

PREDICTION OF THE BODY WEIGHT OF ALGERIAN TAZEGZAWT SHEEP BREED FROM BODY MEASUREMENTS

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ABSTRACT

This study was aimed to determine the practicality of using linear body measurement traits to predict body weight of Tazegzawt sheep breed in the experimental station of INRAA in Bejaia. 38 female and 16 male aged over 2 years were used to investigate the relationships between live weight and body measurements such as scapular-ischial length, withers height, rump height, heart girth, chest depth, shoulder width, hip width, pelvis length and cannon perimeter. Pearson correlations showed a strong positive significant correlation ($p < 0.001$) between BW and rump height ($r = 0.76$), withers height ($r = 0.73$) and the chest depth ($r = 0.73$), with variations by sex. The results of multiple regression and stepwise showed that chest depth, the shoulder width and the cannon perimeter are the most valuable for estimating the body weight of the animals studied. A further implication of this study is to help smallholder farmers to estimate the live weight of their sheep from simple linear measurements and help the vet to determine suitable medication dosage during health care and required feed amount of the animal.

Key words: body weight, chest depth, rump height, pelvis length, regression

جعوط وآخرون

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التنبؤ بوزن جسم نعاج التازغزاوت الجزائري من قياسات الجسم

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المستخلص

هدفت الدراسة تحديد مدى قابلية استعمال صفات قياس الجسم الخطي للتنبؤ بوزن جسم سلالة أغنام تازغزاوت في المحطة التجريبية لـ INRAA في بجاية. تم استخدام 38 أنثى و 16 ذكراً تزيد أعمارهم عن عامين للتحقيق في العلاقات بين الوزن الحي وقياسات الجسم مثل طول الكتف، ارتفاع الكتفين، ارتفاع الردف، محيط القلب، عمق الصدر، عرض الكتفين، عرض الورك، طول الحوض والمدفع محيط. أظهرت ارتباطات بيرسون علاقة ارتباط موجبة قوية ($p > 0.001$) بين وزن ا وارتفاع الردف ($r = 0.76$)، وارتفاع الكتفين ($r = 0.73$) وعمق الصدر ($r = 0.73$)، مع وجود اختلافات حسب الجنس. أظهرت نتائج الانحدار المتعدد والتدرجي أن عمق الصدر وعرض الكتف ومحيط المدفع هي الأكثر قيمة لتقدير وزن الجسم للحيوانات المدروسة. من الآثار الأخرى لهذه الدراسة مساعدة المزارعين أصحاب الحيازات الصغيرة على تقدير الوزن الحي لأغنامهم من قياسات خطية بسيطة ومساعدة الطبيب البيطري على تحديد جرعة الدواء المناسبة أثناء الرعاية الصحية وكمية العلف المطلوبة للحيوان.

الكلمات المفتاحية: وزن الجسم، عمق الصدر، ارتفاع الردف، طول الحوض، الانحدار

INTRODUCTION

Sheep farming in Algeria is considered as the main vocation of semi-arid and arid regions, where these animals express their particular productive performances (1,22). This breeding plays an important role both in the national agricultural economy and for the livestock farmers, thus offering a considerable financial reserve. The national sheep herd has about 27807700 head (17), which ensure a red meat production of about 60% of the total national supply compared to 34% of beef. Meat production from goats (8%) and camels (2%) remains very marginal, with meat only consumed in the south of the country (21). The wool and milk are for family consumption. The Blue Kabylie, commonly called by the breeders "Tazegzawt", which means the blue color in Berber language (11) and said Ham in the region of Mecheria (Naama). It remains so far unknown and does not even appear in the official nomenclature of the Algerian sheep breeds. (11). It is a small local sheep breed, considered among the endangered and extinct breeds in Algeria. There are currently just 300 heads (11). It has recently been the subject of a phenotypic, genetic and zootechnical characterization (11, 12, 14, 19; 20) for its standardization and preservation. Body weight is a very important feature in breeding due to selection criteria and economic profitability (5). For that to determine the most correlated body weight measurements and to establish a specific formula for estimating the body weight of this breed in the absence of flip-flops or weighing livestock.

MATERIALS AND METHODS

Sheep samples: This study was carried out at the INRAA Oued Ghir experimental station located south west of the Bejaia province. Due to the low number of this breed in Algerian territory, a total of 54 sheep (38 ewes and 16 rams) with an age range between 2 and 6 years (3.72 ± 1.2 years) of Tazegzawt breed were used in the study. Animals were identified from birth.

Body measurements: The standard breed descriptor list for sheep developed by FAO (2012) (13) was closely followed in selecting

body measurements like : Body length or Scapular-ischial length (SIL), withers height (WH), rump height (RH), heart girth (HG), chest depth (CD), shoulder width (SW), hip width (HW), pelvis length (PL) and cannon perimeter (CP). The body weight (BW) and the body measurements were measured for each animal before morning feeding to avoid abdominal swelling due to excessive intake of water and feed.

Statistical Analysis: To determine the correlation between body weight (BW) and different body measurements; the various parameters studied were calculated and analyzed by several statistical methods.

Descriptive statistics : To determine the mean and standard deviations of BW and body measurements studied.

Correlation : Correlation coefficient was used to determine degree of the linear relationship between body weight and other continuous variables (24).

Multiple linear regression : This model was used to assess the relative contribution of body weight and different body measurements (24).

Stepwise: The stepwise regression method was used to determine which linear body measurement or combination of measurements was a good estimator of the body weight of Tazegzawt sheep (10).

RESULTS AND DISCUSSION

Descriptive statistics: The influence of sex is very significant ($p < 0.001$); rams are very heavy (BW), very higher (WH and RH) with an important chest depth (CD). They also longer (SIL, $p < 0.05$), larger forward (SW, $p < 0.01$) with a developed heart girth ($p < 0.01$) than ewes. However, cannon perimeter (CP), pelvis length (PL) and rump width (RW) were not affected ($p > 0.05$) by sex (Table 1). The superiority of Tazegzawt males compared with females is noticed in other Algerian sheep breeds such as the Ouled Djellal (8; 9), Rembi (9) and other sheep breeds (15, 16, 27). Males, compared to females are generally higher in body weight and linear body measurements, which might be due to the differences in sex hormones, which regulate through differential genetic constitution in the two sexes (27).

Table 1. Descriptive statistics of body weight (kg) and body measurements (cm)

Measurements	Mean ± Sd			CV	P
	Male	Female	Total		
N	16	38	54		
BWb (kg)	90.8±8.74	56.7±8.36	66.8±17.8	26.7	<0.001
SIL (cm)	91.4±11.1	86.2±6.24	87.7±8.23	9.38	<0.05
WH (cm)	87.9±3.4	81.8±4	83.6±4.72	5.65	<0.001
RH (cm)	87.9±2.14	82.3±3.15	84±3.87	4.62	<0.001
HG (cm)	112 ±7.79	106±6.1	108±7.13	6.59	<0.01
CD (cm)	40.4±2.78	35.8±3.2	37.2±3.7	9.97	<0.001
SW (cm)	26.1±4.12	23.5±2.55	24.3±3.27	13.4	<0.01
RW (cm)	28.1±3.26	27.3±1.93	27.5±2.4	8.71	ns
PL (cm)	32.9±2.63	30.8±3.88	31.4±3.65	11.6	ns
CP (cm)	9.94±0.87	9.51±2.39	9.64±2.06	21.4	ns

Number (N), Body weight (BW), Scapular-ischial length (SIL), Withers height (WH), Rump height (RH), Heart girth (HG), Chest depth (CD), Shoulder width (SW), Rump width (RW), Pelvis length (PL), Cannon perimeter (CP).

Correlation between body weight and different body measurements

Result in Table 2 shows that the linear measurements were highly correlated with

body weight of Tazegzawt sheep (p<0.01). Similar results were reported by Djaout et al. (2018) (9) in Ouled Djellal breed and other sheep breeds (5; 18, 23, 29).

Table 2. Correlation coefficients showing interrelationships between various measurements of body weight of Tazegzawt sheep breed

		SIL	WH	RH	HG	CD	SW	RW	PL	CP	BWb
SIL	T	1									
	M										
	F										
WH	T	0.49***	1								
	M	0.44									
	F	0.43**									
RH	T	0.41**	0.87***	1							
	M	0.15	0.50*								
	F	0.42**	0.86**								
HG	T	0.59***	0.57***	0.53***	1						
	M	0.60*	0.37	-0.03							
	F	0.50**	0.50**	0.55**							
CD	T	0.42**	0.59***	0.55***	0.64***	1					
	M	0.47	0.42	-0.09	0.74**						
	F	0.27	0.37*	0.37*	0.48**						
SW	T	0.62***	0.52***	0.48***	0.71***	0.48***	1				
	M	0.68**	0.57*	0.28	0.87**	0.58*					
	F	0.46**	0.36*	0.42**	0.50**	0.26					
RW	T	0.56***	0.44**	0.22	0.56***	0.51***	0.55***	1			
	M	0.71**	0.64**	-0.01	0.72**	0.74**	0.69**				
	F	0.33*	0.35*	0.26	0.41*	0.42**	0.36*				
PL	T	0.56***	0.61***	0.51***	0.68***	0.56***	0.47***	0.47**	1		
	M	0.64**	0.53*	-0.04	0.75**	0.79**	0.73**	0.91**			
	F	0.54**	0.61**	0.57**	0.64**	0.45**	0.33*	0.29			
CP	T	0.28*	0.34*	0.35**	0.40**	0.21	0.49***	0.06	0.30*	1	
	M	0.52*	0.36	0.19	0.67**	0.30	0.81**	0.38	0.40		
	F	0.27	0.38*	0.42**	0.40*	0.19	0.54**	-0.02	0.28		
BWb	T	0.42***	0.73***	0.76***	0.58***	0.73***	0.54***	0.34*	0.49***	0.20	1
	M	0.42	0.45	0.04	0.74**	0.64**	0.61*	0.72**	0.64**	0.45	
	F	0.32	0.60**	0.62**	0.43**	0.59**	0.47**	0.24	0.55**	0.25	

Total (T), Male (M), Female(F), Scapular-ischial length (SIL), Withers height (WH), Rump height (RH), Heart girth (HG), Chest depth (CD), Shoulder width (SW), Rump width (RW), Pelvis length (PL), Cannon perimeter (CP), Body weight (BWb), *Significant Correlation at p <0.05, **Significant Correlation at p <0.01, ***Significant Correlation at p <0.001.

WH is most correlated with live weight in Highland Ethiopian sheep (2, 26, 27) and the Iranian sheep (23), whereas the rump height (RH) shows significant positive correlations with BW in sheep (2). HG has a positive correlation with BW but is not the most correlated (HG: $r=0.58$, $p<0.001$), while Dekhili and Aggoun (7); Djaout et al. (9) indicated that HG is the most correlated trait to BW in the Ouled Djellal breed. Furthermore, SW, PL, SIL and RW showed significant positive correlations with BW. The scapular-ischial length (SIL) present height correlations with BW in several studies (2, 23, 26). In males, the highest correlation with BW was observed with heart girth (HG: $r=0.74$, $p<0.01$). HW ($r=0.72$, $p<0.01$), PL ($r=0.64$, $p<0.001$) (27) and CD ($r=0.64$, $p<0.01$) also have significant positive correlations with BW.

These results were observed in different study on sheep breed (26, 27). While in females, body weight is more correlated with height (RH: $r=0.62$, $p<0.001$ and WH: $r=0.60$, $p<0.001$) (26, 27), chest depth (CD: $r=0.59$, $p<0.001$), pelvis length (PL: $r=0.55$, $p<0.001$) and shoulder width (SW: $r=0.47$, $p<0.01$). The HG is the least correlated measure to BW unlike males (HG: $r=0.43$, $p<0.01$). The cannon perimeter is used for the calculation of skeletal finesse (3, 6). In this breed, CP has no correlation with BW ($p>0.05$), unlike Ouled Djellal breed (9).

Multiple linear regression and stepwise analysis: Regression coefficients and the probability of the estimated variables in predicting the body weight of Tazegzawt sheep are shown in Table 3.

Table 3. The regression coefficient (b), standard error (SE), t-value and probability (P) of the estimated variables in predicting body weight by the multiple linear regression analysis

Variables	b	Std.Err	t	P
SIL	-0.02	0.23	-0.09	0.926
WH	0.83	0.68	1.22	0.227
RH	1.49	0.78	1.90	0.064
HG	0.09	0.34	0.27	0.787
CD	2.14	0.52	4.12	<0.0001
SW	1.39	0.69	2.02	0.05
RW	-1.25	0.87	-1.44	0.158
PL	-0.34	0.55	-0.61	0.546
CP	-1.62	0.79	-2.05	0.046

Intercept = -188.65, $R=0.872$, $R^2=0.761$, $R^2 Adj=0.712$

The scapular-ischial length (SIL), withers height (WH), rump height (RH), heart girth (HG), rump width (RW) and pelvis length (PL) were statistically non-significant

($P>0.05$). This is an indication that these variables were less important in the estimation of body weight (Table 4).

Table 4. Regression summary for dependent variable by the stepwise procedure analysis

Sex	Step	Variable entered	B	Std.Err	P
Male	1	HG	0.68	0.29	0.042
	2	CD	1.20	0.33	0.001
Female	1	CD	1.28	0.48	0.013
	2	SW	1.43	0.59	0.020
Flock	1	CD	2.11	0.47	<0.0001
	2	SW	1.43	0.59	0.020
	3	CP	-1.65	0.76	0.035
	4	RH	1.52	0.75	0.049

Intercept M= 18, Intercept F= -72.3, Intercept flock = -183. $R^2=0.76$, $R^2 Adj=0.73$

The obtained results show that the prediction model equation for body weight is formulated using the body measurements as follows: $BW = -188.65 - 0.02SIL + 0.83WH + 1.49RH + 0.09HG + 2.14CD^{***} + 1.39SW^* - 1.25RW - 0.34PL - 1.62CP^*$ When the regression equations were constructed using the general model for prediction of BW from all body measurements, the prediction equation the

accuracy of prediction was $R^2=0.71$. The results showed that the chest depth (CD: $p<0.001$) and the shoulder width (SW, $p<0.05$) have a positive and highly significant influence on body weight. However, the direct effect between cannon perimeter (CP) and body weight was negative (-1.62; $P<0.05$) and significant, as well (Table 5).

Table 5. Multiple linear regression of body weight with body measurements in Tazegzawt breed

Sex	Regression equation	R ²	R ² Adj
Flock	BW= -183 + 2.11CD*** + 1.43SW* - 1.65CP* + 1.52RH*	0.76	0.73
Ram	BW= 18 + 0.68HG*	0.69	0.58
Ewe	BW= -72.3 + 1.2CD*** + 1.28SW*	0.63	0.56

Body weight (BW), Heart girth (HG), Chest depth (CD), Shoulder width (SW), Cannon perimeter (CP), Rump height (RH), *p<0.05; **p<0.01; ***p<0.001.

The use of forward stepwise regression showed the prediction equation the accuracy of prediction was R²= 0.76, it is higher than that of the prediction equation. It showed that CD (p<0.001), SW (p<0.05), RH (p<0.05) and CP (p<0.05) have a significant influence on body weight. Therefore, the last step of the regression model, equation for predicting the body weight obtained was presented on Table 5. The other variables were not included in the model because of their relatively low contribution. In this study, the multiple linear regression and stepwise showed that chest depth (CD), the shoulder width (SW) and the cannon perimeter (CP) are the best measurements to determine the body weight of the animals studied. While in Ouled Djellal breed, the hearth girth (HG), withers height (WH), paunch girth (PG), scapular-ischial length (SIL) and the cannon perimeter (CP) were the best measures to predict the BW (9). Topal et al. (28) used the body length (SIL), hearth depth (CD), hearth girth (HG), and rump width (RW) for the BW prediction of Awassi sheep with 85.1%R² which was higher than the present results for Tazegzawt sheep (76% R²) and very close to the Morkaraman sheep, where hearth girth (HG) and rump width (RW) were reported to be the most suitable model with 78.4%R². In Tazegzawt males, only HG has a significant effect on BW (p<0.05) according to Djaout et al. (2018) (9) in Ouled Djellal breed. In females Tazegzawt; CD (p<0.001) and SW (p<0.05), are the two

body measurements that have a significant effect on BW, whereas in the Ouled Djellal breed, the paunch girth (PG), shoulder width (SW), pelvis length (PL) and trochanter width (TW) were used to predict BW (9). Male and female Tazegzawt present very low accuracy of R² (69% and 63% respectively) from heart girth (HG) for estimating body weight compared to the Maghreb breeds (Sardi and Timahdite) which present a very high accuracy of R² (95 and 91% respectively) from heart girth in male and female (4). Cam et al. (2010) (5) reported a great accuracy of R² (91.1 %) from chest depth (CD), rump height (RH), chest width (CW), cannon circumference (CP), and hearth girth (HG) for Karayaka male sheep. These values were higher than the present results with 69% R². In female Karayaka sheep, the hearth girth (HG), rump height (RH), chest depth (CD) and body length (SIL) were used in the model with 90.1 %R² (5) which is very higher than our results (63%).

Linear regression equation

HG was used in regression equations to determine BW in the Ouled Djellal breed (9) and the Moroccan breeds Sardi and Timahdite (4) and other sheep breeds (15) because is the most related to BW (5, 18, 25, 29). The regression equation shows a fairly low R² of 33% of heart girth (HG) to predict the BW in Tazegzawt sheep: BW= 1.44 HG - 89.2 (Table 6 and figure 1).

Table 6. Body weight according to the formulas

	Mean	Std.Dev	Std.Err	CV	Variance	Min	Max
BWb	66.8	17.8	2.42	26.7	317	34	112
BW1	81.8	21.2	2.89	26	451	43.2	163
BW2	64.9	13	1.76	20	168	40.8	109
BW3	74.1	14.8	2.01	20	219	46.6	124

BWb = Bdy weight, BW1= [LSIxHPx(LH+LE)/2]/1050, BW2= TP³*50.7, BW3= TP³*57.9

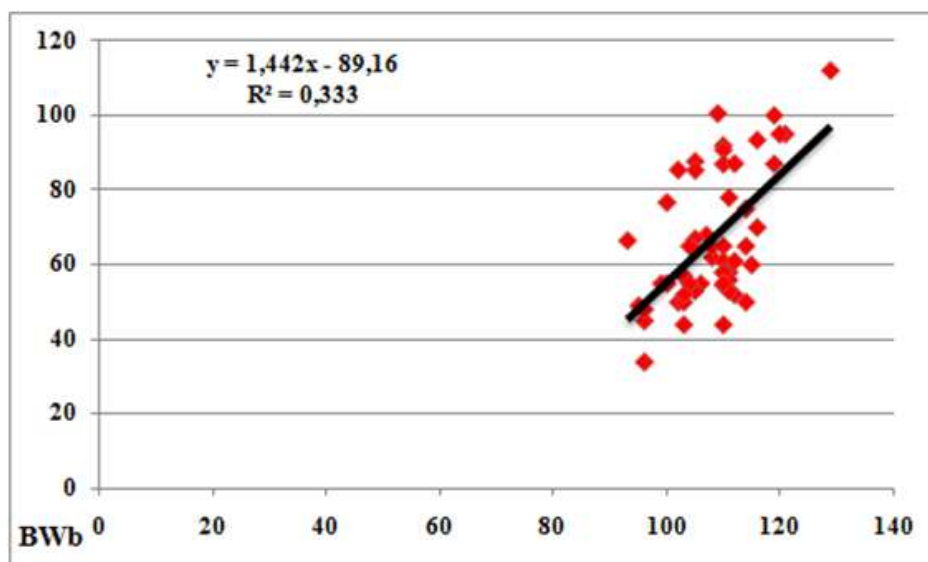


Figure 1. BG regression equation according to HG

The result of several regression analyzes indicates that the addition of other measures to the chest circumference would result in significant improvements in accuracy and weight prediction, even if the additional weight gain was small.

CONCLUSION

This study showed that the body measurements had positive and high correlation with body weight indicating that body measurements can be used for estimation of body where scales are not usually available. It could be concluded that the body weight of sheep Tazegzawt can be estimated using a simple linear measure of body: chest depth, shoulder width, rump height cannon perimeter. However, further research is needed to investigate the relationship between the body weight and different body measurements in other sheep breeds in Algeria.

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