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Comparisons of some physiological and stress behavioral parameters of Kangal shepherd dogs with and without ankyloglossia in different environmental temperatures

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Abstract: The aim of this study was to compare Kangal shepherd dogs with and without ankyloglossia in terms of various physiological and behavioral changes. A total of 24 dogs were used, 11 of which have had ankyloglossia and 13 of which did not have ankyloglossia. Heart rates, respiratory rates, and body temperatures of the dogs were measured at three different environmental temperatures (18, 23, and 28 °C), resting state, and different exercise durations (5, 10, and 15 min). In addition, resting state and some behavioral parameters were recorded with a video camera. Mann–Whitney U, Kruskal–Wallis, and Wilcoxon tests were used to analyze the data. While no statistical difference was detected in the two groups in terms of all parameters during the resting state at all temperatures, the difference between the resting state and exercising was statistically significant ($P < 0.05$, $P < 0.01$). Except for 15 min of exercise for the respiration rates, statistical differences were detected in both groups in parameters at both different temperatures and different exercise durations at each temperature. While some of the stress behavior parameters were not detected at any of the temperatures in normal dogs, the number of the dogs showing other stress behavioral parameters increased in both groups as the temperature increased, but the number was higher in the dogs with ankyloglossia. This study is the first study on physiological and stress behavioral parameters in Kangal shepherd dogs with ankyloglossia.

Key words: Ankyloglossia, environmental temperature, Kangal shepherd dogs, physiological parameters, stress behavioral parameters

1. Introduction

Kangal shepherd dogs, one of the indigenous shepherd dog breeds of Turkey, are preferred as guard and shepherd dogs around the world due to their majestic appearance, bulky figure, agility, bravery that enables them to stand against wild animals larger than themselves, harmlessness and compassion toward children and weaker animals, and loyalty to their owners (1–5). The Kangal shepherd dog is found in many countries around the world, and there are Kangal shepherd dog breeding clubs in some countries such as USA, Belgium, and France (6). The reasons behind the high preference rate of Kangal shepherd dogs are that they execute the assigned duty perfectly and have the skill to rapidly adapt to the environment. Their ability to adjust their thermoregulation mechanism also plays a significant role in the rapid adaptation of Kangal shepherd dogs to the environment. The tongue plays a role in some functions such as making sounds, sucking, eating, and regulation of the body temperature in dogs. As can be the case in every organ in the body, congenital or acquired abnormalities can be found in the tongue. Some of the abnormalities can be listed as aglossia, microglossia, ankyloglossia, and lingua bifida (7). Ankyloglossia (Figures 1 and 2) is a genetic disease seen in humans and rarely in Kangal shepherd dogs, which is known as incomplete release of frenulum linguae, which ties the tongue to the mouth base, or thickens the tongue due to cell proliferation, and thus preventing the release of the tongue (8–10). Tepeli (11) reported that Kangal shepherd dogs were free in their natural life and acted independently. However, various environmental conditions may cause stress in Kangal shepherd dogs. There is no information in the literature regarding the effect of ankyloglossia on physiological and stress behavioral parameters in Kangal shepherd dogs. Therefore, in this study, the aim was to compare some of the physiological and stress behavioral changes in Kangal shepherd dogs with and without ankyloglossia.

2. Materials and methods

2.1. Animal materials

In this study, a total of 24 Kangal shepherd dogs, 11 of which have had ankyloglossia and 13 of which did not

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Figure 1. A dog with ankyloglossia – case 1.

Figure 2. A dog with ankyloglossia – case 2.

have ankyloglossia, under 14 months of age and taken from dog breeders in Sivas, were used.

Ethics committee approval was granted by the Cumhuriyet University Local Ethics Committee for Animal Experimentation (Issue: 65202830-050.04.04-113; Date: 07.12.2017).

2.2. Physiological and stress behavioral parameters

Heart rates, respiratory rates, and body temperatures of the dogs were measured at three different environmental temperatures (18, 23, and 28 °C), resting state and immediately after the end of different exercise durations (5, 10, and 15 min).

Moreover, stress behavioral parameters of the dogs at resting state at the abovementioned environmental temperatures were recorded using video camera, and these records were analyzed and evaluated by using the ethogram that contains stress behavior in dogs (5). In the study, a focal animal sampling method was used as the sampling method (12). The principle behind this sampling method is to follow up a single animal within a certain amount of time.

For all the dogs, measurements and video footage were recorded in the same environmental temperatures during the dogs' usual daily routines.

2.3. Statistical analyses

All the data in the study were assessed for their normality distribution by conducting the Shapiro–Wilks test. From the results, it was determined that the data did not exhibit normal distribution, and therefore, nonparametric tests were conducted. Statistical differences between the groups exposed to same temperatures were analyzed using the Mann–Whitney U test and the statistical differences between different environmental temperatures of the groups were assessed by Kruskal–Wallis test. The Mann–Whitney U test with Bonferroni correction was used for pairwise comparison (P value was taken as 0.017 instead of 0.05), and the Wilcoxon test was used for intragroup evaluation for each temperature. All of the results were shown as median in tables. All tests were performed using SPSS 22.0 package software (IBM Corp., Armonk, NY, USA) (13). Moreover, in the study, the number of the dogs in each stress behavioral parameter was observed and expressed as percentage in groups.

3. Results

Descriptive statistics values for each parameters were shown together in Table 1 as mean ± SEM, median, and mean ranks. As a result of the study, differences between the two groups in terms of physiological parameters at different environmental temperatures, at resting state, and for different exercise durations were given in Table 1. In both groups, no statistical difference was detected at the resting state at all environmental temperatures in terms of all parameters ($P > 0.05$). Except for 15 min of exercise for the respiration rates, statistical differences were detected in both groups in parameters at both different temperatures and different exercise durations of each temperature ($P < 0.01$, $P < 0.001$).

The differences between resting state and exercise at different environmental temperatures in the dogs without and with ankyloglossia were identified and presented in Table 2 and Table 3, respectively. In all environmental temperatures, statistical difference between the resting state and exercise duration in the dogs with and without ankyloglossia was significant in terms of all parameters ($P < 0.05$). While usually no statistical difference was detected between the exercise durations in terms of heart rate and respiratory rate in the dogs without ankyloglossia, statistical difference was detected between the exercise durations in terms of body temperature. In the dogs with

Table 1. Descriptive statistics and significance levels of different physiological parameters at different environmental temperatures for each exercise periods in Kangal shepherd dogs with (n =11) and without ankyloglossia (n =13)

	With ankyloglossia			Without ankyloglossia			P value
Parameters	Mean ± SEM	Median	Mean rank	Mean ± SEM	Median	Mean rank	
18 °C							
Resting							
Heart rate (n/min)	94.09 ± 0.21	94	13.36	93.85 ± 0.27	94	11.77	0.608
Respiratory rates (n/min)	22.18 ± 0.23	22	12.18	22.23 ± 0.23	22	12.77	0.865
Body temperatures (°C)	37.59 ± 0.03	37.60	13.82	37.56 ± 0.02	37.56	11.38	0.424
Exercise (5 min)							
Heart rate (n/min)	114.64 ± 0.59	115	16.09	112.54 ± 0.50	113	9.46	0.022
Respiratory rates (n/min)	35.55 ± 0.31	36	15.45	34.62 ± 0.29	35	10.00	0.063
Body temperatures (°C)	37.78 ± 0.03	37.79	15.55	37.74 ± 0.01	37.73	9.92	0.055
Exercise (10 min)							
Heart rate (n/min)	115. 55 ± 0.59	116	16.27	113.62 ± 0.31	113	9.31	0.015
Respiratory rates (n/min)	36.46 ± 0.21	37	17.73	34.85 ± 0.27	35	8.08	<0.001
Body temperatures (°C)	37.84 ± 0.00	37.84	18.36	37.79 ± 0.01	37.79	7.54	<0.001
Exercise (15 min)							
Heart rate (n/min)	115.91 ± 0.34	116	17.18	114.23 ± 0.28	114	8.54	0.002
Respiratory rates (n/min)	35.73 ± 0.30	36	15.05	35.00 ± 0.30	35	10.35	0.106
Body temperatures (°C)	37.83 ± 0.01	37.84	16.32	37.79 ± 0.01	37.79	9.27	0.013
23 °C							
Resting							
Heart rate (n/min)	94.18 ± 0.23	94	13.73	93.85 ± 0.27	94	11.46	0.459
Respiratory rates (n/min)	22.36 ± 0.20	22	11.50	22.54 ± 0.18	23	13.35	0.531
Body temperatures (°C)	37.59 ± 0.03	37.60	13.86	37.56 ± 0.02	37.56	11.35	0.392
Exercise (5 min)							
Heart rate (n/min)	114.73 ± 0.60	115	15.95	112.77 ± 0.55	114	9.58	0.026
Respiratory rates (n/min)	35.82 ± 0.26	36	15.91	34.85 ± 0.27	35	9.62	0.030
Body temperatures (°C)	37.81 ± 0.02	37.81	16.41	37.75 ± 0.01	37.74	9.19	0.011
Exercise (10 min)							
Heart rate (n/min)	116.00 ± 0.43	116	17.18	114.08 ± 0.29	114	8.54	0.002
Respiratory rates (n/min)	36.82 ± 0.18	37	18.18	35.15 ± 0.25	35	7.69	<0.001
Body temperatures (°C)	37.85 ± 0.01	37.85	18.50	37.80 ± 0.01	37.79	7.42	<0.001
Exercise (15 min)							
Heart rate (n/min)	116.46 ± 0.43	116	17.36	114.54 ± 0.24	114	8.38	0.001
Respiratory rates (n/min)	36.00 ± 0.30	36	14.27	35.54 ± 0.27	36	11.00	0.277
Body temperatures (°C)	37.85 ± 0.01	37.86	18.23	37.80 ± 0.01	37.79	7.65	<0.001
28 °C							
Resting							
Heart rate (n/min)	94.46 ± 0.25	94	12.55	94.39 ± 0.21	95	12.46	1.000
Respiratory rates (n/min)	22.64 ± 0.15	23	11.50	22.85 ± 0.19	23	13.35	0.531
Body temperatures (°C)	37.59 ± 0.03	37.61	13.77	37.57 ± 0.02	37.57	11.42	0.424
Exercise (5 min)							
Heart rate (n/min)	115.64 ± 0.58	116	16.23	113.46 ± 0.54	114	9.35	0.063

Table 1. (Continued).

Respiratory rates (n/min)	36.82 ± 0.33	37	16.55	35.54 ± 0.24	35	9.08	0.009
Body temperatures (°C)	37.83 ± 0.02	37.83	17.05	37.75 ± 0.01	37.75	8.65	0.002
Exercise (10 min)							
Heart rate (n/min)	117.09 ± 0.51	117	17.64	114.69 ± 0.24	114	8.15	<0.001
Respiratory rates (n/min)	37.82 ± 0.30	38	17.91	35.85 ± 0.27	36	7.92	<0.001
Body temperatures (°C)	37.86 ± 0.01	37.86	18.09	37.80 ± 0.01	37.80	7.77	<0.001
Exercise (15 min)							
Heart rate (n/min)	117.09 ± 0.37	117	17.82	115.08 ± 0.21	115	8.00	0.106
Respiratory rates (n/min)	37.27 ± 0.51	38	15.27	36.31 ± 0.24	36	10.15	0.082
Body temperatures (°C)	37.87 ± 0.01	37.87	18.55	37.80 ± 0.01	37.81	7.38	<0.001

n/min: number of times per minute, SEM: Standard error of mean.

ankyloglossia, differences were detected in terms of heart and respiratory rates between 5 and 15 min of exercise at all environmental temperatures, whereas difference was detected in the body temperature between 5 and 10 min, and 5 and 15 min of exercise at all environmental temperatures except 28 °C.

The differences of resting state and exercise durations at different environmental temperatures in all parameters were calculated for both groups and presented in Table 4. P values in Table 4 were shown as P values of the Kruskal–Wallis test. While no statistically significant difference was detected between the body temperatures in the dogs without ankyloglossia ($P > 0.05$), the difference at 10 min of exercise in the heart rate and the difference at 15 min of exercise in the respiratory rate was statistically significant ($P < 0.05$, $P < 0.01$). While there was no statistically significant difference in terms of heart rate in the dogs with ankyloglossia ($P > 0.05$), statistically significant difference was detected at all exercise durations in respiratory rates ($P < 0.01$), and at 10 and 15 min of exercise in body temperatures ($P < 0.05$) for the Kruskal–Wallis test. However, when the P value was taken as 0.017 instead of 0.05 for the Mann–Whitney U test with Bonferroni correction, no statistical differences were observed except for 15 min of exercise in body temperature.

Stress behavioral parameters exhibited by the dogs in both groups at resting state at different environmental temperatures are shown in Table 5. While some stress behavioral parameters including avoidance, lowering the body position, and attention deficiency were not observed in any of the three environmental temperatures in the dogs without ankyloglossia, the number of the dogs exhibiting the behavior in other stress behavioral parameters increased with the increasing environmental temperature. However, it was found that, in the dogs with ankyloglossia, the number of the dogs exhibiting the behavior in all of the stress behavioral parameters increased with the increasing environmental temperature. Moreover, in the dogs with ankyloglossia, it was found that the number of the dogs exhibiting the behavior in the same stress behavioral parameter is higher than the number of the dogs without ankyloglossia.

4. Discussion

It was reported that the increased environmental temperature leads to an increase in the body temperature of the dog (14–16). In this study, it was found that the body temperature of the animal increases with the increasing environmental temperature (Table 1). In parallel with the literature, the increase in the body temperature of animals up to a certain level suggests that it is correlated with the increased environmental temperature. Moreover, it was reported that increased body temperature leads to increased heart rate (17). In this study, the increase in the body temperature leads to an increase in the heart rate up to a certain level. Dogs respond to increased environmental temperature with four physical mechanisms (evaporation, conduction, convection, and radiation) and adjust their body temperature. Evaporation was reported as one of the most important pathways in the adjustment of thermoregulation in dogs, with the evaporation of water from the tongue surface (18).

In this study, it was found that the body temperature rapidly increases in the initial moments of the exercise state, but the increase stops or even reaches a plateau as the exercise continues in the dogs in both groups. This is observed with a rapid increase in respiratory rate at the initial moments of the exercise state followed by a slight decrease in the dogs with ankyloglossia and with continuous increase in the heart rate starting from the initial moments of the exercise state in the dogs without ankyloglossia. The dogs without ankyloglossia can use evaporation by sticking

Table 2. Median values and significance levels of different physiological parameters at different environmental temperatures for each exercise periods in Kangal shepherd dogs without ankyloglossia (n = 13).

Heart rates (n/min)									
18 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	94	115	0.003	94	116	0.003	94	116	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	115	116	0.383	115	116	0.090	116	116	0.679
23 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	94	114	0.001	94	114	0.001	94	114	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	114	114	0.073	114	114	0.040	114	114	0.141
28 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	95	114	0.001	95	114	0.001	95	115	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	114	114	0.072	114	115	0.044	114	115	0.238
Respiratory rates (n/min)									
18 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	22	36	0.003	22	37	0.003	22	36	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	36	37	0.040	36	36	0.589	37	36	0.084
23 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	23	35	0.001	23	35	0.001	23	36	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	35	35	0.499	35	36	0.045	35	36	0.319
28 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	23	35	0.001	23	36	0.001	23	36	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	35	36	0.496	35	36	0.038	36	36	0.161
Body temperatures (°C)									
18 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	37.60	37.79	0.003	37.60	37.84	0.003	37.60	37.84	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37.79	37.84	0.025	37.79	37.84	0.185	37.84	37.84	0.778
23 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	37.56	37.74	0.001	37.56	37.79	0.001	37.56	37.79	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37.74	37.79	0.002	37.74	37.79	0.002	37.79	37.79	0.969
28 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	37.57	37.75	0.001	37.57	37.80	0.001	37.57	37.81	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37.75	37.80	0.002	37.75	37.81	0.002	37.80	37.81	0.755

n/min: number of times per minute.

Table 3. Median values and significance levels of different physiological parameters at different environmental temperatures for each exercise periods in Kangal shepherd dogs with ankyloglossia (n = 11).

Heart rates (n/min)									
18 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	94	113	0.001	94	113	0.001	94	114	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	113	113	0.055	113	114	0.028	113	114	0.191
23 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	94	115	0.003	94	116	0.003	94	116	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	115	116	0.208	115	116	0.027	116	116	0.503
28 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	94	116	0.003	94	117	0.003	94	117	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	116	117	0.196	116	117	0.034	117	117	1.000
Respiratory rates (n/min)									
18 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	22	25	0.001	22	35	0.001	22	35	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	35	35	0.638	35	35	0.357	35	35	0.757
23 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	22	36	0.003	22	37	0.003	22	36	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	36	37	0.016	36	36	0.589	37	36	0.047
28 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	23	37	0.003	23	38	0.003	23	38	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37	38	0.027	37	38	0.395	38	38	0.472
Body temperatures (°C)									
18 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	37.56	37.73	0.001	37.56	37.79	0.001	37.56	37.79	0.001
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37.73	37.79	0.002	37.73	37.79	0.002	37.79	37.79	0.937
23 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	37.60	37.81	0.003	37.60	37.85	0.003	37.60	37.86	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37.81	37.85	0.036	37.81	37.86	0.050	37.85	37.86	0.436
28 °C	Resting	Exer (5 min)	P	Resting	Exer (10 min)	P	Resting	Exer (15 min)	P
	37.61	37.83	0.003	37.61	37.86	0.003	37.61	37.87	0.003
	Exer (5 min)	Exer (10 min)	P	Exer (5 min)	Exer (15 min)	P	Exer (10 min)	Exer (15 min)	P
	37.83	37.86	0.212	37.83	37.87	0.075	37.86	37.87	0.306

n/min: number of times per minute.

Table 4. Median values and significance levels of different physiological parameters at different environmental temperatures for each exercise periods in Kangal shepherd dogs with (n = 11) and without ankyloglossia (n = 13).

Heart rates (n/min)												
without	Resting			Exercise (5 min)			Exercise (10 min)			Exercise (15 min)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
	94	94	95	113	114	114	113a	114ab	114b	114	114	115
	P = 0.249			P=0.367			P = 0.021			P = 0.060		
with	Resting			Exercise (5 min)			Exercise (10 min)			Exercise (15 min)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
	94	94	94	115	115	116	116	116	117	116	116	117
	P = 0.566			P = 0.408			P = 0.171			P = 0.113		
Respiratory rates (n/min)												
without	Resting			Exercise (5 min)			Exercise (10 min)			Exercise (15 min)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
	22	23	23	35	35	35	35	35	36	35a	36ab	36b
	P = 0.184			P = 0.081			P = 0.055			P = 0.009		
with	Resting			Exercise (5 min)			Exercise (10 min)			Exercise (15 min)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
	22	22	23	36	36	37	37	37	38	36	36	38
	P = 0.308			P = 0.030*			P = 0.003*			P = 0.030*		
Body temperatures (°C)												
without	Resting			Exercise (5 min)			Exercise (10 min)			Exercise (15 min)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
	37.56	37.56	37.57	37.73	37.74	37.75	37.79	37.79	37.8	37.79	37.79	37.81
	P = 0.858			P = 0.502			P = 0.497			P = 0.222		
with	Dinlenme			Exercise (5 min)			Exercise (10 min)			Exercise (15 min)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
	37.60	37.60	37.61	37.79	37.81	37.83	37.84	37.85	37.86	37.84a	37.79ab	37.87b
	P = 0.959			P = 0.351			P = 0.044*			P = 0.038		

n/min: number of times per minute.

* P values in the Table are P values of Kruskal–Wallis test. When P value was taken as 0.017 instead of 0.05 for Mann–Whitney U test with Bonferroni correction, no statistical differences were observed.

their tongues out when their body temperature increases and can adjust their body temperature just by increasing the heart rate. The dogs with ankyloglossia cannot use evaporation sufficiently due to their inability to completely release their tongues, and it was found that they increase their respiratory rates in addition to the heart rates in order to adjust their body temperature. It was observed that as the duration of exercise increases in the dogs with ankyloglossia, heart rate, respiratory rate, and body temperature significantly increase. This demonstrates that adjustment of thermoregulation mechanism in these dogs is significantly affected.

Increased environmental temperature leads to increased body temperature in dogs, and increased body temperature can cause stress (18). In studies on stress, there are controversies about the requirement of the corroboration of the behavioral data with physiological parameters. While some researchers believe that collective evaluation of the data is required (19,20), some state that behavioral and physiological data are not parallel under acute stress conditions, and thus the behavioral data must be prioritized (21–23). This is a study in which some physiological and stress behavioral parameters are evaluated together. In this study, since the effect of

Table 5. Behavior parameters at resting state in Kangal Shepherd dogs.

Behavior	Without (n, %)			With (n, %)		
	18 °C	23 °C	28 °C	18 °C	23 °C	28 °C
Tightened lip	0	0	1 (7.69)	0	1 (9.09)	3 (27.27)
Avoidance	0	0	0	0	1 (9.09)	1 (9.09)
Yawning	0	1 (7.69)	2 (15.39)	2 (18.18)	4 (36.36)	5 (45.46)
Lowering the body position	0	0	0	0	0	2 (18.18)
Lowering the tail	0	0	2 (15.39)	2 (18.18)	5 (45.46)	8 (72.73)
Attention deficiency	0	0	0	0	1 (9.09)	3 (27.27)
Increased respiratory rates	0	1 (7.69)	2 (15.39)	3 (27.27)	4 (36.36)	6 (54.55)

n: number of animals showing behavioral parameters.
with: dogs with ankyloglossia, without: dogs without ankyloglossia.

exercise-induced acute stress condition on behavioral data is taken into consideration, behavioral data were evaluated when the dogs were at resting state. At the resting state, with increased environmental temperature, there are more dogs with ankyloglossia than the normal dogs that exhibit tightened lips, avoidance, yawning, lowering the body position, lowering the tail, attention deficiency, and increased respiratory rates. In the current literature, lowering the body position and lowering the tail are reported as indicators of stress-related behavior in dogs (24,25). Bekoff (26) stated that a dog under stress could exhibit altered behavior. Altered behaviors refer to activities performed independently of the incident and motivational status at that time (27). In the light of this information, "yawning" behavior exhibited by the dogs in the study when they were under stress can be considered as an "altered behavior" and this was observed more frequently in the dogs with ankyloglossia than in the normal dogs. Seligman (28) reported that when deep and intense breathing observed in hot weather is accompanied by strained-stretched lips, this is an indicator of stress. In the current study, higher respiratory rate and pronounced strained lips in the dogs with ankyloglossia compared with the dogs without ankyloglossia at increased temperatures can be considered as the behaviors exhibited by dogs under stress. In his study, Bodnariu (29) stated that avoidance, rapid breathing, low tail position, and low body position were behaviors that emerged when the animal was under stress. Similarly, in the present study, avoidance, rapid breathing, low tail position, and low body position behaviors were observed in the dogs with ankyloglossia more prominently than the dogs without ankyloglossia as the temperature increased. Seligman (28) reported that attention deficiency could be observed in dogs when they were under stress. Similarly, in the current study, with increasing temperature, attention deficiency was observed more prominently in the dogs with ankyloglossia compared with the dogs without ankyloglossia.

In conclusion, it is considered important to keep this information in mind during clinical and surgical interventions on the dogs with ankyloglossia. This study is the first in the literature to investigate the physiological and stress behavioral parameters in Kangal shepherd dogs with ankyloglossia.

It was found that as the duration of exercise increases in the dogs with ankyloglossia, heart rate, respiratory rate, and body temperature significantly increase. This indicates that the evaporation cannot fully adjust the thermoregulatory mechanism in the dogs with ankyloglossia, compared to the dogs without ankyloglossia. The fact that all of the stress behavioral parameters included in the study were higher in the dogs with ankyloglossia than the dogs without ankyloglossia suggests that the dogs with ankyloglossia are under stress.

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