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Morphometric Characterization and Body Weight Prediction of Kebumen Ongole Grade (PO Kebumen) Cattle in the Urutsewu Coastal Agroecosystem

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ABSTRACT

Kebumen Ongole Grade (PO Kebumen) cattle is a nationally recognized local cattle strain of Central Java, designated through Decree of the Minister of Agriculture Number 358/2015. This study characterized the quantitative and qualitative morphometric traits of PO Kebumen cattle and developed a practical, population-specific body-weight prediction model from linear body measurements. A total of 130 mature cattle (42 males and 88 females), aged 2–6 years and selected to conform to the strain description, were measured across the coastal sub-districts of Urutsewu (Ambal, Mirit, and Buluspesantren). We recorded nine linear body measurements and seven qualitative traits, and obtained live weight using a digital weighbridge. We analyzed data using independent t-tests, Pearson correlation, and regression. After adjustment for multiple comparisons, males exceeded females only in withers height and head width ($P<0.05$), whereas chest girth did not differ between sexes. Chest girth was the strongest single predictor of body weight ($r=0.94$), yielding the model BW = 5.18 CG − 478.6 ($R^2=0.88$; RMSE=17.4 kg); because accuracy was assessed in-sample, this figure is apparent and requires independent validation. The dominant qualitative traits were a plain white coat, a black muzzle, a thick folded dewlap, and a large erect hump. The selectively sampled animals exceeded the SNI 7651-5:2020 minimum bibit standard, indicating a large frame in this breeding stock. Because the equation was calibrated on animals of mixed sex, age (2–6 years), and physiological status as encountered in the field, it estimates live weight inclusive of these effects and warrants confirmation on independent stock.

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INTRODUCTION

Indonesia possesses a rich diversity of indigenous cattle genetic resources that have adapted over generations to local agroecological conditions and low-input management systems (19). Among these, the Peranakan Ongole (PO) cattle, a breed derived from crossing imported Sumba Ongole (*Bos indicus*) bulls with native Javanese cows, are among the most widely distributed and economically important local cattle in Java. Smallholder farmers value PO cattle for their tolerance to low-quality feed, good reproductive performance, acceptable carcass yield, and dual function as a source of both meat and organic manure for the integrated crop-livestock system (1), (2).

Within the PO population, the cattle reared in Kebumen Regency, Central Java, have long been recognized as a distinct and superior population. The community of the coastal “Urutsewu” area spanning the sub-districts of Ambal, Buluspesantren, Klirong, Petanahan, Puring, and Mirit has maintained and selected these cattle for generations, producing a population with a larger frame, a characteristic thick folded dewlap, and a plain white coat (3), (4). In recognition of this distinctiveness, the Minister of Agriculture of the Republic of Indonesia formally designated the strain through Decree Number 358/Kpts/PK.040/6/2015 on the Determination of the Kebumen Ongole Grade Cattle Strain, and Kebumen Regency was established as a national breeding source area (5).

Phenotypic characterization underpins any genetic improvement and conservation program. Reliable quantitative descriptors of body conformation are needed to define breed standards, monitor purity within breeding villages, and provide selection criteria that farmers can apply in the field (6). Several studies have reported that PO Kebumen cattle exhibit linear body dimensions that exceed the prevailing national bibit standard (SNI 7651-5:2020, which superseded the earlier SNI 7356:2008) and surpass those of PO populations in other regions (3, 7). Nevertheless, characterization data remain fragmented across sub-districts and have rarely been linked to a practical, field-applicable tool for estimating live body weight.

Live body weight is a key economic trait that governs transaction price, feed and drug dosing, and the evaluation of growth performance (18). Direct weighing with a livestock scale, however, is rarely feasible in smallholder villages because scales are expensive and difficult to transport. Consequently, predicting body weight from easily measured linear body dimensions, particularly chest (heart) girth, has become a widely adopted, low-cost alternative (8, 9). Chest girth consistently shows the strongest association with body weight across cattle breeds, and regression-based prediction is generally more accurate than fixed tape formulas when calibrated to a specific population (10, 11).

To date, no calibrated body weight prediction equation has been published specifically for PO Kebumen cattle managed under the Urutsewu coastal agroecosystem, despite the population’s recognized status as a national genetic resource. Although body-weight prediction from chest girth is well established in cattle, this study contributes an updated morphometric characterization of PO Kebumen cattle, along with a body-weight prediction equation calibrated specifically to this population. The objectives were therefore: (i) to characterize the quantitative and qualitative morphometric traits of PO Kebumen cattle by sex, (ii) to compare these traits with the prevailing national bibit standard, and (iii) to develop a practical regression model for predicting live body weight from chest girth.

MATERIALS AND METHODS

This study was conducted from March to May 2026 in three coastal sub-districts in the Urutsewu area, Kebumen Regency, Central Java, Indonesia: Ambal, Mirit, and Buluspesantren. We purposively selected these locations as the core breeding villages of the PO Kebumen strain, where cattle are maintained semi-intensively, kept in individual pens at night, and fed native grasses, agricultural by-products, and rice bran (bekatul), with natural mating as the predominant breeding system.

We used 130 PO Kebumen cattle (42 males and 88 females) aged 2 to 6 years. We estimated age by dental examination (permanent-incisor eruption/POEL score) and cross-checked it with farmer records; this approach carries an inherent uncertainty of approximately ±0.5 year, which we accepted given the field setting. Only cattle conforming to the qualitative breed description and free from visible physical defects were included. Sampling followed a purposive-quota approach proportional to the cattle population in each sub-district. The reproductive status of females (non-pregnant, pregnant, or lactating) was not verified by rectal palpation; cows were therefore measured in the physiological state present at sampling, and the implications of this are addressed in the Limitations. Because the intended application is a field tool for estimating the weight of animals as they are encountered, we deliberately calibrated the equation on the population as sampled—both sexes and all physiological states pooled—rather than restricting to a single class, and we did not include age as a covariate (all animals aged 2–6 years were treated as one mature group).

Nine linear body measurements were recorded for each animal following standard procedures, using a measuring stick (tongkat ukur) and a flexible measuring tape with the animal standing squarely on level ground in the morning before feeding: withers height (WH), hip height (HH), body length (BL), chest girth (CG), chest depth (CD), chest width (CWd), hip width (HWd), head length (HL), and head width (HWi). All measurements were expressed in centimeters. We recorded live body weight (BW, kg) using a portable digital livestock weighbridge. Because chest girth is sensitive to gut and abdominal fill, we read girths before morning feeding and watering to standardize the physiological state.

Seven qualitative (exterior) traits were observed visually and scored by frequency: coat color, muzzle color, hoof color, horn presence and shape, dewlap (gelambir) form, hump (punuk) form, and head profile. We expressed each phenotype frequency as a percentage of observed animals within each sex.

We present quantitative data as mean ± standard deviation and coefficient of variation (CV). We tested differences between sexes with an independent-samples t-test at the 5% significance level; because we compared nine traits, we interpreted results near the threshold with caution, as we did not apply a formal multiple-comparisons correction; we therefore also report which sex differences remain significant after a Bonferroni adjustment ($\alpha = 0.05/9 \approx 0.006$). Because chest girth, body length, and chest depth did not differ significantly between sexes ($P>0.05$), we pooled the sexes ($n=130$) for the correlation and regression analyses. We examined the relationship between body weight and each linear measurement using the Pearson correlation coefficient. Simple and multiple linear regression models were fitted with body weight as the dependent variable and the most strongly correlated measurements as predictors; model adequacy was assessed using the coefficient of determination (R^2), the adjusted R^2, and the root mean square error (RMSE), and residual plots were inspected for departures from linearity and homoscedasticity. We compared the predictive accuracy of the derived equation with the conventional Schaeffer tape formula, $BW(kg) = [CG(cm)^2 \times BL(cm)] / 10838$ (the metric equivalent of the imperial form $[girth^2 \times length] / 300$ with measurements in inches). Because we assessed accuracy on the same animals used to fit the model, the reported deviation is an apparent (in-sample) error. We performed all analyses in R version 4.4.1.

Ethical approval. All procedures were observational and non-invasive, involving only external body measurements and weighing of animals briefly restrained by their owners. No invasive intervention was performed, and data were collected with informed consent from animal owners in accordance with animal-welfare good practice.

RESULTS AND DISCUSSION

Quantitative body measurements

The mean linear body measurements and live body weight of PO Kebumen cattle by sex are presented in Table 1. At the nominal 5% level, males exceeded females in withers height, hip width, head length, and head width, whereas hip height, body length, chest girth, chest depth, and chest width did not differ between sexes. After Bonferroni adjustment for the nine comparisons ($\alpha \approx 0.006$), however, only withers height and head width remained significant; the differences in hip width and head length were marginal ($P \approx 0.05$) and should be regarded as suggestive rather than established. The relatively low coefficients of variation (mostly below 10%) indicate relatively low variability among the sampled animals, consistent with sustained community selection within the breeding villages (although this uniformity partly reflects the deliberate sampling of animals matching the strain description; see Limitations).

Table 1. Linear body measurements and body weight of PO Kebumen cattle by sex

Body measurement (cm)	Male (n=42)	Female (n=88)	CV (%)	Sig.
Withers height	136.1 ± 6.2	132.7 ± 5.1	4.3	*
Hip height	138.9 ± 5.8	137.2 ± 4.7	3.8	ns
Body length	135.5 ± 7.4	137.7 ± 6.5	5.0	ns
Chest girth	167.2 ± 9.6	169.8 ± 9.0	5.5	ns
Chest depth	66.4 ± 5.1	66.8 ± 5.6	8.1	ns
Chest width	47.8 ± 5.3	47.8 ± 4.7	10.3	ns
Hip width	43.1 ± 4.0	41.7 ± 3.6	8.9	*
Head length	49.2 ± 3.4	48.0 ± 2.1	5.6	*
Head width	22.2 ± 2.3	20.8 ± 2.1	10.1	*

Body measurement (cm)	Male (n=42)	Female (n=88)	CV (%)	Sig.
Body weight (kg)	388.6 ± 52.4	401.3 ± 47.9	12.5	ns

Note: * = significantly different between sexes (P<0.05); ns = not significant; CV = pooled coefficient of variation. Significance is shown at the nominal 5% level; after Bonferroni adjustment for nine comparisons, only withers height and head width remain significant.

The chest girth of PO Kebumen cattle (167–170 cm) and withers height (133–136 cm) exceed the minimum requirements of the national bibit standard SNI 7651-5:2020 for adult PO cattle and the dimensions reported for PO populations in other regions of Java (7), (12). This is consistent with the long-standing field observation that PO Kebumen has a notably larger frame, attributed to generations of community-based selection favoring body size and to the relatively favorable forage base of the coastal Urutsewu zone (3), (13). These findings are consistent with multivariate morphometric characterizations of other Indonesian and comparative cattle populations (16), (17), (20), (32). The absence of a significant sex difference in chest girth suggests that this trait is a robust descriptor of overall body size that can be applied uniformly across sexes for field weight estimation. Notably, however, females showed marginally higher mean chest girth and body weight than males despite the males' greater withers height. This pattern most plausibly reflects a female sample that included cows at various stages of gestation and lactation, and possibly an older female age structure, since abdominal fill during pregnancy inflates both chest girth and live weight (34). Because the calibration deliberately pooled all physiological states, the equation reflects field live weight inclusive of gestational and gut fill; a physiological-status-specific model was outside the scope of this field tool (see Limitations).

Qualitative exterior traits

Table 2 summarizes the frequencies of the principal qualitative traits. The PO Kebumen population was highly uniform in diagnostic strain characteristics: a plain white to greyish-white coat, a black muzzle and hooves, and a thick, multiple-fold dewlap forming a continuous line from the chin toward the brisket. Males predominantly exhibited a large, erect hump, while the head profile was mostly flat to laterally triangular. These traits are consistent with the official strain description and with previous phenotypic surveys of PO Kebumen cattle (3), (4), (14).

Table 2. Frequency of dominant qualitative exterior traits of PO Kebumen cattle

Qualitative trait	Dominant phenotype	Frequency (%)
Coat colour	Plain white / greyish-white	94.6
Muzzle colour	Black	90.0
Hoof colour	Black	88.5
Horn	Present, short to medium	82.3
Dewlap (gelambir)	Thick, multiply folded, continuous	87.7
Hump (punuk)	Large and erect (males)	78.6
Head profile	Flat to laterally triangular	80.8

The high uniformity of diagnostic traits has practical value for in-situ conservation: farmers and field officers can readily distinguish pure PO Kebumen cattle from crossbred animals, which supports purity maintenance within the designated breeding villages (6), (15). Maintaining these distinctive traits is essential for preserving the strain's genetic identity and market premium.

Correlation and body weight prediction

Table 3 shows the Pearson correlation coefficients between live body weight and linear body measurements. Chest girth was the most strongly correlated with body weight ($r=0.94$; $P<0.001$), followed by body length ($r=0.81$) and chest depth ($r=0.76$), while head dimensions were only moderately correlated. The dominance of chest girth is consistent with reports across both Bos indicus and crossbred cattle, in which the heart girth captures the combined effect of skeletal size, muscling, and visceral fill (9), (10), (11).

Table 3. Pearson correlation between live body weight and linear body measurements

Predictor	r with BW	P-value
Chest girth	0.94	<0.001
Body length	0.81	<0.001
Chest depth	0.76	<0.001
Withers height	0.62	<0.001
Hip width	0.55	<0.001
Head length	0.41	<0.001

On the basis of these correlations, a simple linear regression of body weight on chest girth (n=130, sexes pooled) produced the population-specific prediction equation:

$$BW = 5.18\ CG - 478.6 \quad (R^2 = 0.88;\ RMSE = 17.4\ kg)$$

where BW is live body weight (kg), and CG is chest girth (cm). Adding body length in a multiple regression marginally improved the fit ($BW = 3.92\ CG + 1.07\ BL - 469.2$; $R^2 = 0.90$; adjusted $R^2 = 0.89$), but the gain was small relative to the added measurement effort, so the single-predictor chest girth model is recommended for field use. The large negative intercept of the linear equation is a fitting artifact that is valid only within the observed chest-girth range (approximately 150–190 cm) and must not be extrapolated to smaller animals, for which an allometric (power) form would be more appropriate; the linear form was retained for its simplicity and adequacy within the mature-cattle range measured here. The chest girth model produced a mean absolute deviation of about 4.1% from scale weights (an apparent, in-sample estimate, since accuracy was evaluated on the fitting sample), outperforming the conventional Schaeffer formula, which overestimated body weight by an average of 8.7% in this population (both comparisons are in-sample). This is consistent with the established finding that population-calibrated regression equations are more accurate than fixed-coefficient tape formulas when applied to a specific breed (8), (11), (21), (22), (33).

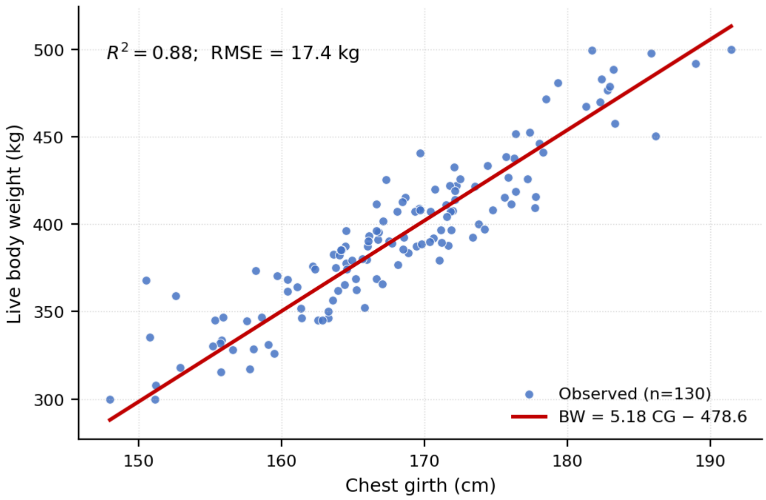

Figure 1. Relationship between chest girth (cm) and live body weight (kg) of PO Kebumen cattle (n=130), with the fitted regression line BW = 5.18 CG − 478.6 (R^2 = 0.88).

The practical implication is substantial: field officers and farmers in the Urutsewu breeding villages can estimate the live weight of PO Kebumen cattle using only a measuring tape and the proposed equation, supporting fairer trading, more precise feed and anthelmintic dosing, and routine growth monitoring without the cost of a weighbridge. The accuracy obtained here (R^2 = 0.88) is comparable to chest girth-based equations reported for zebu and crossbred cattle managed under low-input smallholder conditions elsewhere, in which coefficients of determination typically range from 0.80 to 0.95 (23), (24), (25), (29), (30). However, equations developed for temperate dairy breeds bias estimates when applied to *Bos indicus* populations, reinforcing the value of population-specific calibration such as the present model (26), (27), (28), (31). From a conservation standpoint, combining the morphometric standard in Table 1 with the diagnostic qualitative traits in Table 2 provides an operational toolkit for maintaining strain purity and for selecting superior breeding stock in the designated source area (6), (13). Beyond tape-based prediction, recent image-based and machine-learning approaches have achieved comparable or higher accuracy for estimating cattle body weight (35), (36), and could serve as a low-cost complement to the present chest-girth equation in future field applications.

Limitations

Several limitations should be considered when applying these results. First, we analyzed animals aged 2–6 years together as a single mature group and did not include age as a covariate; this keeps the field equation simple but means any residual age effects on body dimensions are absorbed into the equation rather than adjusted for. Second, we did not restrict or stratify the calibration by reproductive status, so the sample mixes non-pregnant, pregnant, and lactating cows; the equation therefore predicts the live weight of animals as encountered in the field, inclusive of conceptus and gut fill, rather than an empty-body or non-pregnant weight, and the higher mean girth and weight of females than males reflect this mixture. Third, only animals conforming to the qualitative strain description were sampled, which narrowed the observed variation and partly explains the low coefficients of variation; the uniformity reported here should therefore be read as descriptive of selected breeding stock rather than of the entire regional population. Finally, the prediction equation was evaluated on the same animals used to derive it, so the reported accuracy is an apparent (in-sample) estimate; independent, age-stratified validation, for example by hold-out or k-fold cross-validation on additional stock, is required before the equation is generalized.

CONCLUSION

PO Kebumen cattle in the Urutsewu coastal agroecosystem comprise large-framed, phenotypically distinctive breeding stock whose body dimensions, in this selectively sampled set, exceed the national bibit standard and match the diagnostic strain description, consistent with their status as a valued local genetic resource. Chest girth was the best predictor of live body weight, and the calibrated equation BW = 5.18 CG − 478.6 ($R^2 = 0.88$) provides a practical, low-cost field tool for weight estimation that, in-sample, performed better than the conventional Schaeffer formula; independent validation is required before field adoption. The combined morphometric and qualitative standards reported here can help maintain strain purity, support selection, and enable fairer marketing of PO Kebumen cattle. Further work involving larger, age-stratified samples across all Urutsewu sub-districts, control of reproductive status, and validation of the model on independent animals is recommended to refine the prediction equation.

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AUTHOR CONTRIBUTIONS

D.S. and B.W.H.E.P. conceived and designed the study. D.S. and S.E.T. conducted field data collection and morphometric measurements. B.W.H.E.P. performed the statistical analysis and drafted the manuscript. D.S. and S.E.T. reviewed and edited the manuscript. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST

The authors declare no competing interests.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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