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Effects of Non-Genetic Factors and Permanent Maternal Environment on Biometric Traits in Moghani Sheep

Research Article

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ABSTRACT

The present study investigated basic statistics for biometric traits as well as non-genetic factors that may affect these traits in the Moghani breed of sheep. The data-set was computed by using biometric records of the Moghani sheep breeding and raising station over a period of 15 years (1996 to 2012). Year of birth, month of birth, birth type and lamb's sex and dam permanent environment were considered as the non-genetic factors. The studied biometric traits were: height at withers (HW), height at rump (HR), body length (BL), heart girth (HG) and leg circumference (LC). Least square means (cm) ± standard error were 69.8 ± 4.1, 69.7 ± 4.2, 50.2 ± 4.6, 85.9 ± 8.2 and 29.0 ± 5.4 for HW, HR, BL, HG and LC, respectively. All traits were affected significantly (P<0.05) by the fixed effect of year of birth. The lamb's sex had a significant effect (P<0.001) on the investigated traits except HG. The traits were affected significantly (P<0.001) by the birth type and month of birth. The maternal permanent environment as a non-genetic factor had no significant effect on the traits under study. The results of the present study suggested that non-genetic factors can be considered as notable sources of variation in the biometric traits. Therefore, improving environmental conditions can be suggested if an improvement in the biometric traits of Moghani sheep is desired.

KEY WORDS biometric traits, Moghani sheep, non-genetic parameters.

INTRODUCTION

The Moghani sheep is known as one of the country's breeds for production of mutton and lamb with high growth performance. The population of Moghani sheep in Iran is estimated to be 3.5 million (Akbarinejad *et al.* 2014). This sheep is medium-sized (ewe 60-63 kg and ram 63-66 kg) and can be found mostly in the plain of Moghan, Ardabil province, Iran. The main characteristics of the breed are: intermediate and muscular neck, commensurate growth, medium shoulder, straight back muscles and pea white body color (Akbarinejad *et al.* 2014). The Moghani sheep breeding and raising station (MSBRS), as the oldest sheep breeding station of Iran, was established in 1952. The purpose was to improve the performance of the breed. Besides genetic effects, non-genetic factors play a notable role in affecting biometric traits related to the economic income generated by the flock. In other words, genetic factors are affected by environmental factors such as season, management, climatic conditions, health, nutrition, ram-to-ewe breeding ratio, ewe parity and ram libido and fertility. Because of an interaction between genetics and the environment, improving biometric traits is very complicated (Jafari *et al.* 2014). Biometric characters or linear body measurements can be used as indirect criteria in many domestic animal species to help meat-yield improvement.

It seems that an individuals can be described more effectively by body and weight measurements than by conventional methods (Jafari and Hashemi, 2014). Early and late maturing animals can be detected by using body measurements as a reliable indicator of body size (Abbasi and Ghafouri-Kesbi, 2011). Lambs with bigger body size are able to reach earlier maturity. Because non-genetic factors may play a notable role in influencing phenotypic variation, the present study aimed to investigate them in Moghani sheep.

MATERIALS AND METHODS

In total, 3010 body measurement records were used. The dataset was computed by using the records of MSBRS over a 15 year period (1996 to 2012) from the north-west of Iran. Effects to be investigated were: year of birth, month of birth, sex, birth type and maternal permanent environment. Biometric traits were: height at withers (HW), height at rump (HR), body length (BL), heart girth (HG) and leg circumference (LC). HW measures the distance from a platform on which the animal stands to the withers. The measurement is best made with a special measuring stick on two arms, one held vertically, and the other at right angles, so that it slides firmly up and down to record the height. HR is the distance from the surface of a platform to the rump using a measuring stick as described for HW. BL refers to the distance from the first cervical vertebra to the base of the tail where it joins the body. HG is a circumferential measure taken around the chest just behind the front legs and withers with a tape measure. LC refers to the circumference of the rear legs. The midpoint between the hock and pin bone on the right rear leg is used to measure LC using a tape measure.

Alfalfa, fresh fodders, corn and concentrates are used to feed the sheep during the semi-intensive rearing period. The main source of feed for sheep in the spring-summer season is natural pasture, without any additives, whereas during the autumn-winter season, the sheep is fed hay, concentrate and silage. After lambing the lambs are kept individually with their mothers in a specific box for one week to improve the dam-lamb association as well as colostrum and milk suckling. At age two weeks lambs gain access to a creep feeding station containing 18% protein. This period is critical in affecting body measurements (Petrovic *et al.* 2012).

The data structure is summarized in Table 1. The data were analyzed using SAS software (SAS, 2005). The maternal permanent environment was studied using WOMBAT package (Meyer, 2007).

The linear model used was:

$y_{ijklmn} = \mu + YR_i + MO_j + SX_k + BT_l + PE_n$ + interaction between effects + e_{ijklmn}

Where:

y_{ijklmn}: vector of observations in different traits.
μ: overall mean of the population.
YR_i: fixed effects of year i.
MO_j: fixed effect of month j.
SX_k: fixed effects of lamb's sex k.
BT_l: fixed effects of birth type l.
PE_n: maternal permanent environment n.
e_{ijklmn}: residual random effect of observation ijklmn.

The significance of the fixed effects was studied using the general linear models (GLM) procedure in SAS. Least square means were compared using Duncan's test. The year and month of birth had 15 and 5 levels, respectively. The months were July, August, September, December and February whereas the fixed effect of year had a period of 15 years (1996-2011). Lambs' sex and birth type had 2 (male and female) and 3 levels (single, twin and triplet), respectively.

RESULTS AND DISCUSSION

Table 1 shows the dimensions of 69.8 ± 4.1cm, 69.7 ± 4.2cm, 50.2 ± 4.6cm, 85.9 ± 8.2cm and 29.0 ± 5.4cm for HW, HR, BL, HG and LC, respectively. In compared with other Iranian breeds such as Makuie sheep the body dimensions of the Moghani breed were higher (Abbasi and Ghafouri-Kesbi, 2011; Jafari and Hashemi, 2014). However both breeds are classified as medium body size (Akbarinejad *et al*. 2014).

In contrast with Makuie breed (Jafari and Hashemi, 2014) the HW and HR were approximately equal together in the Moghani sheep. It seems a higher measure of HR in compared with HW is an advantage for breeds are reared in a mountainous condition because the higher height of the animal in the rear part of the body promotes climbing ability (Cam *et al*. 2010; Jafari and Hashemi, 2014). While the Moghani sheep has been native to plain condition such as Moghan.

Descriptive statistics of the biometric traits are summarized in Table 1. Relatively low values of the coefficient of variation, except for LC, can be explained by the small differences among the animals of the population, greater uniformity of the traits, minor changes of the traits by environmental conditions, better response to selection and other unknown factors (Jafari and Hashemi, 2014). Low coefficients of variation of biometric traits have been reported by other researchers (Abbasi and Ghafouri-Kesbi, 2011; Jafari *et al*. 2014; Jafari and Hashemi, 2014).

All traits were significantly (P<0.001) affected by the sex except HG (Table 2). Male lambs were significantly taller-than females by 1.10, 2.0, 0.3 and 1.7 centimeters in HW, HR, BL and LC, respectively.

Table 1 Data structure for estimating biometric traits in Moghani sheep*

Traits	Number of records	Mean	Minimum	Maximum	SD	% CV
HW	3010	69.8	56.0	81.0	4.1	5.4
HR	3010	69.7	58.0	82.5	4.2	5.5
BL	3010	50.2	32.0	80.0	4.6	8.8
HG	3010	85.9	62.0	110.0	8.2	8.3
LC	3010	29.0	10.0	54.0	5.4	16.3

* All measurements are in cm.
HW: height at withers; HR: height at rump; BL: body length; HG: heart girth and LC: leg circumference.
SD: standard deviation and CV: coefficient of variation.

Table 2 Analysis of variance for traits HW, HR, BL, HG and LC in Moghani sheep

Fixed effects	Year	Sex	Birth type	Month	Sex × BT	Year × BT	Year × sex	$^{A}C^2$	R-square
HW	***	***	***	***	NS	NS	***	0.05^{ns}	0.16
HR	***	***	***	***	NS	NS	***	0.06^{ns}	0.17
BL	*	***	***	***	NS	NS	NS	0.00^{ns}	0.10
HG	***	NS	***	***	NS	NS	NS	0.02^{ns}	0.26
LC	***	***	***	***	NS	NS	***	0.00^{ns}	0.23

HW: height at withers; HR: height at rump; BL: body length; HG: heart girth; LC: leg circumference and BT: birth type.
A: the significance of maternal permanent environment was studied using AIC values of WOMBAT package.
C^2: variance ratio due to maternal permanent environment and R-square: SS_{model}/SS_{total}.
* (P<0.05); ** (P<0.01) and *** (P<0.001).
NS: non significant.

However, differences between males and females for HG were not significantly different. Significant influences of sex on growth may be due to physiological characteristics, the endocrine system, type and measure of hormone secretion, especially sex hormones (Aghaali-Gamasaee *et al.* 2010). Similar results have been reported for Makuie sheep (Jafari and Hashemi, 2014).

All studied traits were significantly (P<0.001) affected by the fixed effect of birth type (Table 2). Table 3 shows that single born lambs were 1.0, 1.2, 0.7, 1.1 and 0.8 centimeters superior to twins in HW, HR, BL, HG and LC, respectively. As well, singles were 2.6, 3.0, 1.0, 5.3 and 2.5 centimeters superior to triplets in HW, HR, BL, HG and LC, respectively.

These results were in agreement with a report for Muzaffarnagari sheep (Mandal *et al.* 2010). This could be the result of limited uterine space during pregnancy, limited capacity of ewes to provide more nutrients during pregnancy, more milk for singletons in the period of lambing to weaning, and competition for milk between multiple-birth lambs (Jafari *et al*. 2014).

All studied traits were significantly (P<0.001) affected by the fixed effect of month of birth (Table 2). Significant influences of month of birth on these traits can be attributed to environmental factors and climate. Table 3 shows that lambs born in the summer have relatively large body measurements than those born in the winter. In the summer months ewes have access to high quality natural pastures and are more capable of meeting the nutrient requirements of the growing lambs.

The quality and quantity of forage in winter is limited and more dependent on the amount of rainfall than in summer (Alphonsus *et al*. 2010).

The limited feeding during the winter can influence the development of the body growth and condition (Alphonsus *et al*. 2010).

The effect of birth year on HW, HR, HG, LC (P<0.001) and BL (P<0.05) was significant. These results were in accordance with a report for Makuie sheep (Jafari and Hashemi, 2014).

Significant influences of birth year on these traits can be explained by differences in management, food availability, disease, climatic condition (such as rate of rainfall, humidity and temperature, which affected the quality and quantity of pasture forage) and the raising system in different years (Rahimi *et al.* 2014). At the time of pregnancy, older ewes, due to complete maturing, have a tendency to have an enough space in the uterus to support twins and triplets (Gowane *et al.* 2011).

Significant effects of birth year, sex and birth type on growth traits have been reported in breeds such as Kermani (Rashidi *et al.* 2008), Merino (Dixit *et al.* 2001), Horro (Abegaz *et al.* 2005), Sabi (Matika *et al.* 2003) and Mis sheep populations (Petrovic *et al.* 2009). According to R-square values, 10-26% of phenotypic variation in traits was explained by the fixed factors (Table 2).

Interaction effects

Least squares means of the interaction effects are presented in Table 2. The studied traits were not affected significantly by the interaction between sex and birth type. However, the traits HW, HR and LC were affected significantly (P<0.001) by the interaction between birth year and sex. The significant interaction between year and sex indicated the present fixed effect could have collaboration in affecting the biometric traits.

Table 3 Least square means (cm) ± standard error for biometric traits in Moghani sheep

Traits	HW	HR	BL	HG	LC
Sex	***	***	***	NS	***
Male	70.4±4.3[a]	70.8±4.2[a]	50.4±5.0[a]	85.4±8.0[a]	29.9±4.2[a]
Female	69.3±4.0[b]	68.8±4.0[b]	50.1±4.3[b]	86.4±8.4[a]	28.2±6.1[b]
Birth type	***	***	***	***	***
Single	70.1±4.0[a]	70.0±4.1[a]	50.4±4.6[a]	86.3±8.4[a]	29.2±5.3[a]
Twin	69.1±4.3[a]	68.8±4.3[a]	49.7±4.5[a]	85.2±7.9[a]	28.4±5.5[ab]
Triple	67.5±3.3[b]	67.0±3.3[b]	49.4±3.9[a]	81.0±8.2[b]	26.7±5.1[b]
Month	***	***	***	***	***
July	71.7±3.34[a]	72.9±4.0[a]	50.3±4.7[c]	92.1±8.8[a]	33.0±3.7[b]
August	70.2±3.7[b]	70.7±4.0[b]	51.8±3.8[b]	92.0±6.8[a]	27.1±8.5[d]
September	70.9±5.3[b]	72.3±5.3[a]	56.3±4.7[a]	84.7±6.1[cb]	36.8±2.5[a]
December	68.6±4.2[c]	69.1±4.2[c]	49.6±4.0[c]	85.3±6.1[b]	28.0±4.5[d]
February	69.1±4.0[c]	69.5±4.1[c]	48.35± 5.1[d]	83.3±10.0[c]	30.6±3.9[c]
Year	***	***	*	***	***

HW: height at withers; HR: height at rump; BL: body length; HG: heart girth; LC: leg circumference and BT: birth type.
* (P<0.05); ** (P<0.01) and *** (P<0.001).
NS: non significant.

The qualifications related to the fixed effect of year such amount of rainfall, quality and quantity of forages beside the sex factor have promoted the studied traits. Male lambs are more capable to be influenced by sexual hormones to reach weight gain and bigger body size in plenteous years. Table 3 shows that differences in body size in singletons, twins and triplet-born lambs maybe due to limited space in the uterine environment and inadequacy of food available for twins and triplets.

Maternal permanent environment

Table 2 shows a non-significant effect of permanent maternal environment. Using AIC values (Akaike, 1974) the estimates of c^2 were not significantly differ from zero. However, in other Iranian breeds of sheep significant phenotypic variation has been found in HG (Jafari and Hashemi, 2014).

CONCLUSION

The results of the present investigation suggest that non-genetic factors have a notable role in influencing phenotypic variation in the biometric characteristics of Moghani sheep. In genetic selection programs, it will be useful to consider including non-genetic factors, especially fixed effects. In a sheep production system, particularly at a regional scale, the results of the present study can be used as a pattern.

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