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Growth Patterns and Morphometric Characteristics of Female Sakub Sheep Reared by Smallholder Farmers in Brebes Regency of Central Java, Indonesia

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ABSTRACT

The Indonesian government designated the Sakub sheep as a local breed in 2022, and it is mainly cultivated in Brebes Regency, Central Java. This study investigates the growth patterns and morphometric characteristics of Sakub sheep as a local breed in the Brebes Regency. The data were collected from 195 healthy and non-pregnant female Sakub sheep reared by smallholder farmers. The sheep were categorized into eight age groups, and various morphometric measurements were performed, followed by descriptive data analysis. The results showed that body weight (BW), chest width (CW), and chest depth (CD) experienced optimal growth until 36–48 months with average body weight and size of 47.34 kg, 21.76 cm, and 35.35 cm, respectively. The body size of heart girth (HG), body length (BL), and hip height (HH) grew optimally for 7–12 months at 80.40, 64.73, and 65.08 cm, respectively. Wither height (WH) and hip-width (HW) growth were optimal for 12–24 months at 67.27 and 15.77 cm, respectively, gradually developing into maturity. In conclusion, this study showed the rapid growth of female Sakub sheep, indicating that body weight and size (CW and CD) generally grew to maturity. In contrast, the growth pattern of body size related to BL, WH, HH, and HW showed rapid growth from birth to puberty, followed by a decline in development rate

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at post-puberty. The body weight of female Sakub sheep has a positive and significant correlation to all linear body sizes, but in different age categories, the correlation weakens with age.

Keywords: Body weight, body size, growth pattern, morphometrics characteristics, Sakub sheep

INTRODUCTION

Sakub sheep is a unique and original local breed raised in Brebes Regency, Indonesia. According to Decree No. 882/KPTS/PK.010/M/12/2022 issued by the Minister of Agriculture of Indonesia (Ministry of Agriculture, 2022), this breed has been officially recognized as a new local sheep in 2022. Despite being an integral part of the local agricultural landscape, Sakub sheep still lacks more specific and scientific exploration. This knowledge gap provides a significant opportunity to enhance the understanding of Sakub sheep characteristics and the potential for local and regional development.

Qualitative characteristics of Sakub sheep based on the Decree of the Minister of Agriculture (Ministry of Agriculture, 2022), include a body shape with high shoulders and a balanced body length (BL) from front to back. The body color comprises white, brown, and black, with wool distributed throughout the body except for the head and feet. A convex shape with long and sideways ears characterizes the facial profile. Moreover, horns may be found in some Sakub sheep, with most females lacking this feature. The shape of the jaw is wide laterally, with the base extending beyond the temples, along with a prominent chest shape and an elongated rounded tail. Based on classification as meat, Sakub sheep have a calm and non-aggressive temperament. Sakub sheep, mainly raised in highland areas, exhibit unique characteristics and become integral to local agriculture (Jannah et al., 2023; Nurasih et al., 2023).

The value of Sakub sheep depends on their ability to adapt to the local environment, characterized by challenging terrain, climatic variations, and limited resources. Although these sheep are suitable for small-scale farming systems, more comprehensive data are required from various aspects, including body size and weight as discernible characteristics, to determine growth patterns (Jannah et al., 2023). The analysis of growth patterns is crucial for assessing sheep's performance and enhancing the quality of meat-producing animals (Afolayan et al., 2006).

The growth pattern in sheep is an essential area of study that includes various aspects such as bone, body frame development, and growth rates. Understanding and implementing strategies to optimize body weight growth in sheep is crucial for maximizing productivity and profitability. In this context, genetic factors play a significant role, as specific genes and genetic variations have been associated with growth traits in sheep (Pasandideh et al., 2020; Wu et al., 2020; Zhang et al., 2013). Marković et al. (2019) focused on the differentiation of sheep breeds based on morphometric characteristics, providing insight into body size and shape variations.

In light of these considerations, this study aimed to investigate the growth patterns and morphometric characteristics of Sakub sheep as a local breed in the Brebes Regency. The results are expected to fill a crucial knowledge gap, contributing to understanding sheep's growth patterns and providing valuable insights into factors influencing body weight, body sizes, and bone development. Additionally, the results are anticipated to provide valuable information on breeding programs, management practices, and selection strategies to improve growth performance and productivity in sheep populations.

MATERIALS AND METHODS

Ethical Clearance

This study was approved by the Animal Care and Use Committee of the Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia (Certification no. 036/EC-FKH/Eks/2022).

Description of the Study Area

This study was carried out in the highest areas of Sirampog and Paguyangan Districts, Brebes Regency, Central Java, Indonesia, comprising 92.56% of the Sakub sheep populations. The two districts, located in the highlands of mountain slopes, have an altitude of 1342±61.51 above sea level and an excellent horticultural agricultural sector. These districts are characterized by a mean temperature of 23.80±3.00°C with a humidity of 76.40±15.07%, which is low for tropical climates. Meanwhile, light intensity is 2,838.67±554.94 lux, with a relatively low wind speed at 0.03 ± 0.03 m/s, categorized as conducive to various ecosystems. According to the Central Agency on Statistics of Brebes Regency (Badan Pusat Statistik Kabupaten Brebes, 2023), the precipitate in these districts is 3,678 and 4,850 mm/year, respectively. Table 1 shows a description of the agroecological zones of the study areas.

Animal Management

This study was carried out between May 2022 and June 2023. A total of 195 female Sakub sheep raised by 60 breeders were selected for this study. Farmer data was obtained from the Brebes District Department of Animal Husbandry and Animal Health. Most Sakub sheep were reared intensively in colony pens made of wood by smallholder farmers as a side job with the traditional system. Feeding was carried out two times a day, consisting of forage grass and agricultural

Table 1
Measurement of environmental conditions in the Sakub sheep development area

Variable	Mean±Standard deviation	Minimum	Maximum
Altitude (masl)	1,342.00±61.51	1,271.00	1,379.00
Light intensities (lux)	2,838.67±554.94	2,428.00	3,470.00
Temperature (°C)	23.80±3.00	20.80	26.80
Wind velocity (m/s)	0.03±0.03	0.00	0.50
Humidity (%)	76.40 ±15.07	59.00	85.10

residues such as carrot and cabbage leaves, without concentration and drinking water. Although farmers rarely maintain colony pens, measurements are made when there is a competition to select a superior breed. Farmers also ignore signs of estrus, leading to random mating in colony pens.

Data Collection

Sheep measurement was obtained through a door-to-door survey, focusing on body weight and body size of 195 healthy non-pregnant female Sakub sheep. Based on the classification, sheep were categorized into eight distinct age groups, following the procedure of Hakim et al. (2019). The groups consisted of 11 neonatal sheep (aged 0–14 days), 71 young sheep (aged 1–2 months), 16 juvenile sheep (aged >2–4 months), 33 adolescent sheep (aged >4–7 months), 26 young adult ewes (aged >7–12 months, with one pair of permanent incisors), 26 adult ewes (aged >12–24 months, with two pairs of permanent incisors), 27 mature ewes (aged >24–36 months, with three pairs of permanent incisors), and 29 older ewes (aged >36–48 months, with four pairs of permanent incisors). The body weight (BW) of Sakub sheep was measured using digital scale (WeiHeng™, China) with a capacity of 200 kg and an accuracy of 0.01 kg. Meanwhile, body size was measured using measuring tape (Butterfly™, Indonesia) and ruler (FHK™, Japan) with an accuracy of 0.1 cm. The parameters observed for body size, as presented in Figure 1, included heart girth (HG), chest width (CW), chest depth (CD), body length (BL), wither height (WH), hip height (HH), and hip width (HW). Measurements were made based on the Food and Agriculture Organization of the United Nations (FAO) procedure (FAO, 2012) with the sheep's parallelogram position.

Statistical Analysis

Body size data were analyzed descriptively, and the results were compared with those of similar breeds based on the literature.

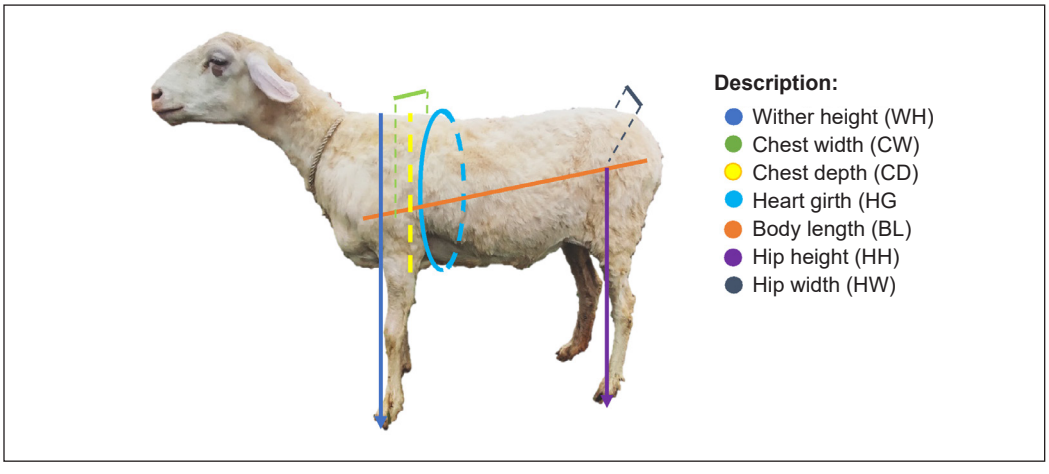

Figure 1. The body size observes in female Sakub sheep

Body weight and size data were categorized according to age groups and assessed for normality using the box plot method. Correlation analysis was carried out on body weight and size, which is presented in the heatmap model. Subsequently, all data were analyzed using the SPSS (version 26) and Microsoft Excel (version 16.78).

RESULTS

Body Size and Body Weight of Female Sakub Sheep

Table 2 and Figure 2 show the results, statistics, and distribution of body weight and size. The analysis using the box spot method showed that the body weight and size of female Sakub Sheep had a distinctive distribution pattern without outliers in the data. Generally, the standard deviation of female Sakub sheep across different sizes and age groups showed normal outcomes.

Table 2 compares the body weight and size of female Sakub sheep in relation to other local breeds in Central Java. Based on the results, the Sakub sheep's body weight was lower than Batur sheep in the age groups of >12–24, >24–36, and >36–48 months. The body weight of Batur sheep between the ages of 12 to 24 months was 63.12±13.80 kg, while 24 to 48 months had a value of 64.37±12.30 kg. At >12–24 and >24–36 months, the body weight of Sakub sheep was lower compared to Batur sheep. However, at 36–48 months, Sakub sheep had a higher value, while Wosonobo sheep in these age categories had 40.17, 43.84, and 44.59 kg, respectively.

Body Weight and Body Size Growth Pattern of Female Sakub Sheep

The data were grouped and stratified by age, consisting of 0–14 days, 1–2 months, >2–4 months, >4–7 months, >7–12 months or one pair of permanent incisors, >12–24 months or two pairs of permanent incisors, >24–36 months or three pairs of permanent incisors, and >36–48 months or four pairs of permanent incisors. This stratification was crucial to enable the features of body weight and size, which could vary depending on age. Moreover, age is an essential parameter in the analysis to determine body and size growth patterns.

Based on Table 3 and Figure 2, the body weight of female Sakub sheep showed optimal growth until >36–48 months, reaching an average weight of 47.34 kg. The linear growth pattern of body weight was followed by CW and CD with sizes of 21.76 and 35.35 cm, respectively. Meanwhile, HG, BL, and HH experienced optimal growth at >7–12 months, with dimensions of 80.40 cm, 64.73, and 65.08, respectively. WH growth was also optimal until the age of >12–24 months with a size of 67.27 cm, followed by a gradual body slope towards maturity. However, the HW growth pattern rapidly developed from >7–12 to >12–24 months, with a body size between 13.04 and 15.77 cm.

Correlation Between Body Weight and Body Size of Female Sakub Sheep

Correlation analysis of female Sakub sheep's body size was carried out on sheep of all ages and in separate age groups. The

Table 2
The mean ± standard deviation of body weight and size in female Sakub sheep is based on different age groups

Traits	Age groups (months)							
	0 (11)*	1-2 (27)*	>2-4 (16)*	>4-7 (33)*	>7-12 (26)*	>12-24 (26)*	>24-36 (27)*	>36-48 (29)*
BW (kg)	5.10±5.10	11.95±2.70	15.99±4.55	22.22±5.74	30.72±4.84	37.48±9.38	41.32±6.47	47.34±7.44
HG (cm)	40.45±5.70	54.37±5.24	61.38±7.26	69.09±7.59	80.04±6.43	84.96±7.17	86.30±6.25	90.21±7.15
CW (cm)	8.86±1.67	12.48±3.13	13.31±2.27	14.82±2.79	15.58±3.63	17.46±4.06	20.76±5.19	21.76±5.69
CD (cm)	14.45±1.57	20.15±2.18	23.94±4.40	26.27±3.07	27.92±4.40	30.04±3.70	31.74±2.59	35.35±3.54
BL (cm)	34.64±4.06	45.81±3.79	50.06±5.77	58.70±7.47	64.73±4.17	67.85±5.63	69.98±6.91	72.55±4.94
WH (cm)	37.36±3.07	50.11±4.57	53.63±5.46	59.06±5.52	63.12±4.02	67.27±4.94	69.09±4.33	70.36±4.14
HH (cm)	36.55±4.61	47.96±4.66	52.13±5.73	58.24±5.52	65.08±5.52	66.62±4.15	68.50±3.28	68.59±2.13
HW (cm)	7.09±1.30	10.33±2.27	10.69±2.15	12.61±1.92	14.23±1.78	15.77±2.72	17.33±2.10	17.91±2.54

Note. * = The number of samples; BW = Body weight; HG = Heart girth; CW = Chest width; CD = Chest depth; BL = Body length; WH = Wither height; HH = Hip height; HW = Hip width

Table 3
Comparison mean ± standard deviation of body weight and body size Sakub sheep with other local breed sheep in Central Java, Indonesia

Breed/Age (months)	BW (cm)	BL (cm)	HG (cm)	WH (cm)	References
Sakub sheep					
>12-24	37.48±9.38	67.85±5.63	84.96±7.17	67.27±4.94	This study
>24-36	41.32±6.47	69.98±6.91	86.30±6.25	69.09±4.33	
>36-48	47.34±7.44	72.55±4.94	90.21±7.15	70.36±4.14	
Batur sheep					
>12-24	63.12±13.80	68.43±7.45	98.35±19.71	59.48±6.57	Ibrahim et al. (2020)
>24-48	64.37±12.30	70.96±5.82	102.96±18.75	62.08±6.37	
Wonosobo sheep					
>12-24	40.17	67.83	79.61	60.04	Hakim et al. (2019)
>24-36	43.84	68.84	81.32	61.52	
>36-48	44.59	69.64	80.89	62.19	

Note. BW = Body weight; BL = Body length; HG = Heart girth; WH = Wither height

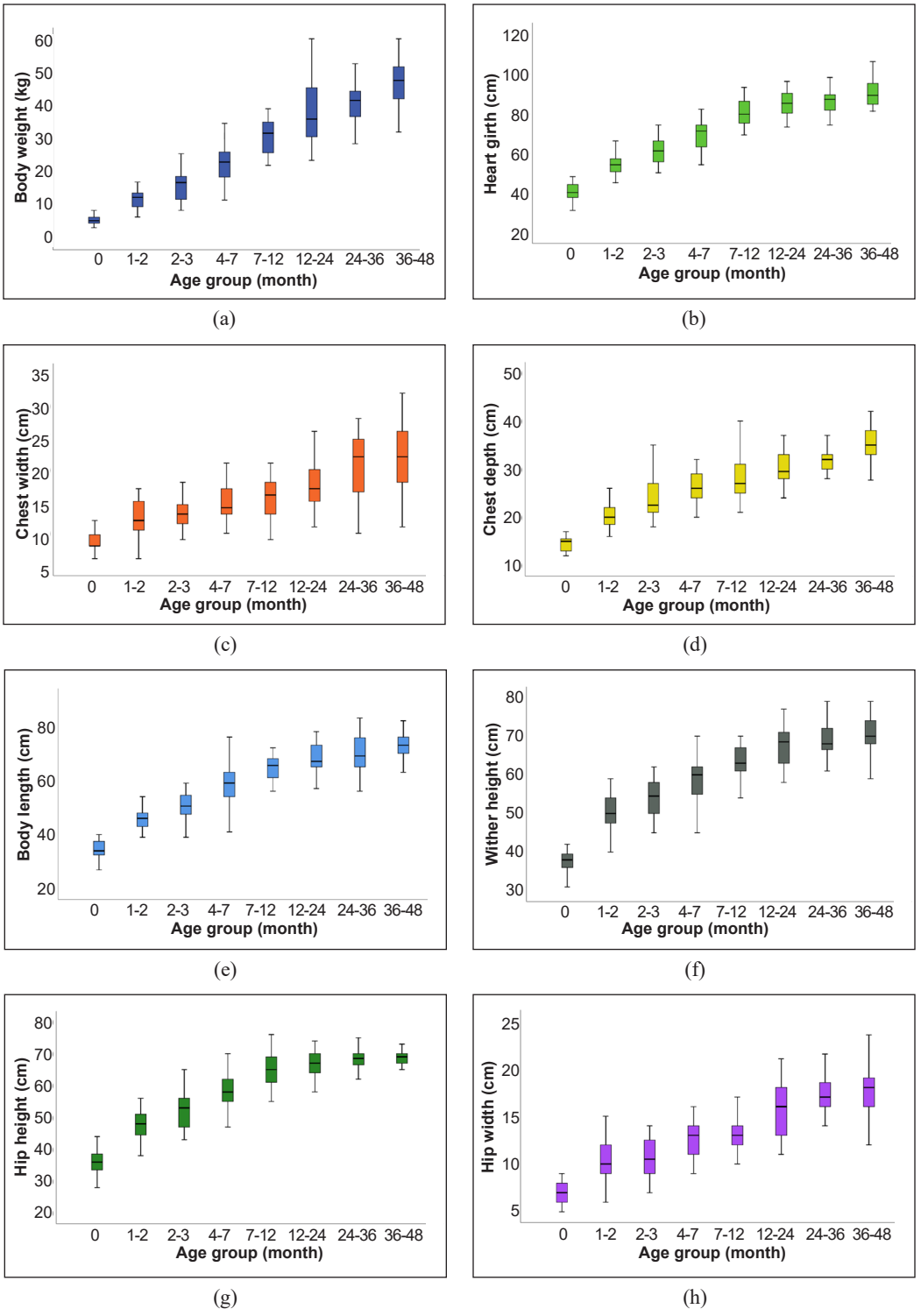

Figure 2. Boxplot of body weight and body size of female Sakub Sheep

phenotypic correlation between body weight and body size of female Sakub sheep is presented in Figure 3. The analysis was carried out on 195 sample sizes in various age categories. Besides that, the phenotypic correlation between body size and body weight at different age groups of female Sakub sheep is presented in Figure 4.

Figure 3 shows the results of Pearson correlation between BW to have a highly positive statistical link with all linear body size (p<0.01). All measured characteristics were highly and positively statistically correlated.

The layout in Figure 4 establishes a link between body size and body weight in different age groups. Overall, the correlation between body weight and body size weakens with age. It can be seen from the color gradation on the heat map, which fades

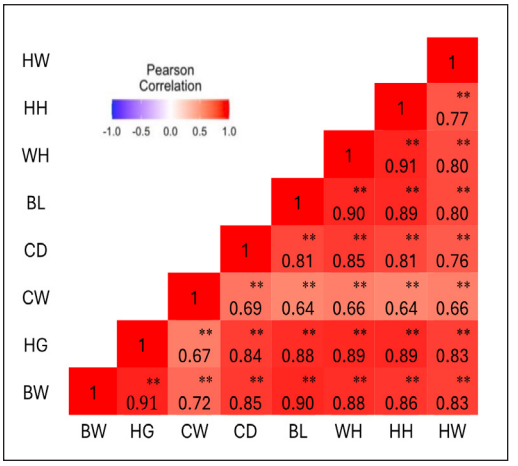

Figure 3. Heat map of body weight correlation and body size in female Sakub. The correlation color demonstration is as follows: high correlation is red, mid correlation is white and low correlation is blue

Note. BW = Body weight; HG = Heart girth; CW = Chest width; CD = Chest depth; BL = Body length; WH = Wither height; HH = Hip height; HW = Hip width; ^{ns} = Not significant; ** = Highly correlation/ Correlation is significant at the 0.01 level (2-tailed); * = Correlated/Correlation is significant at the 0.05 level (2-tailed)

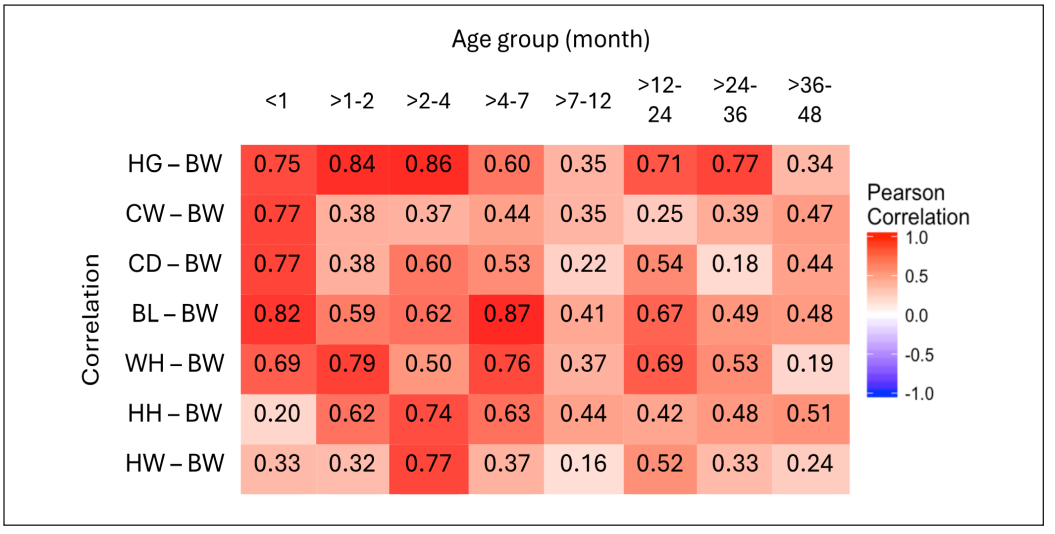

Figure 4. Heat map of body weight correlation of body size in female Sakub in different age groups. The correlation color demonstration is as follows: high correlation is red, mid correlation is white and low correlation is blue

Note. BW = Body weight; HG = Heart girth; CW = Chest width; CD = Chest depth; BL = Body length; WH = Wither height; HH = Hip height; HW = Hip width; ^{ns} = Not significant; ** = Highly correlation/Correlation is significant at the 0.01 level (2-tailed); * = Correlated/Correlation is significant at the 0.05 level (2-tailed)

to the right. Overall, the decrease in the correlation between body size and body weight is significant in the age groups >7–12 and >36–48 months. However, HG, BL, WH, and HH significantly correlate with body weight in almost all age group categories, while CW, CD, and HW are the opposite.

DISCUSSION

The Minister of Agriculture of Indonesia has issued Decree No. 882/KPTS/PK.010/M/12/2022 (Ministry of Agriculture, 2022), which officially recognized the Sakub sheep as a crossed breed. These sheep are obtained from crossbreeding between local Indonesian and foreign breeds, including Suffolk, Dorper, Texel, and Merino. Other local crossbreeds around Brebes Regency, including Wonosobo, result from crossing thin-tailed and fat-tailed sheep with Texel. As indicated by the name, Wonosobo sheep originated from Wonosobo District (Ministry of Agriculture, 2011b). Furthermore, the Batur sheep, identified in Banjarnegara Regency, is a distinct breed obtained from a cross between local (thin-tailed sheep) and Merino sheep (Ministry of Agriculture, 2011a).

The body size of Batur sheep between the ages of >12–24 and >24–48 months was higher for HG (98.35±19.71 and 102.96±18.75 cm) and BL (68.43±7.45 and 70.96±5.82 cm, respectively), but lower compared to Sakub sheep at the age of >36–48 months. Meanwhile, Batur's WH was lower than Sakub sheep in both age categories (59.48 ± 6.57 and 62.08 ± 6.37 cm, respectively) (Ibrahim et al., 2020), indicating a short and fat body conformation. Wonosobo sheep showed relatively the same BL size as Sakub sheep at the ages of >12–24, >24–36, and >36–48 months, with values of 67.83, 68.84, and 69.64 cm, respectively. However, lower values were obtained for HG at 79.61, 81.32, and 80.89 cm, as well as WH at 60.04, 61.52, and 62.19 cm (Hakim et al., 2019), indicating an extended body conformation, with a smaller front body size.

The body weight of livestock is crucial for assessing dietary requirements. It is associated with reproductive capacity regarding the number of offspring produced, administering medicine doses, evaluating growth, and selecting replacements (Al-Khamaiseh et al., 2020). In this study, the body weight of female Sakub sheep experienced linear growth until the >36–48 months group, reaching 47.34 kg. This result varied significantly from Hakim et al. (2019) regarding the growth pattern of Wonosobo female sheep, where the development curve began to slope at the age of >12–24 and >36–48 months, with a weight of 38.4 and 44.6 kg, respectively. Various factors, including genetics, influence optimal body weight in sheep (Pasandideh et al., 2020; Wu et al., 2020; Zhang et al., 2013), nutrition (Huma & Iqbal, 2019; Jiang et al., 2020; Malik & Muryanto, 2020), management practices (Bhateshwar et al., 2023; Ptáček et al., 2014), and environmental conditions (Bhateshwar et al., 2023).

The development of the vertebrae, including the lumbar, sacral, and thoracic, is

represented by body length in sheep, showing the growth of the skeleton and the vertebral structure. BL's linear growth is followed by CD development, while CW slopes at >36–48 months. CD and CW measurements offer valuable information about the thoracic and ribcage dimensions, showing chest conformation and body shape based on bones and the width of the chest cavity of animals. Similarly, López-Carlos et al. (2010) stated that Dorper sheep had high growth, and canonical discrimination analysis showed superiority in traits related to girth, including HG and CW. Meanwhile, Katahdin and Pelibuey sheep are closely related in terms of SH and hip height (HH) at age different sizes. This phenomenon is attributed to the close relationship with Dorper sheep, indicating the categorization of Sakub sheep in the thick form category. According to Zulfahmi et al. (2016), the growth of internal organs and muscular tissue attached to the shoulder blades affected changes in CD. Suharyati et al. (2023) found that the CD in single pregnancies was less compared to twin births, indicating a connection between performance differences of genetic and environmental factors and the interaction between livestock and their surroundings (Noor, 2010). It shows that several factors, such as nutrient intake, health status, age, genetics, and type of birth, influenced CD and CW.

In this study, HG experienced rapid growth until >7-12 months, followed by a gradual decline. The measurement of HG indicates thoracic circumference, providing insight into chest development and body mass. This observation significantly differs from the previous statement, where HG is considered body size with the closest relationship with body weight. The growth of the chest ribs and the accumulation of thicker flesh impact the chest circumference, as reported by Lake (2016). Bautista-Díaz et al. (2020) stated that abdominal circumference is used to estimate carcasses, indicating the decline in HG growth at >7–12 months. Generally, bone growth slows and stops in old age, while flesh development can continue. Body weight growth is assumed to correlate more positively with abdominal circumference after >7–12 months of age than HG.

BL is a representation of the vertebrae growth, including the lumbar, thoracic, and sacral, which resembles the entire skeletal development and vertebral anatomy of sheep. Meanwhile, WH represents the growth and conformation of the forelegs and upper legs, serving as a critical indicator of body support and structural development in sheep. HH and hip-width (HW) indicate the pelvic structure and hindquarter conformation, showing the functional and anatomical characteristics of the hind limbs as well as the pelvis in sheep. Similar to the HG size, the growth of BL and HH also begins to slope at >7–12 months, while WH slopes at >24–36 months. Although the growth pattern of HW shows irregularities, rapid development is observed from >7–12 to >12–24 months.

Based on these results, body size related to body frame relatively experiences a plateau in adulthood. Meanwhile, other parameters except HG have linear growth

patterns similar to body weight. Compared to Kurniawati et al. (2019) and Trisnawanto et al. (2012), where BL showed a strong correlation with body weight due to its positive correlation with livestock body weight, the growth of BL and WH declined between one and two years of age (Hakim et al., 2019; Ibrahim et al., 2021). Similarly, Tillman et al. (1998) stated that sheep grew rapidly from birth to puberty, followed by deceleration until maturation.

According to the Pearson correlation module (raw), the live weight of Yakansa sheep in the 1–4 years age range was very high (p<0.001), which correlated with HG at 0.9. Meanwhile, bone size (HW) was negatively correlated (-0.40) with muscle size (Afolayan et al., 2006). In another study, WH was not included in any trait model correlations with BW in sheep lamb hair (Bautista-Díaz et al., 2020). Zulkharnaim et al. (2016) stated that the BL of goats is an essential factor in stock selection, as higher BL shows a greater potential of bearing twins. However, genetic and nongenetic factors influence animal growth and development curves (Do & Miar, 2019; Kopuzlu et al., 2014) based on breed (Deribe et al., 2023). Pasandideh et al. (2020) and Zhang et al. (2013) further emphasized that genetic factors played an essential role in determining the growth potential of sheep due to the influence of specific genes and genetic variations.

This study showed that body size in female Sakub sheep in the form of CW and CD can continue to grow until maturity. In contrast, the growth pattern in body size related to body frame experiences a gradual slope when entering adulthood. It is attributed to the limitation of bone growth at a certain age, while muscle and fat growth can continue, influencing body size related to muscle. The optimal age for bone growth in sheep varies based on various factors such as breed, genetics, nutrition, and management practices. However, some general patterns and references can provide an idea of bone growth in sheep. Rentsch et al. (2014) stated that bone growth is a complex process influenced by various factors, including hormonal regulation, genetic factors, and environmental conditions. Therefore, the optimal age of bone growth varies between individual animals and breeds (Pearce et al., 2007), indicating that body conformation differs across various sheep.

The correlation between body weight and body size in female Sakub sheep was analyzed using a heat map; the study by Bila (2023) on body measurements of Sussex cows can provide valuable insight. The correlation analysis in this study provides a visual representation of the relationships between different variables and the predicted body weight of the cattle. Adapting this methodology to the context of Sakub sheep could create a heat map illustrating the correlations between different body sizes and body weights in these sheep. Correlation analysis of female Sakub sheep's body size and body weight was conducted on sheep of all ages (Figure 3) and in separate age group categories (Figure 4). The multicollinearity test results for the BW regression model for all HG, CW, CD, BL, WH, HH, and HW

combinations showed a tolerance value >0.10 and the proportion of variance or variance inflation factor (VIF) value <10.00, meaning no multicollinearity in the model (Ibrahim et al., 2021).

The correlation results in Figure 3 demonstrated that BW had an extremely positive, statistically substantial correlation with CD, BL, WH, HH, and HW; nevertheless, it was correlated with CW. For the phenotypic correlation result of female Sakub sheep of all ages, BW had a positive, substantial, and statistical correlation to all linear body measurements. It implies that an increment in size will cause BW to increase and vice versa. The findings support the study of Okpeku et al. (2011), who found positive and highly significant correlations between body weight and biometric traits in West African Dwarf and Red Sokoto goats.

Similarly, Hassen et al. (2012) identified that an increase in heart girth or body length resulted in a corresponding increase in live weight in Ethiopian indigenous goat populations. Furthermore, studies like that of Abera et al. (2014) emphasized the strong relationship between chest girth and body weight in indigenous sheep. It indicates that specific body measurements, such as chest girth, significantly predict body weight in sheep. Moreover, dos Santos Fonseca et al. (2021) highlighted that thoracic perimeter is one of the most correlated body measurements with body weight in goats, consistent with findings in other species like sheep. Additionally, Tuncer et al. (2022) mentioned that measurements such as chest depth and body length are highly correlated with the conformation and growth of sheep. In conclusion, body measurements such as chest girth, heart girth, and thoracic perimeter have been identified as key factors that are positively correlated with body weight in goats and sheep.

The correlation between body weight and body size in different age categories weakens. The color gradation on the heat map fades to the right (Figure 4). Studies have shown that the relationship between body weight and measurements becomes less strong as animals age. Sowande and Sobola (2008) confirmed that the relationship between live weight and body measurements, such as chest girth, in sheep weakens as they age. Furthermore, Abera et al. (2014) highlighted that chest girth, a key body measurement trait, shows the highest correlation with body weight in sheep. However, this correlation weakens as sheep age.

Additionally, studies by Rather et al. (2022) and Zhao et al. (2017) indicated that while certain body measurements like chest width and chest depth significantly correlate with body weight in sheep, this correlation diminishes as the animals grow older. In summary, the correlation between body weight and body size in livestock, particularly sheep, may weaken with age. While certain body measurements are strongly correlated with body weight, this relationship may become less pronounced as animals mature. Understanding these dynamics is crucial for accurate estimation of live weight and effective management practices in livestock farming.

CONCLUSION

The study showed that the rapid growth of female Sakub sheep, including CW and CD, continued to grow until maturity. In contrast, growth patterns associated with body frames such as BL, WH, HH, and HW showed a rapid increase from birth until puberty, followed by a decline that ceased at maturation. The correlation between body weight and body size of female Sakub sheep of all ages showed that body weight has a positive and significant correlation to all linear body sizes. However, the correlation between body weight and size in different age categories weakens.

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