

## The Effects of Age and Gender on Blood Parameters in Arabian Horses

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### Summary

The aim of the present study was to investigate the differences related to age and gender in some blood parameters of Arabian horses bred in Turkey. In this study, 12 mares, 10 stallions, 90 foals (5 to 6 months old), and 35 yearlings were used. It was indicated that total erythrocyte count (RBC) and leukocyte count (WBC) was in normal ranges for mares and stallions while RBC and WBC values were lower for Arabian foals and yearlings. Haemoglobin (Hb) and haematocrit (PCV) were in normal ranges for mares, stallions and yearlings while it was lowest for foals. There was also a significant difference between males and females for PCV values of yearlings ( $P<0.05$ ) and adult groups ( $P<0.01$ ). Mean corpuscular haemoglobin (MCH) was highest in stallions ( $P<0.01$ ) and lowest in female foals ( $P<0.05$ ) within the gender groups. Mean corpuscular haemoglobin concentration (MCHC) was highest in male foals. Mean cell volume (MCV) was significantly lower in the young male ( $P<0.01$ ) and female ( $P<0.001$ ) foals compared to the older horses. Percentage of neutrophil was highest for Arabian mares ( $P<0.001$ ). Percentage of lymphocyte was lowest for mares and male foals ( $P<0.001$ ). Percentage of monocyte was highest for male foals and it was lowest for female yearlings ( $P<0.001$ ) within gender groups. Eosinophil percentage was high in male yearlings ( $P<0.05$ ). As a result of this study, it was found that blood values of Arabian horses changed due to age and gender.

**Keywords:** Arabian horses, Blood parameters, Age, Gender

### Arap Atlarında Cinsiyet ve Yaşın Kan Değerleri Üzerine Etkileri

#### Özet

Bu çalışmada, Türkiye’de yetiştirilen Arap atlarına ait hematolojik parametrelerin yaş ve cinsiyetle ilişkili farklılıklarının belirlenmesi amaçlanmıştır. Çalışma 12 kısırak, 10 aygır, 5-6 aylık 90 tay ve bir yaşlı 35 tay üzerinde gerçekleştirilmiştir. Ortalama alyuvar ve akyuvar sayıları kısırak ve aygırlarda normal, altı aylık ve bir yaşlı Arap taylarında düşük bulunmuştur. Hemoglobini ve hematokrit değerleri, kısırak ve aygırlar ile bir yaşlı taylarda normal sınırlara, altı aylık taylarda düşük olarak tespit edilmiştir. Bir yaşlı taylarda ( $P<0.05$ ) ve erişkinlerde ( $P<0.01$ ) hematokrit değeri cinsiyete bağlı önemli bir farklılık göstermiştir. Ortalama Alyuvar Hemoglobini aygırlarda ( $P<0.01$ ) yüksek, altı aylık dişi taylarda düşük ( $P<0.05$ ) bulunmuştur. Ortalama Alyuvar Hemoglobini Derişiminin erkek Arap taylarda en yüksek düzeyde olduğu tespit edilmiştir. Ortalama Alyuvar Hacmi, altı aylık ve bir yaşlı taylarda erişkin Arap atlarına göre düşük olarak bulunmuştur. Nötrofil yüzde oranı Arap kısıraklarında en yüksek olarak belirlenmiştir. Lenfositlerin yüzde oranı en düşük değeri, dişilerde kısıraklarda ve erkeklerde altı aylık taylarda ( $P<0.001$ ) belirlendi. Monositlerin yüzde oranı altı aylık erkek taylarda en yüksek, bir yaşlı dişi taylarda ise en düşük olduğu belirlendi ( $P<0.001$ ). Eozinofil yüzde oranı bir yaşlı taylarda yüksek olarak bulunmuştur ( $P<0.05$ ). Sonuç olarak Arap atlarında kan değerlerinin yaş ve cinsiyete bağlı olarak değişim gösterdiği tespit edilmiştir.

**Anahtar sözcükler:** Arap atı, Kan parametreleri, Yaş, Cinsiyet



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## INTRODUCTION

Arabian horse has contributed to the formation and improvement of several horse breeds. Some historical information declares that Arabian horse was raised in Mesopotamia and around 3000 years before Christ. Thus it is accepted as the ancestor of athlete horses today <sup>1,2</sup>.

Determining haematological parameters helps us to evaluate the health status of the horse and diagnose some infections. It is a valuable tool for clinicians during observation of recovery period. Blood parameters can be influenced by breed, gender, age, reproductive and training conditions, also handling and restraint method during blood collection. Any event which leads to excitement in horses causes contraction in spleen and sudden increase in the number of erythrocyte in circulation <sup>2-4</sup>.

Because of the large variations in normal haematological parameters of horses, the values obtained from a single animal by a clinic or laboratory points out at same time reference values for horse population <sup>1-5</sup>. Especially, anemia occurred due to deficiency in immune system can be diagnosed by routine blood analyses and other supporting tests <sup>6</sup>. Erythrocyte count indicates oxygen source of foal, changes in haemoglobin concentrations and mean corpuscular hemoglobin level are important for suckling and growing foals <sup>7</sup>. Total and differential leukocyte counts in healthy horses are affected from different factors. Age-related changes in humoral and cellular response have been identified. The most evident of these in horses is the age in which leukocyte count decreases constantly <sup>1,4,5,8</sup>. These studies provide knowledge for breeding and selecting the foals born with immune insufficiency <sup>1,8,9</sup>.

It has been suggested that changes in blood parameters depend on age, gender and environmental factors. Including Arabian horses, most of the studies were done on haematological values of adult horses. Age and gender of horses are important factors while interpreting haemogram in horses <sup>3,4,10,11</sup>. However, information on basic hematological profiles in Arabian horse bred in Turkey is almost non-existent. The present study was therefore conducted to gather information for further scientific and clinical use. The aim of this

study is to determine some haematological parameters [red blood cells (RBC), total leukocyte count (WBC), haemoglobin (Hb), haematocrit (PCV), mean cell volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), differential leukocyte counts] of Arabian horses revealing the differences related to age and gender.

## MATERIAL and METHODS

The material of the study was composed of 44 female, 46 male foals (5-6 months old), 11 female, 24 male yearlings, 12 mares and 10 stallions (8-15 years old), totally 147 Arabian horses bred in Anadolu stud farm (Mahmudiye, Eskişehir/Turkey). All of the foals were born between February and May. Foals were kept separately in departments apart from their mothers. They were housed in individual stalls under a natural photoperiod and natural indoor temperature (19–21°C). Each animal was considered to be clinically normal based upon careful assessment of the health history and physical examination prior to sampling. The study was conducted in October. Food (hay and concentrate) was provided twice daily, with water ad libitum.

Blood samples were taken from jugular vein and transferred into tubes containing EDTA before morning feeding. Sampling was conducted in a manner least likely to excite the horses under controlled and standardized conditions of horses at rest. Samples were placed on ice for transport to the laboratory. Haematological tests were performed in same the day. Haemocytometric method was used to determine erythrocyte and leukocyte counts. Haemoglobin concentration was evaluated by spectrophotometric method. Haematocrit values were determined by microhaematocrit centrifugation. Differential leukocyte counts were determined from smears stained by the May Grunwald-Giemsa method. The erythrocyte indices of MCH, MCV and MCHC values were also evaluated by appropriate formulas. The data were analyzed by variance analysis method by help of SPSS 11.0 package program. All results are presented as means  $\pm$  standard deviation (SD). P values <0.05 were considered statistically significant.

## RESULTS

The mean total erythrocyte and leukocyte counts, haemoglobin, haematocrit, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and mean cell volume and differential leukocyte counts in Arabian horses are presented in *Table 1* and *2*.

Our results indicated that mean erythrocyte count for stallions are significantly higher than male foals ( $P<0.05$ ) and it was lowest in female foals when compared with the two other age groups ( $P<0.001$ ).

Haemoglobin concentrations and PCV values were lowest in foals when compared with other female and male groups ( $P<0.001$ ). There was significant difference between mares and stallions for Hb ( $P<0.01$ ) and PCV ( $P<0.01$ ) values. PCV values were also significantly different in yearlings ( $P<0.05$ ). MCH values were highest for stallions ( $P<0.01$ ). It was lowest for foals when compared

with other female groups ( $P<0.05$ ). Our results indicated that MCHC was highest for male foals ( $P<0.01$ ), it was lowest for female yearlings ( $P<0.01$ ) within the gender groups. There was no significant difference between females and males within the same age groups for MCH and MCHC values. Mean cell volume values were lower for foals compared with other age groups. The only significant difference for MCV was between male and female yearlings ( $P<0.05$ ).

Leukocyte count was highest in yearlings ( $P<0.001$ ) when compared with other male groups. However, it was highest in mares ( $P<0.05$ ) among females. There was significant difference between male and female yearlings for leukocyte counts ( $P<0.001$ ). In the current study, neutrophil percentages were greater in foals ( $P<0.01$ ) and mares ( $P<0.001$ ) when compared with other male and female groups respectively. There were significant differences between females and males within the same age groups. Lymphocyte percentages were lowest for male foals ( $P<0.001$ )

**Table 1.** Total erythrocyte counts, haemoglobin, haematocrit, MCH, MCHC and MCV values in Arabian horses (mean±SD).  
**Tablo 1.** Arap atlarında alyuvar sayısı ile hemoglobin, hematokrit ve alyuvar indeks değerleri

Age	Gender	RBC ( $\times 10^9/\text{mm}^3$ )	Hb (gr/dl)	PCV (%)	MCH (pg)	MCHC ( $\mu\text{m}^3$ )	MCV (%)
Foals	♂ (n=46)	7.23±0.29 <sup>a</sup>	7.92±0.29 <sup>a***</sup>	23.59±0.98 <sup>a***</sup>	11.08±0.50 <sup>a</sup>	34.64±1.18 <sup>b**</sup>	33.43±1.91 <sup>a**</sup>
	♀ (n=44)	6.96±0.25 <sup>c***</sup>	8±0.26 <sup>c***</sup>	23.60±0.55 <sup>c</sup>	12.28±0.73 <sup>c*</sup>	34.40±1.14 <sup>d</sup>	35.16±1.92 <sup>c***</sup>
Yearlings	♂ (n=24)	9.33±0.20 <sup>ab</sup>	11.67±0.45 <sup>b</sup>	37.18±1.03 <sup>ba</sup>	12.58±0.55 <sup>a</sup>	28.90±2.70 <sup>a</sup>	39.93±0.98 <sup>abB</sup>
	♀ (n=11)	8.72±0.40 <sup>d</sup>	11.76±0.38 <sup>d***</sup>	39.58±0.69 <sup>dA</sup>	13.93±0.62 <sup>cd</sup>	29.65±0.74 <sup>c**</sup>	47.28±2.05 <sup>dB</sup>
Adults	♂ (n=10)	8.12±0.47 <sup>b*</sup>	11.60±0.22 <sup>bc</sup>	37.33±0.56 <sup>bd</sup>	14.90±1.05 <sup>b**</sup>	31.13±0.65 <sup>ab</sup>	45.46±4.62 <sup>b</sup>
	♀ (n=12)	8.69±0.62 <sup>d</sup>	13.57±0.50 <sup>ec***</sup>	43.89±0.96 <sup>ed</sup>	15.97±1.24 <sup>d</sup>	30.88±0.81 <sup>cd</sup>	52.84±4.58 <sup>d</sup>

a,b (♂); c,d,e (♀) The difference among means showed by different letters at the same column was statistically significant.  
\*  $P<0.05$ , \*\*  $P<0.01$ , \*\*\*  $P<0.001$   
The difference between means having same letters for the same parameters within the group was statistically significant.  
A-B  $P<0.05$ , C-D  $P<0.01$

**Table 2.** Total leukocyte counts and differential leukocyte counts in Arabian horses (mean±SD)  
**Tablo 2.** Arap atlarında akyuvar sayısı ile nötrofil, lenfosit, monosit, eozinofil, bazofil yüzde oranları

Age	Gender	WBC ( $\times 10^3/\text{mm}^3$ )	Neutrophil (%)	Lymphocyte (%)	Monocyte (%)	Eosinophil (%)	Basophil (%)
Foals	♂ (n=46)	7.25±1.34 <sup>a</sup>	50±2.3 <sup>aA**</sup>	42.5±2.2 <sup>aB***</sup>	5.3±0.4 <sup>b***</sup>	3.7±0.4 <sup>b</sup>	1±0
	♀ (n=44)	6.83±0.35 <sup>c</sup>	43.5±2.6 <sup>cA***</sup>	51.2±2.7 <sup>cB***</sup>	4.8±0.5 <sup>d</sup>	2.9±0.3	1±0
Yearlings	♂ (n=24)	10.87±0.43 <sup>bj***</sup>	38.3±3.4 <sup>bc</sup>	56.64±3.9 <sup>bf</sup>	2.3±0.4 <sup>ag</sup>	3.9±0.8 <sup>ad*</sup>	1±0
	♀ (n=11)	7.36±0.52 <sup>cdj</sup>	30.5±1.4 <sup>dc***</sup>	67.8±1.6 <sup>df***</sup>	1.2±0.1 <sup>cG***</sup>	2±0.4 <sup>p</sup>	1.5±0.5
Adults	♂ (n=10)	7.73±0.83 <sup>a</sup>	37.8±2.6 <sup>bH</sup>	59.2±2.8 <sup>bi</sup>	1.5±0.2 <sup>ae</sup>	2.7±0.6 <sup>b</sup>	-
	♀ (n=12)	9.16±1.40 <sup>d*</sup>	62.6±4.9 <sup>eh***</sup>	32±5.8 <sup>ei***</sup>	5.3±1.5 <sup>de</sup>	1.7±0.3	1±0

a,b (♂); c,d,e (♀) The difference between means showed by different letters at the same column was statistically significant.  
\*  $P<0.05$ , \*\*  $P<0.01$ , \*\*\*  $P<0.001$   
The difference among means having same letters for the same parameters within the group was statistically significant.  
A-E:  $P<0.05$ , F-I:  $P<0.01$ , J:  $P<0.001$

and mares ( $P < 0.001$ ) compared within the gender groups. There was a significant difference for lymphocyte percentages between males and females in foals ( $P < 0.05$ ), yearlings ( $P < 0.01$ ) and adults ( $P < 0.01$ ). Monocyte percentages was high for male foals compared with other male groups ( $P < 0.001$ ) and it was lowest for female yearlings ( $P < 0.001$ ). It was found that eosinophil percentages were highest for male yearlings compared with others ( $P < 0.05$ ). Our results indicated that there was significant difference in female and male yearlings ( $P < 0.05$ ) for eosinophil percentages.

## DISCUSSION

In our study, it was determined that the mean counts of erythrocyte and leukocyte in mare and stallions were within the reference values stated for Arabian horses <sup>2,4</sup>. Moreover, it was found that Arabian horses were within the limits stated for warm-blooded horse breeds and above the values stated for cold-blooded breeds <sup>4</sup>. It was found that RBC and WBC in Arabian foals and yearlings were lower when compared with the other studies <sup>1,2,12</sup> while RBC and WBC in Arabian stallions and mares were within the reference values compared to Thoroughbreds <sup>3</sup>. Moreover, our results indicated that mean RBC was higher than Lipizzan and Standardbred mares <sup>3,5</sup>. Comparison of our results with previously published values for the stallions of the same breed the RBC values for Arabian stallions were slightly lower <sup>2,3,12</sup>.

Harvey et al.<sup>13</sup> reported that the value of Hb in foal decreased rapidly within two weeks following the birth and the Hb at this low level went on until one year old. Our results indicated that the value of Hb in mares, stallions and yearlings were within the limits reported for warm-blooded breeds including Arabian horses <sup>3,4</sup>. However, it was lower than Thoroughbred mares and foals <sup>14</sup>. It is suggested that decreased haemoglobin concentration in foals may result from the fact that the life span of erythrocytes is shorter in young animals, and younger cells also contain less haemoglobin so there is a mild anaemia around one year of age. This was confirmed in this study by the lower RBC, Hb concentration and PCV in the foals. It was found that while PCV values for mares, stallions and female yearlings were within the limits stated for Arabian breed <sup>3,4</sup> and values of

Arabian foals were similar to Lipizzan foals <sup>5</sup> but was lower when compared to Thoroughbred foals <sup>3,4,13</sup>.

Mean corpuscular haemoglobin for mares and stallions was higher the value reported for Arabian and Thoroughbred <sup>2,3,14,15</sup>. Except for female yearlings MCH for female and male foals, and male yearlings was below the average values stated for warm-blooded horse breeds <sup>3</sup>. A low MCH value was found compared with Lipizzan and Thoroughbred foals <sup>8,13</sup>. Arabian horses have small erythrocyte diameter compared with other breeds and because of this, PCV values were low compared to other breeds <sup>3</sup>. Arabian mares and stallions we studied had lower MCH than adult Thoroughbreds <sup>10</sup>. These findings were supported by MacLeod et al.<sup>15</sup>. On the other hand, MCH was higher in Arabian foals compared with Thoroughbred <sup>3,10</sup>. This study indicated that MCHC in Arabian mares and stallions and Arabian yearlings was lower compared with the previously published values <sup>3,4,10</sup>. Our data was in agreement with the values given for Arabian foals by Schalm et al.<sup>3</sup>. It was found that Arabian foals have slightly higher MCHC compared with Thoroughbred foals but a low value of MCHC compared with Lipizzan foals <sup>5</sup>.

MCV in this study was within the values reported for adult warm-blooded and Arabian horses while it was lower for foals and yearlings <sup>3,4</sup>. Paralleled to the previous studies, we found that MCV value for Arabian horses was lower than Thoroughbred mares and stallions <sup>3,10</sup> but higher than Ponies <sup>16</sup>. Lipizzan horses had similar value with Arabian stallions, but mares had lower MCV <sup>5</sup>. In the current study MCV for Arabian male foals was lower than Lipizzan foals <sup>5</sup>. However, as horses increase in age the MCV become elevated. When we compare yearlings and adults, a decrease was observed in RBC with age but the decrease was not accompanied with similar reduction in PCV and Hb concentration because of a compensating increase in MCV. Mean MCV values reflect changes in erythrocyte size <sup>2,3</sup>. When age was taken in consideration, haemoglobin concentration and PCV attained their lowest levels in foals and then improved with advancing age. Mean MCH and MCV consistently increased from youngest to oldest horses in this study.

Due to fact that horses are sensitive to many environmental factors, some of the blood values change rapidly. Various stress factors, hormonal profile, lactation, and training can increase the neutrophil number in circulation<sup>17,18</sup>. In this study, neutrophil percentage was higher compared with the value stated for adult Arabian mares, probably reflects any of factors mentioned above<sup>1,3,4</sup>. In our study the WBC was higher than the normal value reported for Arabian foals<sup>1</sup>, and it was within the normal range stated for adult warm-blooded horses<sup>4,18</sup>. We concluded that adult Arabian mares had higher neutrophil percentage compared with Pony and Lipizzan mares while stallions had lower neutrophil percentages than Pony stallions<sup>8,16</sup>. Although foals had higher neutrophil percentage compared with Thoroughbred foals<sup>1</sup>, our data was similar to those seen in the thoroughbred foals reported by Mc Load et al.<sup>15</sup>. It was discovered that Arabian yearlings had lower neutrophil percentages Thoroughbred yearlings<sup>15</sup>.

Horses are very sensitive to stress and this fact causes the increase in the number of neutrophil released to circulation and the decrease in the number of lymphocyte and eosinophil<sup>3,4,18</sup>. In our study, we found that lymphocyte percentage was in normal ranges for adult mares<sup>1</sup>, higher for stallions in comparison with the mean values reported by Knill et al.<sup>2</sup>. Lymphocyte percentage was higher both sexes of Arabian foals compared with Thoroughbred foals<sup>4,14,15</sup>. In the current study monocyte percentage was higher for Arabian mares but lower for stallions and it was within the normal limits for female and male foals compared with the previous studies<sup>1,3</sup>. A significant change of neutrophil percentages by ageing was observed, which may reflect the maturation of immunity. Although a significant decline in lymphocytes was observed for females by ageing as reported in other horse breeds<sup>3,4,10,17</sup>. The decrease in lymphocyte count in healthy aged horses may contribute to an age-associated decrease in immunocompetency<sup>11</sup>.

Differences between mares and stallions for erythrocyte counts are small and not significant, which differs from literature data<sup>3,4</sup>. Female foals and yearlings had slightly lower erythrocyte counts which are contrast to adults. Mares had significantly greater mean values for haemoglobin concentration and PCV than stallions ( $P < 0.01$ .) By

contrast, males of warm blooded breeds had a greater Hb<sup>3,4</sup>. Total leukocyte counts were highest in the male yearlings. Males have slightly higher values of RBC and WBC in foals and yearlings. The only exception is the stallions, which have lower RBC, WBC than mares. Mean corpuscular haemoglobin, MCV values, neutrophil, and monocyte percentages were also lower in stallions than in mares. The effect of hormonal changes should also be taken into account for significant gender-related differences<sup>3,4,8</sup>.

As horses have a relatively long lifespan, it seemed important to obtain more information on the age-related changes in haematological parameters of Arabian horses for both sexes. Several parameters varied with age and gender. Haematological values determined in the present study serve as reference values for Arabian horse populations and can be used for health control and diagnosis of diseases.

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