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Research Article

Path Analysis for Body Measurements on Body Weight of Saanen Kids

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Abstract

The aim of this study was to examine the direct, indirect and total effects of some body measurements on body weight of Saanen kids by using path analysis. For this aim, relationship between body weight (BW) and four morpho-biometrical traits [chest girth (CG), height at withers (HW), height at sacrum (HS) and body length (BL)]were studied in 75 Saanen kids at one month of age using path analysis. However HW trait was excluded from analyze because of its multicollinearity with HS. The effects of CG, HS and BL on BW were found statistically significant. BL was found as variable with highest indirect effect (0.521) on BW. The direct effect of CG was higher than HS and BL. The total effect of BL was higher than those of HS and CG. These results showed that chest girth could be used to estimate the body weight of Saanen kids for practical purposes as well as for selection purposes.

Keywords: *Correlation, Path coefficient, Saanen kids, Body measurements*

Saanen Oğlaklarının Canlı Ağırlıkları Üzerine Vücut Ölçümleri İçin Path Analizi

Özet

Bu çalışmanın amacı Path analizi kullanılarak Saanen oğlaklarının canlı ağırlıkları üzerinde bazı vücut ölçümlerinin doğrudan, dolaylı ve toplam etkilerini incelemektir. Bu amaçla canlı ağırlık (BW) ve dört morfolojik-biyometrik özellikleri [Göğüs Çevresi (CG), Cidago Yüksekliği (HW), Sağrı Yüksekliği (HS) ve Vücut Uzunluğu (BL)] arasındaki ilişkiler Path analizi kullanılarak bir aylık yaştaki 75 adet Saanen oğlaklarında çalışıldı. Ancak HW özelliği HS özelliği ile çoklu bağlantıdan dolayı analizden çıkarılmıştır. BW üzerine CG, HS ve BL'nin etkileri istatistiksel olarak önemli bulunmuştur. BL, BW üzerine en yüksek dolaylı etkili (0.521) değişken olarak bulunmuştur. CG'in doğrudan etkisi, HS ve BL'den daha yüksektir. BL'nin toplam etkisi HS ve CG'ninkinden daha yüksektir. Bu sonuçlar seleksiyon seçimi yanında pratik seçim için Saanen oğlaklarının canlı ağırlığını tahmin için göğüs çevresinin kullanılabileceğini göstermiştir.

Anahtar sözcükler: *Korelasyon, Path katsayısı, Saanen oğlakları, Vücut ölçüleri*

INTRODUCTION

In general, the aim of animal breeding is to genetically improve populations of livestock so that they produce more efficiently under the expected future production circumstances. Genetic improvement for economic traits is achieved by selecting the best individuals of the current generation and by using them as parents of the next generation [1]. In many cases, the animals with higher potential for body weight and body measurements are selected as breeding material or these criteriaare used to valorize the animals. To evaluate the data relational statistics such as regression and correlation are used. Generally, body weight is selected as response variable and body measurements are selected as explanatory variables. So, it is aimed to explain the response variable from explanatory variables. However, indirect effects of explanatory variables on response variable should be considered beside the direct effects [2]. Path analysis is used to describe the directed dependencies among a set of variables [3]. Therefore, application of path analysis in animal breeding practices began to increase [4-13]. Also, there are some studies which examined the direct and indirect effects of body measurements on body weight [14-17]. However there is not enough study for Saanen kids within this scope. In this study, direct, indirect and total effects of body measurements on body weight in Saanen kids were investigated.

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MATERIAL and METHODS

Material

This study was carried out at the private dairy goat farm in Bafra province of Samsun, Turkey (40°31'N, 36°53'E and 650 m above the sea level). Data was collected from 75 Saanen kids one month after birth and body weight (BW) was selected as response variable and body size parameters; body length (BL), height at sacrum (HS), height at withers (HW) and chest girth (CG) were selected as explanatory variables. While CG was measured with tape, other body size parameters were measured with stick (BL, HS and HW) and bascule (BW). SPSS [18] statistical software was used to analyze the data with the license of Ondokuz Mayıs University.

Method

Every linear model has a direct effect and amount of indirect effect which is number of explanatory variables minus one. The general expression of multiple regression model formed for the measurements (one response and p explanatory variables) is given in Eq. 1 [19].

$$y_k = \beta_0 x_{k_1}^{\beta_1} x_{k_2}^{\beta_2} x_{k_3}^{\beta_3} \dots x_{k_p}^{\beta_p} e_i; \quad i = 1,2,\dots,n \qquad (1)$$

The multiple linear regression model adopted was

$$\hat{y}_k = b_0 + b_1 x_{k1} + b_2 x_{k2} + b_3 x_{k3} \qquad (2)$$

where:

$\hat{y}_k$ = response variable (BW),

b_0 = intercept,

b_i = standardized regression coefficients,

x_{kp} = explanatory variables (CG, BL, HS)

A path coefficient (*P*) is a standardized regression coefficient (b) showing the direct effect of an independent variable on a dependent variable in the path model [20,21]. Path coefficient, which indicates the effect of one standard deviation change of any explanatory variable *X* versus on response variable *Y*, can be calculated as [22];

$$Pyx_k = b\frac{Sx_k}{S_y} \qquad (3)$$

Here; P_{yx} is the path coefficient which indicates the direct effect of *X* explanatory variable on response variable *Y*,S_x indicates the standard deviation of *X*, S_y indicates the standard deviation of *Y* and *b* indicates the partial regression coefficient.

Path coefficients can be shown with path diagrams. One way and two way arrows are used in path diagrams. One way arrows which named as direct effects are drawn from explanatory variable to response variable and two way arrows which showed correlations are drawn between explanatory variables [10]. Path diagram for this study was given in *Fig. 1*.

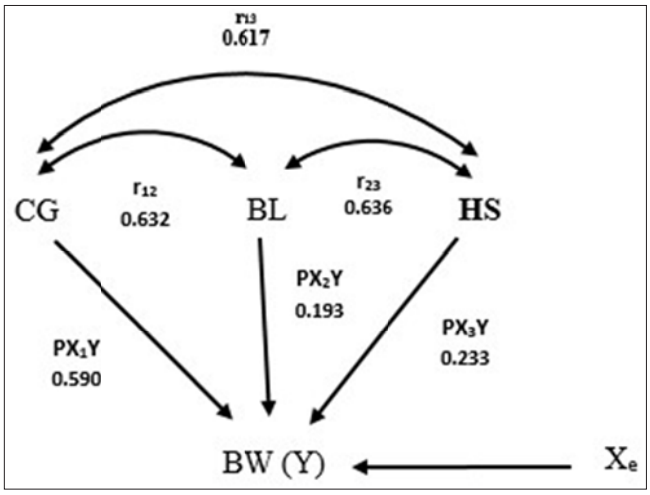

Fig 1. Path diagram
Şekil 1. Path diyagramı

To obtain the path coefficients should be replaced in linear equation system as given in equation 4.

$$\begin{bmatrix} P_{YX_1} \\ P_{YX_2} \\ P_{YX_3} \end{bmatrix} = \begin{bmatrix} 1 & r_{X_1X_2} & r_{X_1X_3} \\ r_{X_2X_1} & 1 & r_{X_2X_3} \\ r_{X_3X_1} & r_{X_3X_2} & 1 \end{bmatrix}^{-1} * \begin{bmatrix} r_{YX_1} \\ r_{YX_2} \\ r_{YX_3} \end{bmatrix} \qquad (4)$$

In the Eq. (4), coefficients given by P_{YX_i} were path coefficients (direct effects) between explanatory variable and response variable and $r_{x_ix_j}P_{YX_i}$ represented indirect effects of explanatory variable ith on response variable via explanatory variable jth, $r_{x_ix_j}$ represented pearson correlation coefficients between ith an jth traits [23].

RESULTS

Descriptive statistics for body weight, chest girth, height at withers, height at sacrum and body length for Saanen kids were given in *Table 1*. Having normal distribution of obtained data was determined with Kolmogorov-Smirnov one sample test.

Pearson correlation coefficients between examined traits were given in *Table 2*. Results were not divided by sex factor because correlations among traits were similar in both sexes. All estimated correlation coefficients were positive and significantly ($P<0.01$) differ from zero.

Height at withers was removed from the analysis because multicollinearity was determined between HW and HS. HW was removed from the model because Type I error rate of HW (0.928) was higher than of HS (0.181). The highest and lowest relations on BW were observed with CG and BL, respectively. Standardized partial regression coefficients and significance levels were given in *Table 3*.

Standardized multiple regression equation was obtained, with 0.802 adjusted coefficient of determination, as follows;

BW = 0.590(CG) + 0.193(BL) + 0.233(HS)

In this equation constant was estimated as zero because of standardization. Partial regression coefficients of that equation stated direct effects of each explanatory variable on response variable. *Table 3* showed that all coefficients were statistically significant and there were no multicollinearity observed between variables, because VIF values were under the threshold of 10.

Path coefficients belong to direct and indirect effects of explanatory variables on body weight for Saanen kids were given in *Table 4*.

All direct effects were positive and CG had the highest direct effect on BW. Besides, the lowest indirect effect was observed between BL and CG. The lowest relation was determined between BW and BL which direct effect was 0.193. But, the highest total indirect effect on BW was obtained with BL. Also, direct effect of CG on BW was higher than total indirect effects of other explanatory variables.

Table 1. *Descriptive statistics of Saanen kids for examined traits*
Tablo 1.*İncelenen özellikler için Saanen oğlaklarının tanımlayıcı istatistikleri*

Traits	n	Mean	SD	Min	Max	*P**
BW	75	6.21	1.18	3.60	9.20	0.830
HW	75	42.85	3.19	36.00	49.00	0.334
HS	75	43.55	3.19	37.00	50.00	0.450
BL	75	38.47	3.06	31.50	43.00	0.249
CG	75	42.82	2.79	34.00	49.00	0.254

** Type I error rate for Kolmogorov-Smirnov one sample test*

Table 2. *Pearson correlation coefficients between traits*
Tablo 2. *Özellikler arasındaki Pearson korelasyon katsayıları*

Traits	BW	HW	HS	BL
HW	0.720**			
HS	0.720**	0.946**		
BL	0.714**	0.633**	0.636**	
CG	0.856**	0.638**	0.617**	0.632**

*** P<0.01*

Table 3.*Results of standardized regression analysis*
Tablo 3. *Standardize edilmiş regresyon analizi sonuçları*

Parameters	CG	BL	HS
Coefficients (b_i)	0.590	0.193	0.233
Significance (P)	<0.001	0.010	0.002
VIF value	1.914	1.991	1.930
Tolerance	0.523	0.502	0.518

DISCUSSION

Body weight is an important economic trait in the selection of animals [16]. So, some factors affecting body weight should be determined. Owing to this, the path analysis is very important for determining factors affecting body weight [17]. In this study, which aimed to investigate the direct, indirect and total effects of body measurements on body weight in Saanen kids, it was determined that there were positive relations between BW and CG, BL and HS. Although any study related to the effects of body measurements on body weight in Saanen kids, were not found, some results of this study (for example, CG had the

Table 4.*Direct and indirect effects of explanatory variables on body weight*
Tablo 4.*Canlı ağırlık üzerine açıklayıcı değişkenlerin doğrudan ve dolaylı etkileri*

Trait	Correlation Coefficient with BW	Direct Effect	Indirect Effect			
			HS	BL	CG	Total
HS	0.720**	0.233**	-	0.123	0.364	0.487
BL	0.714**	0.193**	0.148	-	0.373	0.521
CG	0.856**	0.590**	0.144	0.122	-	0.266

*** P<0.01*

direct and total effects on BW) were supported by some studies conducted with crossbreed kids of German Fawn X Turkish Hairy goats [17] and with Akkaraman lambs [24]. But, results of this study was not coherent with the results of Keskin et al.[25] who studied with male lambs of Anatolian merino. Similarly, BL was found to have the lowest direct and the highest total effect on body weight [6]. As a result, it was concluded that chest girth could be used for management decisions and as indirect selection criteria for selection on body weight due to CG had the highest direct and the lowest indirect effect on body weight.

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