OPEN ACCESS
Advances in Animal and Veterinary Sciences

Research Article

Regression Model and Correlation Analysis to Predict Body Weight of Rural Area Female Kacang Goat Based on Body Measurement

Lendrawati*, Tinda Afriani, Eli Ratni

Department of Animal Production and Technology, Faculty of Animal Science, Universitas Andalas, Kampus Unand Limau Manis Padang, 25165, Indonesia.

Abstract | This study aimed to determine the optimal model for predicting the body weight of adult female Kacang goats based on certain body measurements and to investigate correlation and regression. This study used 91 heads of Kacang Does collected from Talawi village from 2021-2022. The body weight (BW) data was regressed and associated with body dimensions (body length = BL, chest girth = GH and shoulder height = SH) using the SPSS program. The Pearson correlation (r) between body weight and measurements was calculated and the degree of fit of the models was assessed using the coefficient of determination (R^2), Adj R^2 and root mean squared error (RMSE). Body weight had a highly significant ($P< 0.01$) correlation with BL (r = 0.723), CG (r = 0.814), and SH (r = 0.549). The optimal estimation of body weight was achieved through a blend of chest circumference and body length, as indicated by the regression model: BW = -15.705 + 0.133BL + 0.457CG.0.457CG with the highest r (0.822), R^2 (0.676) and adjusted R^2 (0.668) and the lowest RMSE (13.427). These findings suggested that chest girth and body length can be used as predictors for body weight of adult female Kacang goats in rural areas. The findings could help farmers in adult female Kacang goat breeding by estimating body weight from body measurements.

Keywords | Does, Morphometric, Regression model, Rural farm

Received | October 29, 2023; **Accepted** | December 10, 2023; **Published** | March 01, 2024
***Correspondence** | Lendrawati, Department of Animal Production and Technology, Faculty of Animal Science, Universitas Andalas, Kampus Unand Limau Manis Padang, 25165, Indonesia; **Email:** len1303@yahoo.com
Citation | Lendrawati, Afriani T, Ratni E (2024). Regression model and correlation analysis to predict body weight of rural area female Kacang goat based on body measurement. Adv. Anim. Vet. Sci., 12(5):802-806.
DOI | https://dx.doi.org/10.17582/journal.aavs/2024/12.5.802.806
ISSN (Online) | 2307-8316

INTRODUCTION

Goats are important animals, especially in the tropics region. This animal can adapt to hard climate conditions, illness tolerance, and the ability to supply a wide range of products for people (Assefa *et al*., 2023). The goat population in Indonesia is about 19.39 million, with a total meat production of about 63.66 tonnes and a total slaughter of goats of 1.57 million (Livestock and Animal Health Statistics, 2022). This goat is widely raised in various parts of Indonesia, dominated by indigenousand local breeds. Moreover, the Kacang goat is the largest indigenous goat in Indonesia and is used for meat production (Ilham *et al*., 2023; Hariyono and Endrawati, 2023). Regardless of the enormous population, the significance of resource-poor farmers, and the adaptability of diverse agroecology, the current level of productivity of the Kacang goat is low, especially in rural areas (Lendrawati and Ratni, 2023; Khalil *et al*., 2019). As a result, improving productivity and conservation activities are crucial for the long-term usage of these breeds.

The primary goal of Kacang goat farming is to produce meat and generate cash through the sale of live animals and their products. Meat production is related to body weight, type, body measurements, and structural indices of livestock animals (Khandoker *et al*., 2017). Moreover, body measures are significant factors for describing animal

growth and are utilized as selection criteria for animals (Rashid *et al*., 2016; Habib *et al*., 2019; Putra and Ilham, 2019). Aziz *et al*. (2023) claimed that growth traits such as live body weight and body measurements such as body length, shoulder height, and chest girth were relevant in the breed selection based on the Indonesian National Standard (SNI). In addition, knowledge of goat body weight is also useful in estimating feed requirements and dosages of medicines, as well as for other management purposes (Mahieu *et al*., 2011; Dakhlan *et al*., 2020).

Weighing is the most precise approach to determining the body weight of goats. However, collecting scales in the field is difficult, especially in rural locations (Assefa *et al*., 2023; Sam *et al*., 2016). Using body measurement as a prediction of body weight can be an alternative to measuring goat body weight in this case. A previous study reported a strong relationship between body weight and morphometric measurements such as in female Etawa grade goats (Dakhlan *et al*., 2020), Saburai goats (Dakhlan *et al*., 2021), Beetal goats (Iqbal *et al*., 2013; Waheed *et al*., 2020), black Bengal goat (Habib *et al*., 2019).

Although live body weight can be properly determined using a scale, certain occasions and settings necessitate a more practical technique for estimating body weight. The accuracy and suitability of approaches to determining body weight from body measurement in goats varies depending on breeds, ages, sexes, and production systems.

Dakhlan *et al*. (2021) reported that body weight is tightly related to body measurements, and chest girth is one of the body measurements that is widely regarded as the best single predictor of body weight in Saburai goats. Furthermore, many predictive regression equations are based on these data alone or in combination with other body measurements. Currently, there is limited data available pertaining to the estimation of body weight in Kacang goats through the utilization of body measurement and the regression method. The purpose of this study was to evaluate the association between body weight and body measurements (body length, shoulder height, and chest girth), as well as to identify the best-fitted regression model for predicting body weight in adult female Kacang.

MATERIALS AND METHODS

This research was carried out from August to October 2022 on small-scale farmers in Talawi District, Sawahlunto Regency, Indonesia. In this investigation, adult female Kacang goats aged 1-3 years were used. All goats used in this study were reared under semi-intensive management, allowing them to graze on the pasture throughout the day and then housed and fed in the afternoon.

The survey approach was used in this study, and data were acquired through the purposive sampling techniques of adult female Kacang goats aged 1-3 years, reared in a semi-intensive system (allowing them to graze in the pasture throughout the day and then housed and fed in the afternoon).

The study involved the measurement of various variables, namely body weight (BW), body length (BL), chest girth (CG), and shoulder height (SH). Body weight was determined by weighing adult female Kacang goats using hanging scales with a capacity of 200 kg (DLE brand). The girth of the chest was assessed by applying adhesive tape around the thoracic cavity just behind the front legs. Employing a measuring rod, the length of the body (BL) was measured in a direct manner from the shoulder joint to a mass of the coccyx. Shoulder height was determined by employing a measuring stick to ascertain the distance from the most elevated point of the shoulder to the ground (Nurhayati *et al*., 2014; Dakhlan *et al*., 2020).

The data was analyzed using the SPSS version 23 platform (IBM Inc, USA). The boxplot and the Kolmogorov-Smirnov and Shapiro tests were used to determine the normality of the data distribution. The Pearson correlation coefficient was employed for the purpose of determining the correlations that exist between the variables. Simple and multiple regression models were employed to assess the association between body measurement and body weight as shown below.

a. $BW = a + b1*BL$
b. $BW = a + b2*CG$
c. $BW = a + b3*SH$
d. $BW = a + b1*BL + b2*CG$
e. $BW = a + b1*BL + b3*SH$
f. $BW = a + b2*CG + b3*SH$
g. $BW = a + b1*BL + b2*CG + b3*SH$

Where; BW was a live weight as a dependent variable (kg), a is a constant or intercept, b1, b2 and b3 is the regression coefficient for each independent variable (body measurements), BL are body length, CG are chest girth, and SH are shoulder height, in cm. Based on the regression model with the highest coefficient correlation (r), coefficient of determination (R^2), and adjusted R^2, the lowest root mean square error (RMSE) will be suggested for use in predicting the body weight of the adult female Kacang goat.

RESULT AND DISCUSSSION

Descriptive statistics

The body weight and body measurements of adult female Kacang goat were illustrated in Table 1 and Figure 1.

Table 1: Descriptive statistics of body weight and body measurements of adult female Kacang goat.

Items	n	Mean	Sd	CV	Median	Min	Max
Body weight (kg)	91	19.66	3.51	12.35	19.50	13.85	27.00
Body length (cm)	91	57.90	5.03	25.37	58.00	45.00	67.00
Chest girth (cm)	91	60.55	5.07	25.77	61.00	52.00	70.00
Shoulder height (cm)	91	50.95	5.06	25.60	50.50	42.00	63.00

N: number of records, Sd: standard deviation, Min: minimum, Max: maximum.

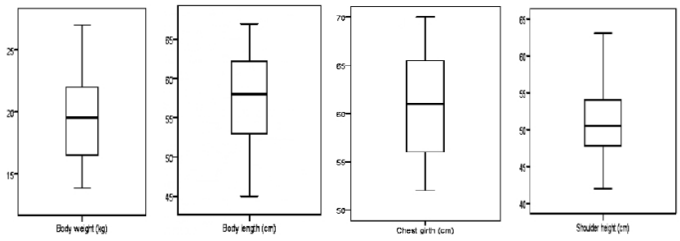

Figure 1: Boxplot of body weight and measurements of adult female Kacang goat.

These demonstrated that the mean and median of the data were similar, indicating that the data were balanced between below and above the median, which means the data were distributed normally. The result showed that means with standard deviation for body weight, body length, chest girth, and shoulder height of adult female Kacang goats were 19.66±3.51 kg, 57.90±5.03 cm, 60.55±5.07 cm, and 50.95±5.06 cm, respectively.

Body weight is an important feature in animal productivity because it serves as an indicator of nutrition, health, breeding, and livestock selection (Ruchay *et al*., 2022). The data on body weight and body measurements of adult female Kacang goat were normally distributed (Figure 1). These findings found that the average of body weight of adult female Kacang goat (1-3 years in age) was 19.66± 3.51 kg with a coefficient variation of 12.94%. This result indicated that the variation of body weight of female Kacang goats in this case was low enough even though their ages were far apart (1-3 years old). The lower variation could be caused by the similarity of their environmental factor such as the management of feeding and rearing (semi-intensive rearing system).

The body weight and body measurement of female Kacang goat in this study is higher than the study reported by (Azmidaryanti *et al*., 2017), adult female Kacang goats that are raised semi-intensively in Riau Province have a body weight of 15.95±2.15 kg, body of length of 49.76±2.5, chest girth of 53.19±2.95 cm, and shoulder height of 47.26±2.60 cm. However, this current study is lower than those of does Kacang goat with a body weight of 27.11±4.93 kg, body length of 60.26±4.27 cm, and chest girth of 69.42±4.64 cm (Putra and Ilham, 2019). This finding was also lower than female Malaysian Kacang with body weight, body length, and chest girth was 23.65 kg, 70.5 cm, and 63.46 cm respectively (Khandoker *et al*., 2017). The difference in body weight and measures between this study and the previous study is assumed to be influenced by maintenance environment variables such as different feedstuff, feeding management, and temperature (Dakhlan *et al*,. 2020).

Correlation between body measurement and body weight of adult female Kacang goat

Table 2 shows the Pearson correlation between variables. The findings of this study revealed that body measurements were positively related to body weight, with chest girth (0.814) having the strongest correlation to body weight, followed that body length (0.723) and shoulder height (0.549). The correlation between body measurements was similarly positive, ranging from 0.750 to 0.822, showing that there was no multicollinearity due to less than 0.90 (Dakhlan, 2019). Pearson correlation between body weight and body measurements supports the findings in other Indonesian local breeds of goat such as Etawa Grade goats (Dakhlan *et al*., 2020), Batur sheep (Ibrahim *et al*., 2021) and Bali Cattle (Aziz *et al*., 2023) who found that chest girth had the highest correlation with body weight comparing to body length and shoulder height.

Table 2: The coefficient correlation between the variable of adult female Kacang goat.

Body weight	1.000			
Body length	0.723	1.000		
Chest girth	0.814	0.822	100	
Shoulder height	0.549	0.750	0.814	1.000

Regression equation between body measurement and body weight of adult female Kacang goat

Table 2 presents the result of the regression analysis between body weight and body measurements of adult female Kacang goats, while the scatter plot and regression model are shown in Figure 1. This study found that using a single body measurement, chest girth was the best predictor of body weight, with the highest R2 (0.663), adjusted R2 (0.659), and lowest RMSE (13.689). This data showed that chest girth influenced 66.30% of body weight variation, whereas the remainder was driven by other factors. The regression model using body measurement of two predictors showed the highest R^2 (0.676) and Adj R^2

(0.668) and the lowest RMSE (13.421) for the regression model BW =- 15.705 + 0.133 BL + 0.457 CG, followed by R^2 (0.663), Adj R^2 (0.656) and RMSE (13.671) for the equation BW = - 14.650 + 0.553 CG + 0.016 SH, and R^2 (0.563), Adj R^2 (0.553) and RMSE (15.486) for the the equation BW = - 12.812 + 0.418 BL + 0.164 SH. Meanwhile, Stepwise regression analysis with all independent variables found that chest girth was the best predictor for body weight with Adj R^2 (0.659) and RMSE (13.689). As a result, based on the highest R^2, adj R^2 and lowest of RMSE value, the combination of chest girth and shoulder height became the best model among the seven model regression.

Table 3: Simple and multiple linear regression model to estimate body weight using body measurement of female Kacang goat.

BW = -9.381 + 0.504 BL	0.723**	0.522	0.517	16.297
BW = -14.473 + 0.564 CG	0.814**	0.663	0.659	13.689
BW = 0.246 + 0.381 SH	0.549**	0.301	0.293	19.748
BW = -15.705 + 0.133 BL + 0.457 CG	0.822**	0.676	0.668	13.427
BW = -12.812 + 0.418 BL + 0.164 SH	0.750**	0.563	0.553	15.486
BW = -14.650 + 0.553 CG + 0.016 SH	0.814**	0.663	0.656	13.671
BW =-15..912 + 0.134 BL + 0.445 CG + 0.018 SH	0.822**	0.676	0.665	14.018

BW: body weight; BL: body length; CG: chest girth; SH: shoulder height; r: pearson correlation; R^2: determination coefficient; Adj R^2: adjusted R^2; **: significant at level 0.01

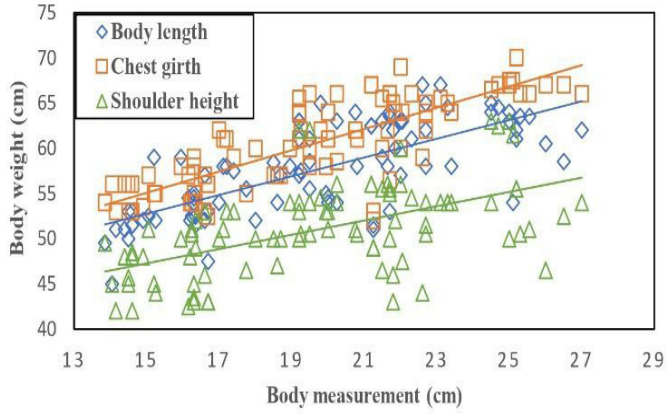

Figure 2: Scatter plot and regression model of body weight and body measurements (body length, chest girth, and shoulder height).

The finding of regression models of a recent study similar to (Dakhlan *et al*., 2020; Ibrahim *et al*., 2021) that the combination of chest girth and body length was the best predictor for body weight of female goats and sheep. The best predictor of chest girth and body length for body weight may be related to the shape of the goat body, which is similar to a tube shape, with chest girth as the base area and body length as the height of the tube resulting in volume, which is body weight, so that the greater the chest girth and body length, the heavier the goat body weight (Ilham *et al*., 2023).

CONCLUSIONS AND RECOMMENDATIONS

Body weight was highly associated with body length, chest girth, and shoulder height with chest girth having the highest correlation (0.814) and the best predictor for body weight (BW) of adult female Kacang goats followed by body length (0.723) and shoulder height (0.549) if using single body measurement. The fittest prediction of body weight with model regression BW = -15.705 + 0.133BL + 0.457CG had the greatest r (0.822), R^2 (0.676), and adjusted R^2 (0.668), as well as the lowest RMSE (13.427). These findings suggested that chest girth and body length be used as predictors for body weight of adult female Kacang goats in rural areas.

ACKNOWLEDGEMENTS

The authors thank LPPM of Andalas University for supporting to preparation of this manuscript by Scopus Camp series 5 and for Animal Science Faculty for funding this research.

NOVELTY STATEMENT

This study found the best-fitted regression model for predicting the body weight of female Kacang goats in rural areas, which will help farmers with the selection process for Kacang goat breeding. It also provided information on the relationship between body weight and body measurements (body length, chest girth, and shoulder height).

AUTHOR'S CONTRIBUTION

LDW: conceptualization, writing original draf, and statistical analyses, TA: methodology and supervision. ER: review and manuscript editing. All authors accepted for the final version of the manuscript.

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Assefa T, Alemayehu K, Tesema Z (2023). Towards understanding the type and function of indigenous goats: input for genetic improvement and conservation programme. J. Appl. Anim. Res, 51(1): 588–598. https://doi.org/10.1080/09712119.2023.2254368

Aziz R, Ciptadi G, Wahjuningsih S, Hariyono DNHH, Tribudi YA, Margareta V, Nurgiatiningsih A. (2023). Prediction

of body weight from body measurement in bali cattle of Indonesia using regression analysis. Adv. Anim Vet. Sci, 11(9): 1486–1491.

Azmidaryanti R, Misrianti R, Siregar S (2017). Perbandingan morfometrik kambing kacang yang dipelihara secara semi intensif dan intensif di kabupaten kampar, provinsi riau. Jurnal Ilmu Prod Teknol. Hasil Petern., 5(2): 84–88. https://doi.org/10.29244/jipthp.5.2.84-88

Dakhlan A, Hamdani MDI, Putri DR., Sulastri, Qistthon A (2021). Prediction of body weight based on body measurements in female Saburai goat. Biodiversitas, 22(3): 1391–1396. https://mail.smujo.id/biodiv/article/view/7785. https://doi.org/10.13057/biodiv/d220341

Dakhlan A, Saputra A, Hamdani MDI, Sulastri (2020). Regression models and correlation analysis for predicting body weighy of female etttawa grade goat using its body measurements. Adv. Anim.Vet. Sci, 8(11): 1142–1146. https://doi.org/10.17582/journal.aavs/2020/8.11.1142.1146

Dakhlan A (2019). Experimental design and data analysis using R. Graha Ilmu. Yogyakarta.

Habib MA, Akhtar A, Haque Bhuiyan, AKF, Choudhury MP, Afroz, MF (2019). Biometrical relationship between body weight and body measurements of black bengal goat (BBG). Curr. Appl. Sci. Technol. May, pp. 1–7. https://doi.org/10.9734/cjast/2019/v35i230172

Hariyono DNH, Endrawati E (2023). Indigenous goat genetic resources in Indonesia: current status and future improvement. J. Adv. Vet. Res., 13(1): 141–149.

Ibrahim A, Artama WT, Budisatria IGS, Yuniawan R, Atmoko BA, Widayanti R (2021). Regression model analysis for prediction of body weight from body measurements in female batur sheep of banjarnegara district, Indonesia. Biodiversitas, 22(7): 2723–2730. https://doi.org/10.13057/biodiv/d220721

Ilham F, Ciptadi G, Susilorini T, Putra WBP, Suyadi (2023). Morphology and morphometric diversity of three local goats in Gorontalo, Indonesia. Biodiversitas, 24(3): 1366–1375. https://www.smujo.id/biodiv/article/view/13172, https://doi.org/10.13057/biodiv/d240305

Iqbal M, State K, Academy M, Javed K, Sciences A, Ahmad N, Sciences A (2013). Prediction of body weight through body measurements in Beetal goats. Pak. J. Sci., 5(4): 458–461.

Khalil, Bachtiar A, Evitayani (2019). Reproductive performance of Female Kacang Goats supplemented by mineral under a tethering feeding system. Trop. Anim. Sci. J., 42(3): https://doi.org/10.5398/tasj.2019.42.3.215

Khandoker M, Syafiee M, Rahman M (2017). Morphometric characterization of Katjang goat of Malaysia. Bangladesh J. Anim. Sci., 45(3): 17–24. https://doi.org/10.3329/bjas.v45i3.31035

Lendrawati, Ratni E (2023). Reproductive index of female Kacang goat managed by smallholder in Talawi district, Indonesia. Developing Modern Livestock Production in Tropical Countries, pp. 124–127. https://doi.org/10.1201/9781003370048-30

Livestock and Animal Health Statistics 2022. ISSN 2964-1047, 1: 1–276.

Mahieu M, Navès M, Arquet R (2011). Predicting the body mass of goats from body measurements. Livest. Res. Rural. Dev., 23(9): 1–15.

Nurhayati R, Dilaga WS, Lestari CMS (2014). The correlation between body measurements and body weight of young and adult female jawarandu goats in blora regency. Anim. Agric. J., 3(4): 575:580.

Putra WPB, Ilham F (2019). Principal component analysis of body measurements and body indies and their correlation with body weight in Katjang does of Indonesia. J. Dairy Vet. Anim. Res., 8(3): 124–134. https://doi.org/10.15406/jdvar.2019.08.00254

Rashid MM, Hoque MA, Huque KS, Talukder MAI, Bhuiyan AFH (2016). Morphometric characterization of Brahman crossbred cattle and prediction of live weight using linear body measurements. Asian J. Med. Biol. Res., 1(3). https://doi.org/10.3329/ajmbr.v1i3.26480

Ruchay A, Kober V, Dorofeev K, Kolpakov V, Gladkov A, Guo H (2022). Live weight prediction on cattle based on deep regression of RGB-B images. Agriculcure 12:1794. https://doi.org/10.3390/agriculture12111794

Sam I, Ekpo J, Ukpanah U, Eyoh G, Warrie M (2016). Relationship between inear body measurement and live body weight in West African Dwarf Goats in Obio Akpa. J. Biol. Agric. Health, 6(16): 118–124.

Waheed HM, Moaeen-Ud-din M, Khan MS, Saif-Ur-rehman M, Nawaz-Ul-rehman MS (2020). Prediction of monthly body weight from body measurements in beetal goats reared under field and farm conditions. J. Anim. Plant Sci., 30(1): 25–31. https://doi.org/10.36899/JAPS.2020.1.0003