 | 0.097 | 0.054 | 0.106 | 0.501 |
| **Comb type** | | | | | | | | |
| Cushion | 1.34±0.06 [a] | 26.13±0.55 [a] | 14.79±0.40 [a] | 13.62±0.28 [a] | 19.44±0.39 [a] | 8.83±0.24 [a] | 10.56±0.30[a] | 10.16±0.22[a] |
| Pea | 0.89±0.07 [b] | 22.30±0.64 [b] | 13.77±0.46 [b] | 11.98±0.32 [b] | 17.20±0.45 [b] | 6.86±0.28 [b] | 8.91±0.35 [b] | 8.95±0.26 [b] |
| Rose | 1.08±0.12 [b] | 23.25±1.09 [b] | 13.38±0.79[b] | 12.25±0.54 [b] | 17.75±0.77 [b] | 7.75±0.48 [b] | 8.88±0.60[b] | 9.63±0.44 [b] |
| Single | 0.94±0.03 [b] | 22.49±0.28 [b] | 13.93±0.20 [b] | 12.07±0.14 [b] | 17.09±0.20 [b] | 7.26±0.12 [b] | 8.64±0.15 [b] | 9.26±0.11 [b] |
| P-values | <0.001 | <0.001 | 0.008 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| **Skin colour** | | | | | | | | |
| Brown | 1.06±0.12 | 23.15±1.02 | 15.50±0.74 [b] | 11.50±0.51 | 16.25±0.72 | 6.70±0.45 | 8.70±0.56 | 8.40±0.41[c] |
| Grey | 1.20±0.16 | 26.00±1.37 | 19.00±1.00[a] | 12.00±0.69 | 16.50±0.97 | 7.50±0.60 | 9.50±0.76 | 10.50±0.56[a] |
| Red | 1.11±0.06 | 23.80±0.49 | 14.09±0.35[c] | 12.79±0.24 | 18.25±0.34 | 7.87±0.21 | 9.50±0.27 | 9.57±0.20 [a] |
| Violet | 0.96±0.05 | 23.55±0.39 | 13.51±0.29[c] | 12.35±0.20 | 17.61±0.28 | 7.46±0.17 | 9.25±0.22 | 9.40±0.16 [a] |
| White | 1.30±0.22 | 27.00±1.94 | 15.00±1.41[bc] | 13.00±0.97 | 19.00±1.37 | 9.00±0.85 | 11.00±1.07 | 9.00±0.79 [a] |
| Yellow | 1.07±0.06 | 22.55±0.52 | 13.73±0.37[c] | 12.75±0.26 | 18.20±0.36 | 7.84±0.23 | 8.94±0.28 | 9.73±0.21[ab] |
| P-values | 0.047 | 0.211 | <0.001 | 0.249 | 0.190 | 0.127 | 0.888 | 0.001 |

[a,b,c] Means with different superscript in a column differ significantly; WT: Weight; BDL: Body length; CC: Chest Circumference; DL: Drumstick Length; WGL: Wing Length; TC: Thigh Circumference; SL: Shank Length; HL: Hip length


(a) (b) (c) (d) (e) (f)

**Figure 1**. Ages (in months) of local chicken in Gomoa West district of Ghana: (a) cock: 26, (b) cock: 17; hens: 19, (c) cock: 20, (d) hen: 11, (e) Pullet: 7 and (f) Pullet: 4



(a) (b) (c) (d)

**Figure 2**. Comb types in local chicken in Gomoa West district of Ghana: (a) single, (b) rose, (c) cushion and (d) pea comb


(a) (b) (c)

**Figure 3**. Feather distribution in local chicken in Gomoa West district of Ghana: (a) Frizzled feathers, (b) Naked neck and (c) Normal feathers.

## DISCUSSION

### Morphometric traits of the head of local chicken

This current study showed that the males were generally superior to females in all measurements of the head. For wattles in particular, males had much longer wattles than their female counterparts. The larger combs and wattles of the males suggest that indigenous chicken exhibit sexual dimorphism in the expression of those traits. This finding is in agreement with the findings of Banerjee et al. (2013) who reported that the male chickens were superior to females in all measurements of the head in Harro and Jarso districts of Ethiopia. Though the comb lengths of male and female chicken in this study were much similar to those of male and female local chicken respectively in Southeastern Oromia Regional State of Ethiopia, the present birds had shorter wattles but much longer beaks than those Ethiopian chicken (Negesa et al., 2014). The superiority of cushion comb-type birds to other comb types in all measurements of the head could be attributed to the fact that, the cushion comb may be controlled by or associated with productive genes whose expression is favoured in the tropical climate. The comb type may be useful as selection criterion, thereby providing a basis for the genetic manipulation and improvement of local chicken in Ghana.

The larger heads, combs as well as wattles of white skin birds probably suggests that, such birds have advantage over birds with other skin colours in the growth and developments of head traits. It may also mean that the underlying carotenoid pigmentation for white skin colouration is possibly associated with genes which favour the development of head, comb and wattle. The significant effects of skin colour observed in this study disagreed with the findings of Tabassum et al. (2014) in Bangladesh where body measurements were not affected by skin colour in indigenous chicken. White skin coloured birds are expected to reflect light very effectively and so will experience less heat stress, thereby adapting and growing well in a tropical environment.

### Morphometric traits of the general body of local chicken

The present local chickens were generally smaller than village chicken of Sri Lanka (Liyanage et al., 2015). The superiority of males in this study was similar to reports of earlier works in chicken (Petrus et al., 2011; Guni and Katule, 2013). The birds in the present study weighed less when compared to local chicken of Oman which weighed 1.65kg for cocks and 1.24kg for hens (Petrus et al., 2011). The body weights of the present birds were comparable to indigenous chicken of Sherpur district in Bangladesh (Tabassum et al., 2014), but less than indigenous chicken of Ethiopia (Negesa et al., 2014). Al-Qamashoui et al. (2014) reported that cocks were significantly heavier (1.33±0.65kg) than hens (1.17±0.86 kg) and Guni and Katule (2013) also reported that male chickens were heavier (2.86kg) than female (1.03kg) chickens.

The longer bodies and shanks of cocks in this study agreed with the findings of Al-Qamashoui et al. (2014) who reported that cocks had higher values for body length (18.4±0.14cm) and shank length (8.1±0.11cm) than hens (17.3±0.13cm; 7.1±0.14cm) in Oman. Guni and Katule (2013) reported that males were superior to females in all measurements of the body. The birds in this study were longer than 20.2cm and 18.1cm reported for male and female chickens respectively in Botswana (Badubi et al., 2006). Shank length of males from Horro and Jarso districts were 11.32cm and 9.99cm respectively and among the local hens were 9.22 cm and 8.51cm respectively (Dessie et al., 2013). In small ruminants, male superiority has been reported in sheep (Birteeb et al., 2014) and goats (Birteeb and Lomo, 2015), which suggests occurrence of differential growth and development due to sex in domesticated livestock species. The general superiority

of males to females suggests that body size is a clear exhibition of sexual dimorphism in local chicken. The variability of measurements of the present chicken from their counterparts in other localities might be attributed to a wider variation in the genetic resource of chicken as well as differential response to different environmental conditions.

The superior weight of the naked neck birds may mean that weight related genes are expressed better in these birds than the normal and frizzled feathered birds. It has been suggested that the naked neck chickens have greater weight in the hot season due to genes that cause a reduction in the number of feathers from four to seven weeks than their counterpart chickens (Abdul-Rahman, 2000). Perhaps the naked neck birds dissipate heat easier than their counterparts during hot conditions. This could result in increased performance on growth and productivity.

The significant effects of comb type on body measurements were earlier reported in indigenous chicken in Bangladesh (Tabassum et al., 2014). The higher measurements of cushion comb-type birds than other comb-types may mean that birds with cushion combs have the ability to grow and develop well and faster in the study area. It means that such birds have potential of being developed into broilers. Such birds could be favoured for breed improvement in the local chicken genetic resources in Ghana.

## CONCLUSION

The age, sex and comb type of birds affected the variabilities in all morphological traits of local chicken. Male birds were superior in all measurements of the head and body than their female counterparts. Cushion comb type chickens were also generally superior to all birds of other comb types in all head and body measurements. Feather distribution also affected body weight and thigh circumference while skin colour affected chest circumference and hip length. The knowledge of these morphological variabilities could be useful as selection criterion to poultry breeders, researchers and farmers, thereby providing a basis for genetic manipulation and improvements of the genetic resources of local chicken in Ghana.

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**Competing Interests**

The authors declare that they have no competing interests.

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