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Effects of Certain Environmental Factors on Growth Performances of Kivircik Lambs

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Abstract

Determining the growth performance of lambs is essential for producers to supply the lamb meat with the features demanded by the market as soon as possible. Therefore, the study aimed to determine the effect of year, birth type and sex of lamb on body weight and various body measurements of Kivircik lambs. Live weights of 612 Kivircik lambs (299 males and 313 females) were used in the study, which were born in 2014, 2015 and 2016. Body measurements of 47 male lambs and 50 female lambs, randomly selected from 508 lambs born in 2014 and 2016, were used in the study.

Birth year had significant effect on both live weights and body measurements of lambs in various growth periods. Single born and male lambs are significantly superior in both live weight and body measurements over female and twin born lambs. This situation results in being preferred for both meat production and breeding purposes more than their opponents. In order to have a more productive herd structure, female and twin lambs should be reared according to their needs for a better growth performance.

Rump height of single born lambs and chest depth of male lambs were higher than their counterparts throughout the study. Therefore, these two body measurements can be used as reliable parameters for investigation of growth performance of Kivircik lambs.

Keywords: Kivircik lambs, growth performance, body measurements, daily weight gain

Introduction

The growth performance of lambs is one of the most important parameters affecting the profitability of lamb production. Determining the growth performance of lambs is essential for producers to supply the lamb meat with the features demanded by the market as soon as possible. On the other hand, body weight is not only crucial for meat production but also has great affects to vitality and mortality of the lambs.[1] Several studies have shown that many factors, such as breed1, age and weight of ewes[2], birth type[3] and sex[4,5] of lambs with nutrition[6], year[5,7] and season[8] have an impact on body weight and growth performance of lambs.

The method for determining productivity in animal breeding should be easy and inexpensive to be achievable. Not only the live weight but also using body measurements can be useful in determination of some performance traits and many studies have reported the relationship between them. [9-11]

Sheep production in Turkey is mainly based on low-yielding indigenous breeds, which are usually reared in low-quality grassland under extensive production. [12] This situation usually results with undernourishment, insufficient production and high mortality rate of lambs. On the other hand, animal-based protein demand of Turkey is highly increased in the past couple of decades and therefore meat production needs to be increased. Turkey has 35.19 million head sheep and most of them are indigenous breeds. [13] Therefore, determining growth performance of

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indigenous sheep breeds can be a key to the solution of increasing the meat demand of Turkey.

Kivircik is a thin-tailed indigenous sheep breed from the Marmara Region of Turkey and it is also bred in Greece and Bulgaria. Among the indigenous sheep breeds of Turkey, Kivircik has a moderate growth performance and average daily gains of Kivircik lambs were reported as 168-225 g.[12,14,15] However, Kivircik is distinguished from meat quality and consumers prefer Kivircik lamb over other breeds raised in Turkey and Kivircik meat is sold at higher prices.[16]

Daily weight gain performance varies among the breeds, therefore, having information about a breed's growth performance has always been an asset for animal production.1 There are many studies on growth performances, the relationship between body weight and measurements for different breeds all over the world. But identifying breed-specific performances are more valuable for the producers and there is limited information about body measurements in different periods of growth for Kivircik lambs. Therefore, this study was aimed determine the effect of year, birth type and sex of lamb on body weight and various body measurements of Kivircik lambs.

Material and methods

Animals and data collection

The study was conducted at the experimental sheep farm of Istanbul University-Cerrahpasa, Faculty of Veterinary Medicine with approval of Istanbul University Ethics Committee (approval number 2013/112, approval date 4/11/2013). Six hundred twelve Kivircik lambs (299 males and 313 females) were used in the study, which were born in 2014, 2015 and 2016. Lambs were reared in the same conditions for those years, staying in birth cubicle (2 m^2 per dam and lamb) with their dams until 7 days of age, then added to a flock with similar aged lambs and their dams for the next month. Ad-libitum alfalfa hay was given to lambs after 15 days of age, while concentrated feed, which contains 89% dry matter, 17% crude protein and 12 MJ/kg metabolisable energy, was given after a month old. The amount of concentrated feed was increased gradually and reached 400 g/lamb per day after weaning. After the 45th day of age, ewes were separated in the morning and sent to grazing by day and reunited with their lambs at night. Lambs were fed with their mother's milk at night until approximately 75 days of weaning age. Thirty cm concentrate feeder width was given to each lamb, where only lambs can be fed after weaning. Once the lambs adjust to the weaning process, they start to graze with the herd during the day. However, they were kept and fed in a different section of the barn at night.

Birth date, birth type, sex and birth weights of lambs were recorded for all lambs born in those 3 consecutive years. Live weights of lambs were recorded every two weeks from birth to 135th days of age and were used for the calculation of the average daily weight gains.

Body measurements were recorded with a measurement cane and measuring tape every two weeks from 45th to 135th days of age. Body measurements were made only for lambs born in 2014 and 2016. Body measurements of 47 male lambs and 50 female lambs, randomly selected from 508 lambs born during those years, were recorded. The descriptions for investigated body measurements given below:[17]

- Withers height (WH): The vertical distance from the top of the scapula to the ground (cm)
- Back height (BH): The vertical distance from the back to the ground (cm)
- Rump height (RH): The vertical distance from the top of the pelvic girdle to the ground (cm)
- Body length (BL): The distance between Art. Scapulohumeralis to tuber ischii (1st thoracal to last sacral vertebrae) (cm)
- Chest depth (CD): The distance from the top of the scapula to the bottom of the sternum (cm)
- Chest width (CW): The distance between the shoulder blades (cm)
- Chest circumference (CHC): The girt was measured from right behind the scapula (cm)
- Cannon circumference: the circumference of left metatarsus (cm)

During the editing of the dataset, the net 15, 30, 45, 60, 75, 90, 105, 120 and 135th day body weights of each lamb and the 45, 60, 75, 90, 105, 120 and 135th day body measurements of each lamb were linearly interpolated.

Statistical analysis

The GLM procedure was used in the SPSS 13.0 package program to investigate the effects of sex (male, female), type of birth (single, twin) and birth year (2014, 2015, 2016) on live weight and average daily weight gains of lambs at different growth periods. In the statistical analyses of live weight and ADG, significant two-way interactions were also added to the statistical model in addition to the main effects. The GLM procedure, including fixed effects of lamb sex, birth type and birth year, was also used in the statistical analyses of various body measurements. However, since the body measurements were not recorded in 2015, only the data from 2014 and 2016 were used in the statistical model for the body measurements.

Results

The significant effect of birth type was consistent until the end of the study, however, effects of year and sex lost their influences on live weight after 120th days of age (Table 1). Birth weight of the lambs was observed as 4,15; 3,87 and 4,67 kg from 2014 to 2016, respectively. Similar to the birth weights, the lambs born in 2015 had the lowest live weights on weaning and 120th days of age. Although, the difference on live weights in 135th days of age was not significant.

Male lambs had higher weights than female lambs until the 120th day of age. Mean live weight difference between male and female lambs was 0,29 kg at birth, 1,25 kg at weaning, 0,96 kg at the end of the study. The difference between sexes was continuously increased until the 90th days of age, later than that, it has fluctuated until the end of the study.

Single born lambs had higher live weights throughout the study than twin-born lambs, (in e.g., 0,38 kg higher at birth, 2,82 kg higher at weaning, 2,56 kg higher at the end of the study) and this situation enhances their chance to be preferred by the breeders for both meat production and selection for breeding.

Table 1. Mean live weights and standard errors of lambs in various growth periods

Factors	n	Birth Weight (LSM±SE)	At 15th day (LSM±SE)	At 30th day (LSM±SE)	At 45th day (LSM±SE)	At 60th day (LSM±SE)	At 75th day (LSM±SE)	At 90th day (LSM±SE)	At 105th day (LSM±SE)	At 120th day (LSM±SE)	At 135th day (LSM±SE)
Year (Y)											
2014	261	4.15^{b}±0.05	6.32^{b}±0.09	8.16^{b}±0.12	10.45^{b}±0.15	12.93^{b}±0.18	15.38^{b}±0.21	17.26^{a}±0.27	18.65^{b}±0.24	20.14^{b}±0.26	22.68±0.28
2015	104	3.87^{c}±0.08	6.15^{b}±0.11	8.13^{b}±0.18	10.46^{b}±0.23	12.54^{b}±0.28	14.24^{c}±0.31	16.15^{b}±0.35	17.68^{c}±0.43	18.65^{c}±0.55	22.79±0.73
2016	247	4.67^{a}±0.07	7.38^{a}±0.16	9.55^{a}±0.19	11.60^{a}±0.25	13.87^{a}±0.29	16.25^{a}±0.33	17.93^{a}±0.35	19.64^{a}±0.40	21.83^{a}±0.43	23.55±0.35
Sex (S)											
Male	299	4.37±0.05	6.83±0.09	8.87±0.12	11.22±0.15	13.64±0.18	15.92±0.20	17.86±0.22	19.38±0.26	21.10±0.30	23.49±0.38
Female	313	4.08±0.05	6.40±0.09	8.36±0.12	10.45±0.16	12.59±0.19	14.67±0.21	16.36±0.23	17.93±0.26	19.31±0.31	22.53±0.44
Birth type (BT)											
Single	467	4.44±0.04	7.10±0.06	9.37±0.09	11.86±0.12	14.46±0.15	16.70±0.17	18.77±0.19	20.63±0.21	22.45±0.24	24.29±0.28
Twin	145	4.02±0.07	6.13±0.13	7.86±0.16	9.81±0.21	11.76±0.25	13.88±0.29	15.45±0.32	16.68±0.37	17.96±0.44	21.73±0.48
Overall Mean	612	4.23±0.04	6.62±0.07	8.62±0.09	10.84±0.12	13.11±0.15	15.29±0.17	17.11±0.18	18.65±0.21	20.21±0.25	23.01±0.31
P values											
Year		<0.001	<0.001	<0.001	<0.001	0.003	<0.001	0.002	0.004	<0.001	0.093
Sex		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.074
Birth Type		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Y × S		-	-	-	-	-	-	-	-	-	0.002
Y × BT		-	0.006	0.002	0.002	0.003	<0.001	<0.001	<0.001	<0.001	-
S × BT		-	-	-	-	-	-	-	-	-	-

$^{a, b, c}$: Different letters in the same row show statistical differences between Year.

Table 2. Average daily weight gain of lambs calculated at cumulative intervals from birth.

Factors	n	ADG at 0-15th days	ADG at 0-30th days	ADG at 0-45th days	ADG at 0-60th days	ADG at 0-75th days	ADG at 0-90th days	ADG at 0-105th days	ADG at 0-120th days	ADG at 0-135th days
Year (Y)										
2014	261	142.52^{b}±4.53	133.51^{b}±3.56	139.78±3.10	146.22±2.88	149.71^{a}±2.63	145.54±2.38	138.01±2.44	133.23^{b}±2.21	137.06±2.04
2015	104	153.51^{ab}±6.03	143.35^{b}±5.32	147.21±4.65	144.99±4.32	138.75^{b}±3.96	136.75±3.73	132.39±4.24	124.56^{b}±4.59	140.15±5.25
2016	247	173.32^{a}±8.32	162.99^{a}±7.36	154.96±6.43	154.78±5.95	156.35^{a}±5.64	148.78±5.10	142.80±5.42	144.19^{a}±4.92	142.27±2.94
Sex (S)										
Male	299	160.53±4.62	148.37±3.94	151.06±3.43	153.63±3.19	153.13±2.97	148.99±2.71	142.68±2.91	139.77±2.77	142.27±2.88
Female	313	152.37±4.80	144.87±4.02	143.58±3.50	143.69±3.25	143.41±3.01	138.39±2.75	132.79±2.94	128.22±2.82	137.39±3.25
Birth type (BT)										
Single	467	176.36±3.44	165.81±2.92	165.77±2.55	167.75±2.37	163.88±2.17	159.83±2.02	153.69±2.13	150.92±2.04	148.40±2.08
Twin	145	135.54±6.65	127.42±5.82	128.86±5.07	129.57±4.70	132.66±4.41	127.55±4.02	121.77±4.38	117.07±4.26	131.26±3.66
Overall Mean	612	156.45±3.74	146.62±3.25	147.32±2.84	148.66±2.63	148.27±2.46	143.69±2.25	137.73±2.43	133.99±2.36	139.83±2.34
P values										
Year		0.005	0.001	0.074	0.369	0.018	0.081	0.296	0.015	0.273
Sex		0.155	0.444	0.061	0.007	0.004	0.001	0.002	<0.001	0.221
Birth Type		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Y × S		0.024	-	-	-	-	-	-	-	-
Y × BT		0.043	0.044	0.013	0.013	0.002	<0.001	<0.001	<0.001	0.004
S × BT		-	-	-	-	-	-	-	-	-

$^{a, b, c}$: Different letters in the same row show statistical differences between Years.

The differences in mean daily weight gains (ADG) fluctuated between the intervals, even though the effect of the year on the live weights of the lambs was significant for almost all the study (Table 2). Lambs born in 2016 had higher ADG's from the ones born in 2014 until 45th day of age, yet they had similar ADG's at weaning (75th day of age). The highest cumulative ADG's on 120th days of age was observed in the lambs born in 2016, however, the differences in the total cumulative ADG's (0-135th day of age) between all 3 years were not significant at the end of the study.

The differences between male and female lambs' ADG's was not significant until the first 60 days of age even though males had higher live weight, but, male lambs had higher ADG's than females for all intervals between 60 to 120th day of ages. However, for the total cumulative ADG's (0 to 135th days old), the difference between male and female lambs was not significant.

In the meantime, the effect of birth type on the ADG's of lambs was significant on all periods. Single born lambs had higher ADG throughout the study than twin-born lambs. Detailed information about investigated body measurements (withers height, back height, rump height, body length, chest depth, chest width, chest circumference) was given in the Tables 3 to 9.

Lambs born in 2016 had higher withers height than 2014 born lambs, except between 90th to 120th days of age (Table 3). The difference between male and female lamb's withers height before 75th days of age was not significant. However, afterwards, male lambs had higher withers heights' than females until the end of the study. Single born lambs had higher withers height than twins throughout the study similar to the live weights and ADG's.

Table 3. Withers heights of lambs (mean and standard errors) in various growth periods.

Factors	n	WH at 45th day	WH at 60th day	WH at 75th day	WH at 90th day	WH at 105th day	WH at 120th day	WH at 135th day
Year (Y)								
2014	61	45.18±0.46	47.03±0.43	49.17±0.39	51.12±0.41	52.73±0.41	53.49±0.44	54.20±0.67
2016	36	47.23±0.45	49.20±0.54	51.02±0.55	51.70±0.57	52.92±0.56	54.75±0.58	56.43±0.71
Sex (S)								
Male	47	46.26±0.46	48.41±0.50	50.91±0.49	52.20±0.51	53.75±0.50	55.18±0.52	56.36±0.72
Female	50	46.15±0.45	47.81±0.47	49.27±0.44	50.62±0.46	51.90±0.46	53.06±0.49	54.27±0.64
Birth type (BT)								
Single	65	47.17±0.36	49.64±0.40	51.45±0.38	52.64±0.39	54.06±0.39	55.22±0.41	56.32±0.57
Twin	32	45.25±0.56	46.59±0.58	48.74±0.56	50.18±0.59	51.59±0.59	53.02±0.62	54.31±0.84
Overall Mean	97	46.21±0.33	48.11±0.35	50.09±0.35	51.41±0.36	52.83±0.36	54.12±0.38	55.31±0.50
P values								
Year		0.001	0.002	0.006	0.396	0.767	0.077	0.023
Sex		0.863	0.360	0.010	0.016	0.005	0.002	0.029
Birth Type		0.006	<0.001	<0.001	0.001	0.001	0.004	0.057

Table 4. Back heights (BH) of lambs (mean and standard errors) in various growth periods.

Factors	n	BH at 45th day	BH at 60th day	BH at 75th day	BH at 90th day	BH at 105th day	BH at 120th day	BH at 135th day
Year (Y)								
2014	61	43.56±0.71	46.50±0.51	48.50±0.43	49.89±0.42	51.63±0.39	52.72±0.52	52.50±0.70
2016	36	46.80±0.60	48.26±0.62	49.65±0.59	50.72±0.58	51.62±0.54	53.58±0.60	54.81±0.72
Sex (S)								
Male	47	45.33±0.63	47.48±0.58	49.54±0.53	51.03±0.51	52.64±0.48	54.04±0.59	54.35±0.75
Female	50	45.04±0.67	47.28±0.55	48.60±0.49	49.58±0.48	50.61±0.45	52.26±0.53	52.96±0.65
Birth type (BT)								
Single	65	46.05±0.52	48.54±0.47	50.27±0.42	51.20±0.41	52.96±0.38	54.13±0.44	55.15±0.59
Twin	32	44.32±0.82	46.22±0.68	47.87±0.62	49.41±0.61	50.29±0.56	52.17±0.71	52.16±0.85
Overall Mean	97	45.18±0.49	47.38±0.41	49.07±0.38	50.31±0.37	51.63±0.34	53.15±0.42	53.65±0.51
P values								
Year		0.001	0.027	0.110	0.237	0.993	0.260	0.023
Sex		0.735	0.798	0.173	0.033	0.001	0.022	0.154
Birth Type		0.078	0.006	0.002	0.015	<0.001	0.024	0.007

The differences between 2014 and 2016 born lambs about back heights were not significant between 75th to 120th days of age, yet 2016 born lambs had higher back heights at the end of the study (Table 4). The back heights of male and female lambs were not significant until weaning. Later then, male lambs had higher back heights, but the difference between male and female lambs was not significant at the end of the study. Single lambs had higher back heights from 45th day of age until the end of the study.

Rump height differences between the years was not significant until the 75th day of age, after than, 2016 lambs had higher rump heights until the end of the study (Table 5). The rump heights of male and female lambs was similar until weaning, but from weaning to 135th day of age, male lambs had higher rump heights than female ones. Single born lambs had higher rump heights at all evaluation days.

Table 5. Rump heights (RH) of lambs (mean and standard errors) in various growth periods.

Factors	n	RH at 45th day	RH at 60th day	RH at 75th day	RH at 90th day	RH at 105th day	RH at 120th day	RH at 135th day
Year (Y)								
2014	61	46.48±0.57	49.02±0.51	49.45±0.43	51.58±0.40	52.82±0.42	54.22±0.48	54.11±0.72
2016	36	47.62±0.50	50.20±0.63	52.51±0.58	53.16±0.57	55.01±0.60	56.44±0.60	57.63±0.73
Sex (S)								
Male	47	46.96±0.52	49.83±0.58	51.38±0.53	53.14±0.49	55.17±0.53	56.59±0.58	56.70±0.76
Female	50	47.14±0.54	49.39±0.55	50.57±0.49	51.60±0.47	52.66±0.48	54.07±0.50	55.04±0.67
Birth type (BT)								
Single	65	47.85±0.43	51.11±0.47	52.59±0.42	53.72±0.39	55.28±0.40	56.52±0.42	57.07±0.61
Twin	32	46.26±0.66	48.10±0.68	49.37±0.61	51.01±0.59	52.54±0.62	54.14±0.70	54.67±0.88
Overall Mean	97	47.05±0.39	49.61±0.42	50.98±0.37	52.37±0.36	53.91±0.38	55.33±0.40	55.87±0.52
P values								
Year		0.128	0.141	<0.001	0.021	0.003	0.003	0.001
Sex		0.800	0.574	0.237	0.018	<0.001	0.001	0.097
Birth Type		0.049	<0.001	<0.001	<0.001	<0.001	0.005	0.031

Table 6. Body Length (BL) of lambs (mean and standard errors) in various growth periods.

Factors	n	BL at 45th day	BL at 60th day	BL at 75th day	BL at 90th day	BL at 105th day	BL at 120th day	BL at 135th day
Year (Y)								
2014	61	43.29±0.70	43.71±0.56	45.50±0.48	47.49±0.53	49.03±0.51	50.51±0.70	51.08±0.72
2016	36	44.40±0.61	45.39±0.72	47.69±0.66	50.44±0.73	51.89±0.70	53.40±0.83	55.91±0.74
Sex (S)								
Male	47	43.63±0.64	44.78±0.65	46.69±0.58	49.65±0.64	51.21±0.62	53.23±0.81	54.80±0.77
Female	50	44.07±0.65	44.32±0.61	46.50±0.55	48.28±0.61	49.71±0.58	50.68±0.73	52.20±0.68
Birth type (BT)								
Single	65	44.60±0.53	45.66±0.52	47.73±0.46	50.72±0.50	52.22±0.49	53.77±0.60	55.14±0.62
Twin	32	43.10±0.79	43.44±0.77	45.46±0.69	47.20±0.78	48.70±0.74	50.14±0.98	51.86±0.88
Overall Mean	97	43.85±0.48	44.55±0.47	46.60±0.42	48.96±0.47	50.46±0.45	51.96±0.57	53.50±0.53
P values								
Year		0.224	0.061	0.007	0.001	0.001	0.006	<0.001
Sex		0.610	0.593	0.798	0.101	0.066	0.016	0.012
Birth Type		0.124	0.019	0.007	<0.001	<0.001	0.002	0.004

Body length of 2016 lambs was significantly higher than 2014 lambs after 60th day of age (Table 6). The difference between male and female lambs' body length were not significant until weaning. However, male lambs had higher body length until the end of the study. Single born lambs had higher body lengths from 45th day of age to until the end of the study.

Chest depth of 2016 lambs was higher than 2014 born lambs from 60th day of age to 135th day of age (Table 7). Male lambs had higher chest depth than females at all measurement days. Single born lambs had higher chest depth between 60th to 120th day of age, but the difference between groups was not significant at the end of the study.

The chest width of 2016 born lambs was higher than 2014

Table 7. Chest Depth (CD) of lambs (mean and standard errors) in various growth periods.

Factors	n	CD at 45th day	CD at 60th day	CD at 75th day	CD at 90th day	CD at 105th day	CD at 120th day	CD at 135th day
Year (Y)								
2014	61	16.69±0.33	17.93±0.28	19.48±0.29	21.16±0.26	22.05±0.24	22.62±0.33	23.38±0.41
2016	36	16.73±0.28	18.42±0.35	21.19±0.39	23.12±0.37	24.31±0.34	24.71±0.39	25.68±0.42
Sex (S)								
Male	47	17.15±0.29	18.64±0.32	20.91±0.35	22.76±0.32	23.83±0.30	24.47±0.38	25.34±0.44
Female	50	16.26±0.31	17.71±0.30	19.76±0.33	21.52±0.30	22.54±0.27	22.85±0.34	23.72±0.38
Birth type (BT)								
Single	65	16.76±0.24	18.66±0.26	21.04±0.27	22.74±0.25	23.77±0.23	24.33±0.28	24.92±0.35
Twin	32	16.66±0.38	17.69±0.38	19.63±0.41	21.54±0.38	22.60±0.35	22.99±0.45	24.14±0.50
Overall Mean	97	16.71±0.23	18.17±0.23	20.34±0.25	22.14±0.23	23.18±0.21	23.66±0.27	24.53±0.30
P values								
Year		0.926	0.268	<0.001	<0.001	<0.001	<0.001	<0.001
Sex		0.031	0.032	0.012	0.003	0.001	0.001	0.006
Birth Type		0.827	0.036	0.005	0.008	0.005	0.015	0.212

Table 8. Chest Width (CW) of lambs (mean and standard errors) in various growth periods.

Factors	n	CW at 45th day	CW at 60th day	CW at 75th day	CW at 90th day	CW at 105th day	CW at 120th day	CW at 135th day
Year (Y)								
2014	61	13.14±0.31	14.87±0.78	16.62±1.12	16.74±0.22	17.80±0.25	18.76±0.34	18.94±0.38
2016	36	13.33±0.27	14.60±0.99	17.03±1.55	19.42±0.31	20.05±0.35	20.45±0.42	21.85±0.40
Sex (S)								
Male	47	13.22±0.28	14.13±0.89	16.20±1.37	18.60±0.27	19.21±0.31	20.08±0.41	21.01±0.40
Female	50	13.25±0.30	15.33±0.86	17.44±1.27	17.56±0.26	18.64±0.28	19.13±0.36	19.78±0.36
Birth type (BT)								
Single	65	13.89±0.23	16.03±0.73	18.22±1.10	18.64±0.22	19.56±0.24	20.39±0.30	21.04±0.32
Twin	32	12.58±0.36	13.44±1.05	15.42±1.58	17.52±0.33	18.29±0.36	18.82±0.48	19.75±0.47
Overall Mean	97	13.24±0.21	14.73±0.64	16.82±0.98	18.08±0.20	18.92±0.22	19.61±0.28	20.40±0.28
P values								
Year		0.621	0.824	0.827	<0.001	<0.001	0.002	<0.001
Sex		0.925	0.318	0.488	0.004	0.146	0.069	0.023
Birth Type		0.003	0.046	0.143	0.004	0.003	0.008	0.031

Table 9. Chest Circumference (CHC) of lambs (mean and standard errors) in various growth periods.

Factors	n	CHC at 45th day	CHC at 60th day	CHC at 75th day	CHC at 90th day	CHC at 105th day	CHC at 120th day	CHC at 135th day
Year (Y)								
2014	61	54.62±0.93	60.13±0.71	66.03±0.81	70.85±0.77	73.17±0.86	77.01±1.16	80.53±1.42
2016	36	56.80±0.79	63.21±0.88	69.98±1.13	75.88±1.10	78.85±1.22	81.96±1.42	86.45±1.45
Sex (S)								
Male	47	55.96±0.82	61.96±0.81	69.09±1.00	74.93±0.96	77.90±1.07	81.44±1.37	85.37±1.51
Female	50	55.46±0.88	61.38±0.77	66.91±0.93	71.80±0.88	74.12±0.99	77.53±1.23	81.62±1.32
Birth type (BT)								
Single	65	57.06±0.68	63.81±0.65	70.25±0.79	75.35±0.76	78.21±0.84	81.39±1.01	84.99±1.20
Twin	32	54.36±1.06	59.52±0.95	65.75±1.18	71.38±1.12	73.81±1.26	77.58±1.65	82.00±1.73
Overall Mean	97	55.71±0.63	61.67±0.58	68.00±0.72	73.37±0.69	76.01±0.77	79.49±0.96	83.49±1.03
P values								
Year		0.067	0.006	0.004	<0.001	<0.001	0.006	0.004
Sex		0.658	0.589	0.094	0.013	0.007	0.029	0.059
Birth Type		0.036	<0.001	0.002	0.004	0.004	0.055	0.168

lambs after weaning until the end of the study (Table 8). The differences about chest width between male and female lambs were only significant at the ages of 90th day and 135th days. Single born lambs had higher chest width than twin born lambs at all evaluation days, except 75th day of age.

Chest circumference of the 2014 and 2016 born lambs was similar at the beginning of the study, but after 60th day of age, 2016 born lambs had higher chest circumference. Male lambs had higher chest circumference than females only between 90th to 120th days of age. Later then, they had similar chest circumference with female lambs. Single born lambs had higher chest circumference than until the age of 105th day of age, after that, both single and twin born lambs had similar chest circumference.

Discussion

Birth weight of the Kivircik lambs were observed as 4,15; 3,87 and 4,67 kg from 2014 to 2016, respectively, which were lower than Ekiz[3], Özcan et al.[18] and Yakan et al.[19] reported for Kivircik lambs in their studies, but higher than Ceyhan et al.[20]. Live weights of Kivircik lambs were lower than Ekiz[3], Özcan et al.[18] and Yakan et al.[19] not just at birth weight, but also for nearly all observation days. However, it is an expected result since the feeding and housing conditions effects growth performance of lambs significantly.

Lambs born in 2016 had higher live weights than others, except at the 90th and 135th days of age. Many authors noted that the difference depending on the year can be a result of climatic (quantity and quality of forage and amount of rainfall), nutritional and management (hygiene etc.) differences. [1,21,22] These factors may affect both dams' and lambs' health, body condition and quantity and quality of its milk, which will eventually affect the lambs' growth performance.

Male lambs had higher weights than female lambs until the 120th days of age, similar to many authors. [19,23] This was an expected result because of the effect of sexual hormones on the growth. While testosterone endorses skeletal growth, oestrogen has a limited effect on the growth performance of long bones in females, which leads to a smaller body and lighter weight of female animals. [21,24,25]

Single born lambs had higher live weights throughout the study than twin-born lambs, which is an expected result of higher birth weight and not sharing their mother's milk with a sibling. Kabuga and Akowuah[26] explained this with multiple birth lambs cannot be able to reach their full potential both before and after birth because they grew up in more restricted environment during gestation. Many authors reported similar results to the current findings about the effect of birth type on lamb weight. [21,23,24, 27]

When the overall mean values for cumulative ADG at various periods of growth are examined, it is seen that ADG decreases evidently after the 75th day. One of the reasons for this result might be the decrease in daily calorie intake due to the disappearance of milk consumption after the 75th day. In addition, feeding the lambs on pasture during the day after weaning may also have caused the decrease in ADG.[28] Supporting the current result, Ekiz et al.[29] also observed decreased ADG after weaning in Kivircik lambs and they attributed this result to the weaning stress caused by separation from mother and negative impact of feed changes after weaning.

Results indicated that even if the difference was not significant between sexes on the ADG's in first 60 days of age, male lambs had higher ADG's than females for all intervals between 60 to 120th day of age. However, the difference

between male and female lambs was not significant for total cumulative ADG's. On the contrary, Koyuncu and Kara Uzun[23] reported that male lambs had higher ADG's until 60th day of age, but after that, male and female lambs had similar ADG's until the 150th day of age. Since they studied Karacabey Merino and Kivircik lambs together, this situation might be a result of the effect of breed.

Results of the current study indicate that single lambs were not just born heavier but also grew faster than twin-born lambs at all ages. Many authors [21,23,25] reported similar findings about single lambs growing faster and being heavier than multiple born lambs due to having a non-competitive maternal environment during gestation and not sharing the mother's milk with a sibling. On the other hand, Ekiz et al.[29] reported that single born lambs had higher live weights than twin-born lambs, but cumulative ADG's of single and twin born lambs between 45 days to 120 days of age were similar, different from current study's results. The difference between the studies may be due to the different weaning age and ad-libitum concentre feed consumption of the lambs in Ekiz et al.[29].

Daily weight gain of Kivircik lambs was reported between 168-225 g in some of the previous studies[12,14,15]. However, the ADG's in almost all measurement periods in all years were lower than the ADG's reported for Kivircik lambs stated above. In the current study, lambs were grazed on the pasture during the day after weaning. Therefore, the lower ADG's in the study can be a result of different feeding and management conditions between the studies.

Similar to live weights, body measurements are also useful for defining the growth performance, reflecting breed standards and being an important data source for the morphological structure of animals.[11,30] Also, when weighing of live animals are unavailable or improbable in remote rural areas, knowing a various number of body measurements can be crucial, since there is an important relationship between live weight and several body measurements. [31,32]

Study results indicated that year has a significant effect on body measurements in different growth periods, (for withers height and back height it was in the first 60-75th days of age, for the rest of the parameters significant after the 60th days of age), which indicates that different sampling year not only effect the live weight but also the body measurements of Kivircik lambs. Jafari and Hashemi[7] indicated similar results about the effect of year on various body measurements of Makui sheep.

The effect of sex increased with age for most of the investigated body measurements. Costa Júnior et al.[33] reported that there was no significant difference between male and female Santa Inês lambs in terms of various body measurements in the first year, but later than with the increased sexual hormone secretion, the differences between sexes become significant. However, current findings showed that even in the early growth period, there is a significant difference between sexes.

It was observed that chest width and chest circumference were identified as the parameters that showed the least difference between male and female lambs. However, for the other body measurements, male lambs consistently had higher body measurements after weaning (75th day of age). Chest depth of male lambs was higher than females throughout the study, which means chest depth can be a reliable parameter for investigation of growth performance of lambs.

Body measurements of male mammals are higher due to many reasons, such as sexual selection, females usually reach reproductive age earlier and male can allocate more energy to growth.[34] Additionally, mainly because of the endocrine system, type and amount of hormone secretion (especially sexual hormones) effects the growth significantly.[35] On the other hand, Cam et al.[9] reported that chest width, body length, hearth girth and thigh circumstances were similar between male and female Karayaka lambs, however, they stated that male lambs had higher withers height, chest depth, rump height and canon circumstances. The differences between the current study results and other studies indicate that the effect of sex on body measurements of lambs may vary among the breeds.

Results showed that birth type can effect body measurements significantly at many stages of growth of lambs. It was determined that single born lambs had larger body measurements at all measurement times when the effect of birth type was important. Rump height of single lambs was higher than twin born lambs throughout the study, which means rump height can be used as a reliable parameter for investigation of growth performance of Kivircik lambs. Jafari and Hashemi[7] similarly observed that single born lambs had higher body measurements than twin and triple born lambs when the effect of birth type was significant.

Conclusion

Knowing a breed's standard body measurements and live weights in various growth periods can be useful to establish a breed standard and being able to have a more uniform herd and a more profitable production. The ability of relate live weight and body measurements to growth characteristics are vital for breeders to have optimal livestock production. Determining the effect of environmental factors on growth performance is crucial for understanding the breed-specific growth characteristics of Kivircik lamb.

Birth year had significant effect on both live weights and some body measurements of lambs in various growth peri-

ods. Single born and male lambs are found significantly superior in both live weight and body structure over female and twin born lambs. This situation results in being preferred for both meat production and breeding purposes more than their opponents. In order to have a more productive herd structure, female and twin lambs should be reared according to their needs for a better growth performance. Rump height of single born lambs and chest depth of male lambs were higher than their counterparts throughout the study. Therefore, these two body measurements can be used as reliable parameters for investigation of growth performance of Kivircik lambs.

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