



## Influence of Phenotypic Body Measurements on Reproductive Efficiency of Indigenous Barbary Females in Al-Sekt Region, Libya

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This study was conducted in Misurata city, Al-Sikt area included a sample of (6 twin-birthed and 10 single-birthed females). The weights of these females varied, ranging from 40 to 64.5 kg, While the ages of these females ranged between 3 to 6 years. The main objective of this study was to evaluate the effect of apparent anthropometric parameters such as weight, body length, body height, chest circumference, abdominal circumference, abdominal height, and wither circumference on the reproductive performance of the well-known local Barbary females. The results showed that the averages of these parameters were ( $50 \pm 1.8$  kg,  $73.5 \pm 1.2$ ,  $78.7 \pm 0.9$ ,  $90.7 \pm 1.6$ ,  $105 \pm 2.2$ ,  $37 \pm 0.7$ ,  $39.4 \pm 0.4$ , and  $8.3 \pm 0.1$  cm) respectively, reflecting the observed differences in anthropometric parameters. The study also showed a significant effect ( $P < 0.05$ ) of these measures on the reproductive efficiency of local, as females that gave birth to twins outperformed females that gave birth to singletons in body measurements, indicating the importance of these measures in determining reproductive productivity levels.

## 1 Introduction

Sheep provide meat, milk, wool, and hides for local and international markets (Morris, 2017). Worldwide, there are over 1.2 billion sheep, with 0.40% of the total population located in semi-arid regions, with higher concentrations in India, the Middle East, the highlands of East Africa, and South America (Dos Santos, *et al.* 2023; IWTO, 2022). The world's population growth, particularly in Arab countries, is leading to a continuous rise in the standard of living, education, and culture,

which increases the demand for food, particularly proteins and energy. However, this increase in food consumption, whether for human or animal use, does not keep pace with the required increase in agricultural and livestock production. This gap contributes to the spread of famine and malnutrition in many countries around the world, as these countries are unable to meet the food needs of their populations. Data has shown a significant shortage of animal products in the Arab region, in light of the growing demand. This is due to the lack of rainfall, the degradation and shrinkage of natural pastures, and

desertification (available at the following link: <https://www.un.org/ar/208249>).

Sheep farming in Libya, particularly the Barbary breed, faces numerous challenges the increasing demand for animal products. One of the most prominent challenges is the low twinning rate, which negatively impacts productivity.

Sheep farming occupies a significant position in Libya and is one of the most important pillars of livestock production. It is also the primary source of meat, with the number of sheep in Libya estimated at approximately 7.3 million, according to a 2021 FAO report. The Barbary breed constitutes the largest portion of Libya's sheep population and is the most widespread throughout the country. It relies on natural pastures for its nutrition and is considered one of the most important sources of meat production (Shariha & Al-Ghadri 1996).

Studying the effect of body measurements on the reproductive efficiency of local (Barbary) sheep great importance for understanding how various body factors affect reproductive capacity. Understanding this effect can help improve sheep breeding and increase productivity. Furthermore, the results can contribute to preventive measures to maintain animal health and reduce reproductive diseases and abnormalities.

Body measurements are an important indicator of reproductive efficiency in local sheep. The body dimensions and symmetry of an animal can be indicative of reproductive capacity and health. Therefore, body measurements provide valuable information for assessing reproductive performance and improving local sheep breeding.

Barbary sheep are highly resilient and adaptable to various challenging environmental conditions and are highly efficient at exploiting poor pastures and converting them into protein, milk, and wool. Many imported breeds were introduced for testing in experimental stations with the aim of introducing them into local sheep improvement programs, the most important of which are the Awassi, the Kiyos, the Morino, the Karman, and the Karakul. Sarda, Suffolk, Dorset, and Australian sheep were also introduced (Shariha & Al-Ghadri 1996).

Reproductive efficiency has been a priority for local sheep improvement programs, particularly twin births. Reproduction and lamb production are the primary goals of local sheep breeding. Ewe production efficiency can be improved by increasing the number of offspring per litter through genetic selection, improving environmental conditions, and exploiting genetic variation between animals of the same breed and between different breeds (Al-Qass et al., 1993).

Amin (2003) also emphasized the importance of genetic selection in increasing twinning and the need for special records to ensure successful development and management of sheep farms. The aims of present study the effect of phenotypic body measurements on reproductive efficiency in local Barbary sheep, one of the most significant drawbacks of which is the rarity of twins (Majid *et al.*, 2006).

The relationship between anthropometric measurements of Barbary females and reproductive efficiency, with the goal of identifying factors that influence the ability of females to produce twins. Previous studies indicate a potential association between certain anthropometric measurements and twinning rates in several sheep breeds. Understanding this relationship will contribute to the development of a more effective genetic improvement program to increase the productivity of local sheep flocks and enhance food security in the country. Roved valuable information for breeders to make better decisions about selecting females with high production potential.

## 2 Materials and Methods

This study was conducted in Sakt area of Misrata. A standard metre was used to measure body length, body height, chest circumference, abdominal circumference, chest height, abdominal height, and hump circumference. A watch scale was then used to keep the animal suspended in the air, not touching the ground, to ensure more accurate weighing.

### 2.1 Animals:

Sixteen Barbary sheep were kept in a semi-open pen (50% open and 50% closed). Twelve feeders were available, each measuring 2.5 meters in length. Feed was provided in two shifts, in the form of course and concentrated feed. The feed quantity provided was estimated at approximately 700 grams per head per day. The ages of the ewes determined by dentition.

### 2.2 Statistical Analysis:

SPSS was used to analyze variance and test the least significant difference between the studied measures. The correlation coefficient between these measures was calculated for females with twin and singleton births and reproductive efficiency.

## 3 Results

The study results showed statistically significant differences ( $p \leq 0.01$ ) in some body measurements between females who gave birth to twins and females who gave birth to singletons. It was observed that females with twins had significantly ( $96 \pm 1.23b$ ) larger

chest circumference, abdominal circumference, and erect circumference compared to females with singletons. However, no significant differences were found between the two groups in other measurements ( $P \geq 0.05$ ), such as body length, body height, abdominal height, and chest height, as shown in Table (1).

**Tables (1):** relationship between mean value of body measurements for singleton and twin-born females.

Body Measurements	Singleton females	Twin-born females	Overall mean
Body Length	72± 1.76a	75.50±0.88a	73.56±1.19
Body Height	77.5±1.11a	80.83±1.04a	78.75±0.88
Chest girth	87.6±1.73a	96±1.23b	90.75±1.55
Abdominal girth	100.8±2.36a	112.3±2.57b	105.12±2.23
Abdominal height	37±0.92a	37.16±1.22a	37.12±0.71
Chest height	39±0.55a	40.16±0.79a	39.34±0.46
Shank circumference	8±0.8a	8.58±0.2b	8.25±0.11

"Lowercase letters (b, a) in the same row indicate significant differences ( $P < 0.05$ )."

The findings of this study suggest a significant association between multiple births and specific anthropometric measurements in females. The greater

chest, abdominal, and hip circumferences observed among female twins may be associated with physiological or developmental adaptations related to multiple gestations.

These results are consistent with a study by (Jayed *et al.* 2008). This indicated a significant effect of different body measurements (body length, front height, rear height, chest circumference, and hip circumference) on the fertility rate, as females who gave birth to twins had a better body condition compared to females who gave birth to singletons.

The increased chest and abdominal circumferences in female twins may be explained by the increased uterine size and the amount of amniotic fluid required to carry twins. Increased pressure on internal organs may also contribute to the increased hip circumference. However, the lack of significant differences in body length and height suggests that female longitudinal growth is not significantly affected by multiple births.

The strong correlation between various body measurements (weight, body length, chest girth, etc.) and reproductive efficiency, as shown in the accompanying Table 2, highlight the importance of body size and structure in relation to the reproductive potential of Barbary sheep. These correlations indicate that females with larger body dimensions, particularly chest girth measurements, tend to exhibit higher reproductive efficiency.

**Table (2):** Correlation coefficients between body measurements and reproductive efficiency in Barbary sheep.

	Reproductive performance	Body weight	Body Length	Body Height	Chest girth	Abdominal girth	Abdominal height	Chest height	Shank circumference
Reproductive performance	1	0.45	0.32	0.47	0.67**	0.64**	0.01	0.31	0.6*
Body weight	-	1	0.66**	0.53*	0.83**	0.93**	0.35-	0.17	0.45
Body Length	-	-	1	0.64**	0.63**	0.62*	0.04-	0.38	0.41
Body Height	-	-	-	1	0.62*	0.54*	0.34	0.79**	0.51*
					0.01	0.03	0.19	0.00	0.04

Chest girth	-	-	-	-	1	0.92**	0.17-	0.35	0.57
						0.00	0.51	0.18	0.02
Abdominal girth	-	-	-	-	-	1	0.38-	0.23	0.53*
							0.28	0.39	0.03
Abdomina l height	-	-	-	-	-	-	1	0.79**	0.1
								0.00	0.00
Chest height	-	-	-	-	-	-	-	1	0.26
									0.33
Shank circumference	-	-	-	-	-	-	-	-	1

\* Correlation coefficient significant at  $p < 0.05$

\*\* Correlation coefficient significant at  $p < 0.01$

The analysis results showed a statistically significant positive correlation ( $p < 0.01$ ) between chest and abdominal girth and reproductive efficiency, indicating that sheep with larger body measurements tend to be more fertile. These results are consistent with previous studies (Shirzeyli *et al.* 2013, Afolayan *et al.* 2006, Awuah *et al.* 2000), which indicated that sheep with larger body measurements tend to be more fertile. This association is likely due to a relationship between body size and energy reserves, as larger sheep provide greater energy reserves to support pregnancy and lactation. To further understand this relationship, it is recommended to conduct a multiple regression analysis to control for the influence of other factors such as age and breed. In addition, future studies could be conducted to determine the precise biological mechanisms linking body measurements and reproductive efficiency.

In addition, Table (2) showed a strong and statistically significant correlation ( $p \leq 0.01$ ) between different body parameters (weight, chest circumference, and abdominal circumference) and reproductive efficiency in Barbary sheep. The highest correlation coefficients were found between body weight and abdominal circumference (\*\*0.93) and chest circumference (\*\*0.83). The results also showed a positive correlation between reproductive efficiency and chest circumference (\*0.67), abdominal circumference (\*0.64), and rump circumference (\*0.60). These values were similar to those found by

(Shirzeyli *et al.* 2013 – Afolayan *et al.* 2006 – Awuah *et al.* 2000).

As for the subject of the study, there was a highly significant correlation coefficient at ( $P < 0.01$ ) between reproductive efficiency and chest circumference and abdominal circumference, which were (\*\*0.67 - \*\*0.64) respectively, and with the upright circumference (\*0.60). Accordingly, we conclude that measures of different body parts can be used to improve reproductive efficiency through selection, and this is consistent with (Jayed *et al.* 2008).

#### 4 Discussion

The observed positive correlation between chest and abdominal girth and reproductive efficiency is consistent with the results of previous studies (Shirzeyli *et al.*, 2013; Afolayan *et al.*, 2006; Awuah *et al.*, 2000), which also showed that larger females are more fertile. This relationship may be related to body size and energy reserves. Larger females generally have greater energy reserves, which is important for meeting the physiological demands of pregnancy and lactation, potentially improving reproductive outcomes.

The significant correlation between chest and abdominal girth suggests that these measurements may be useful phenotypic indicators for predicting reproductive

potential in Barbary sheep. The positive correlation with femur circumference, although somewhat weak, suggests a potential relationship between bone growth and reproductive performance.

Our results are consistent with previous studies across different breeds and geographic locations, reinforcing the notion that body size plays an important role in sheep reproductive efficiency. This is consistent with the findings of Jayed *et al.* (2008) and also demonstrated the potential of using body measurements as a selection criterion to improve reproductive performance in sheep populations.

## 5 Conclusions

This study aimed to investigate the relationship between apparent body size and reproductive performance in local Barbary sheep. Significant differences ( $p < 0.01$ ) were observed between goats with a history of twin births and those with single births in chest girth, abdominal girth, and tibia girth; goats with twin births exhibited larger girths. Correlation analysis also showed a significant positive association ( $p < 0.01$ ) between chest girth and abdominal girth with reproductive efficiency. These results are consistent with previous research showing that larger body dimensions indicate greater fertility in sheep, possibly due to greater energy reserves supporting pregnancy and lactation. These results suggest that chest girth and abdominal girth can be useful phenotypic indicators of reproductive potential in Barbary sheep and highlight the potential for using anthropometric measurements in selection strategies to improve reproductive efficiency in this breed.

## 6 Recommendations:

Based on the results of this study, we offer the following recommendations:

1- Phenotypic selection: Chest and abdominal girth should be considered as easily measurable phenotypic traits to select Barbary sheep with the greatest reproductive efficiency. Sheep with higher values for this parameter could be prioritized in breeding programs aimed at improving fertility.

2- Body condition score integration: Although not directly measured in this study, future studies should investigate the relationship between body condition score (BCS) and observed body size at different reproductive stages, as BCS is closely related to energy reserves and reproductive success. Combining BCS assessment with body measurements may provide a more comprehensive approach to predicting and managing reproductive performance.

3- Further study of snout circumference: Although there is a weak significant association between snout circumference and reproductive efficiency, its potential role as an indicator of reproductive fitness in Barbary sheep requires further investigation. Exploring the underlying physiological mechanisms linking structural development to reproductive traits can provide valuable insights.

4. Longitudinal Studies: Longitudinal studies tracking body size and reproductive performance in individual multiparous females are recommended to better understand the temporal dynamics of this relationship and assess the predictive power of early body size on long-term reproductive performance.

5. Genetic Analysis: Future studies should explore the genetic basis of the observed association between body size and reproductive efficiency. Identifying potential genes associated with these traits may facilitate the development of marker-assisted selection (MAS) to further improve reproductive performance in Barbary sheep.

6. Larger Population Studies: Given the limited sample size of this study, similar studies should be conducted on larger and more diverse groups of Barbary sheep in different geographical locations and management systems to confirm and expand current findings.

7. Integration with Management Practices: The potential impact of management practices, such as feeding and health protocols, on the relationship between body size and reproductive efficiency should be investigated. Improving these practices, combined with body composition-based selection, could lead to synergistic improvements in reproductive performance.

These recommendations aim to guide future research and practical application in the management and breeding of Barbary sheep to improve their reproductive efficiency.

**Conflict of interest:** The authors declare that there are no conflicts of interest

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