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COMPARISON OF NUTRITIONAL STATUS, ANTHROPOMETRIC FEATURES AND BONE MINERAL DENSITY MEASUREMENTS IN ADOLESCENT WRESTLERS AND APPRENTICE JOCKEYS

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Abstract: The aim of this study is to investigate the relationship between bone mineral density and nutritional status in adolescent apprentice jockeys and wrestlers. The study included a total of 54 athletes, consisting of 31 apprentice jockeys and 23 wrestlers. More ever, in the evaluation of the study 7 apprentice jockeys and 5 wrestlers whose weight averages were between the 25th and 75th percentiles were also evaluated. All athletes that participated in the study got their bone mineral density measured by Dual Energy X-ray Absorptiometry (DEXA) method, and also got their 7-day food and fluid intake recorded. Based on overall evaluation, apprentice jockeys were found to have lower total-body bone mineral density (1.013±0.99) than wrestlers (1.352±0.121). However, the BMI (kg/m^2) and mean age of the athletes whose weights are between the 25th and 75th percentile were found to be similar, and the BMD (1.226±0.084) values of the wrestlers in this group were also higher than the apprentice jockeys (1.062±0.037) (p= 0.007). Food and fluid intake comparisons showed that apprentice jockeys had higher energy intake (kcal/kg), CHO intake (g/kg) and water intake (ml/kg) compared to wrestlers. Statistical analysis revealed a positive correlation between calcium and phosphorus intake and bone mineral density measurements ($p < 0.05$). It has been determined that the BMD values of the wrestlers are higher than the apprentice jockeys, whether they have similar BMI and average age or not. Wrestlers resort to less weight loss practices and less food restriction, and engage in higher-intensity exercise, which may be associated with higher bone mineral density.

Key Words: Wrestlers, apprentice jockey, bone, nutrition

ADOLESAN GÜREŞÇİLER VE APRANTİ JOKEYLERDE BESLENME DURUMU İLE KEMİK MİNERAL YOĞUNLUĞU ARASINDAKİ İLİŞKİNİN KARŞILAŞTIRILMASI

Öz: Bu çalışmanın amacı adölesan apranti jokey ve güreşçilerde kemik mineral yoğunluğu ile beslenme durumu arasındaki ilişkinin araştırılmasıdır. Çalışmaya 31 apranti jokey ve 23 güreşçi olmak üzere toplam 54 sporcu katılmıştır. Ayrıca çalışmanın değerlendirmesinde ağırlık ortalamaları 25 ile 75. persantil arasında olan 7 apranti jokey ve 5 güreşçi de değerlendirilmiştir. Araştırmaya katılan tüm sporcuların kemik mineral yoğunlukları Dual Energy X-ray Absorpsiyometri (DEXA) yöntemiyle ölçüldü ve ayrıca 7 günlük yiyecek ve sıvı tüketimleri kaydedildi. Genel değerlendirmeye göre apranti jokeylerin toplam vücut kemik mineral yoğunluğunun (1,013±0,99) güreşçilere (1,352±0,121) göre daha düşük olduğu belirlendi. Ancak ağırlıkları 25. ile 75. persantil arasında olan sporcuların BMI (kg/m2) ve yaş ortalamaları benzer bulunurken, bu gruptaki güreşçilerin Kemik Mineral Yoğunluğu (1.226±0.084) değerleri de Apranti jokeyler'den (1,062±0,037) daha yüksek bulundu (p= 0,007). Apranti jokeylerin güreşçilere kıyasla enerji alımının (kcal/kg), karbonhidrat tüketiminin (g/kg) ve su tüketiminin (ml/kg) daha yüksek olduğu belirlendi. Ayrıca sporcuların kalsiyum ve fosfor alımı ile kemik mineral yoğunluğu ölçümleri arasında pozitif bir ilişki olduğu belirlendi (p<0.05). Güreşçilerin Kemik Mineral Yoğunluğu değerlerinin, benzer BKI ve yaş ortalamalarına sahip olsun veya olmasın, apranti jokeylere göre daha yüksek olduğu belirlendi. Güreşçiler daha az ağırlık kaybı uygulamalarına ve daha az yiyecek kısıtlamasına başvuruyor ve daha yüksek yoğunlukta egzersiz yapıyorlar, bu da daha yüksek kemik mineral yoğunluğuyla ilişkili olabilir.

Anahtar Kelimeler: Güreşçi, apranti jokey, kemik, beslenme

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INTRODUCTION

Horse races and wrestling are weight-category sports where athletes compete in certain weight classes (Burke et al., 2021). In horse races, riders are divided into two categories: apprentice jockeys and jockeys. The term apprentice jockey refers to riders who can be qualified as a jockey after winning a certain number of races (Illidge et al., 2022). Wrestling, on the other hand, can be defined as a hand-to-hand combat contended between two athletes on a mat where the aim is to establish superiority on the rival (Silver, 1988). Wrestlers and jockeys have to participate in competitions within certain weight classes. In wrestling, weight selections are mostly based on the physical characteristics of the wrestler while in horse racing, weight classes are determined more on the basis of the characteristics of the horse than that of the rider (Belski, 2020; Reale et al., 2017).

Jockeys and wrestlers face similar weight control issues. In order to participate in races that continue all year round, jockeys go through weigh-in before and after the race, and they may be required to meet different weight classes if they need to participate in several races during a day. That means jockeys need to regularly implement weight control throughout the year (Dolan et al., 2012; Ryan et al., 2020). In weight-category sports such as wrestling and boxing, athletes participate in major competitions once or twice a year, and thus need fewer cycles and shorter periods of rapid weight loss (Dolan et al., 2012; Lakicevic et al., 2021; Baranauskas et al., 2022).

To maintain weight control, athletes follow diets with calorie restriction and certain quantities of nutrients (Burke et al., 2021). Studies have reported that jockeys, in particular, resort to calorie restriction and fluid restriction to continuously control their weight, leading to low bone mineral density (Poon et al., 2018; Jeon et al., 2018; Ryan et al., 2021). Although it is known that calcium and vitamin D are the most important minerals and vitamins for bone health, it is stated that jockeys restrict these nutrients to prevent height growth (Poon et al., 2018; Jeon et al., 2018; Ryan et al., 2021; Capozzi et al., 2020). In an effort to stunt growth and contribute to weight control, jockeys limit the intake of dietary calcium, which is the primary component of bones and 99% of which is stored in the bones (Waldron-Lynch et al., 2010; Burke et al., 2018; Sale and Elliott-Sale, 2018). Studies have shown that athletes engaged in weight-category sports such as judo, weightlifting, boxing and wrestling have higher bone density levels , because the strength athlethes do not continuously use calorie restriction throughout the year like jockeys and engage in more regular and intense exercise; studies with similar groups of athletes have achieved similar results (Reale et al., 2017; Barley et al., 2018; Herbert et al., 2019; Sagayama et al., 2020).

DEXA is accepted as the gold standard in bone mineral density measurements and is frequently used in bone health assessment. DEXA measurements are interpreted using the T-score that compares results to the optimal bone density of a 30-year-old adult, as recommended by the World Health Organization (WHO), but this value is not recognized as a reference for assessment in adolescent athletes. The Z-score is recommended in the evaluation of age-matched groups. Z-score indicates low bone mineral density when it is -2.0 or less in adolescent groups (Krugh and Langaker, 2021).

In healthy adults, 90% of bone development is completed by age 20, and peak bone mass is reached at age 30. It has been reported that especially insufficient calcium intake and low exercise intensity cause low bone mineral density in adolescent athletes (Sale and Elliott-Sale, 2018). Most studies conducted with athletes are thought to lack data on bone density assessment in young athletic populations.While planning this research, it was thought that apprentice jockeys' bone mineral density would be lower than wrestlers, and they would resort to more weight loss methods with fluid and food restriction. It is known that adequate and balanced nutrition practices, especially in adolescence, are directly related to physical and mental development. If a weight category sport is performed during this period, excessive fluid and food restriction practices are observed. It is known that these restrictions during the development period lead to many health problems, especially bone health. This study is important in terms of determining the energy and nutrient consumption of athletes in adolescence, determining their fluid consumption and evaluating the practices they perform for weight loss. In addition, the limited number of studies evaluating the weight control and nutritional status of adolescent athletes increases the importance of the study.

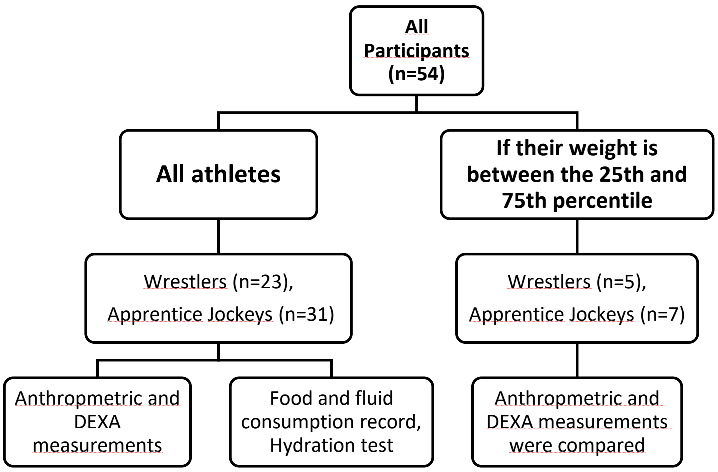
This study aims to determine and compare bone mineral density in adolescent wrestlers and apprentice jockeys and to investigate the relationship between these results and the nutritional status of the athletes. In this study, we examine the relationship between the nutritional status and bone mineral density of horse riders, for whom being physically small is an advantage, and wrestlers in a similar age group. We believe the present study is particularly interesting as it is the first to investigate bone mineral density in Turkish apprentice jockeys.

METHODS

Participants

All licensed adolescent apprentice jockeys in jockey club of Turkey and athletes between the ages of 15-19 affiliated with Basaksehir Wrestling Club were included in the study. The sample size consisted of 54 participants in total, consisting of apprentice jockeys (n=31) and wrestlers (n=23). The study was approved by the Hamidiye Clinical Research Ethics Committee on 27/08/2021, mtg. no. 2021/28, decision no. 28/10, and received permission after the Jockey Club of Turkey and Basaksehir Wrestling Club were provided with information about the study. The athletes participating in the study were also subjected to a partial evaluation according to their weight percentile values between the 25th and 75th to increase their physical similarities. BMD values of 12 athletes, including 7 apprentice jockeys and 5 wrestlers, were also evaluated. In this section, athletes with similar BMI (kg/m2), age and weight values between the 25th and 75th percentile were subjected to evaluation. The percentile classification was determined according to the reference values in Turkish children performed by Neyzi et al. in 2008 (Neyzi et al., 2008).

Figure 1. Study design



Abbreviations: DEXA: Dual Energy X-ray Absorptiometry

At the beginning of the study, athletes were asked to fill in a personal data questionnaire and a 1-week fluid and food consumption record. Also, in the morning on day one of the study, hydration tests and DEXA measurements were performed to determine body composition: body composition and hydration tests were performed between 08:00 and 10:00 a.m. after 12 hours of fasting. Information about the study design and measurements are given in Figure 1.

Assessment Of Bone Mineral Density

Bone Mineral Density (BMD) was determined using the Dual Energy X-ray Absorptiometry (DEXA) (GE Lunar NT DPX, Wisconsin, USA). Before DEXA measurements, participants were asked to take off all metal objects they might have. They were then taken to the measurement room one by one and were asked to lie still on the DEXA bed for 20 minutes. Measurements calculated bone mineral density in g/cm^2 for the head, arms, legs, trunk, ribs, spine, pelvis and total body. Z-scores were also determined.

Determination of Nutritional Status

Food and fluid intake questionnaires were prepared for athletes to record their 7-day consumption. While recording their food consumption, the athletes were asked to take pictures of their meals and share them with the researchers. Completed food and fluid consumption records were collected from the athletes at the end of 7 days and checked through individual interviews. The data obtained from the records were used to calculate daily calorie and nutrient intake for the athletes included in the research. The data obtained were analyzed using the Nutrition information System (BeBiS 9) (Ülker et al., 2024).

Hydration Status

For urine density measurements, urine samples were taken from the athletes in the mornings of 1., 2. and 3. days at the beginning of the study. Then, the average of these 3 measurements was recorded and the urine specific gravity (USG) value was determined. Measurements were performed using a hand-held clinical refractometer (Atago Pen Digital Refractometer, Japan). The measurement results were considered as normal between 1.005 and 1.020, hypohydration between 1.020 and 1.030, and severe hypohydration for 1.030 and above (Durguerian et al., 2016).

Training Program

There was a difference between wrestlers and apprentice jockeys according to the time/load/volume of their training. Wrestlers are in training program including morning conditioning (90 min/day) and evening technical training (90 min/day) under the supervision of their coaches 6 days a week. The apprentice jockeys training program, on the other hand, including horse training (60 min/day) in the morning and conditioning training (45 min/day) in the evening 5 days a week.

Statistical Analysis

Statistical analysis of the data collected in the study was performed using SPSS 25.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). The data were analyzed using descriptive statistical methods (Mean, Standard Deviation, Median, Frequency, Ratio, Minimum, Maximum) and were checked for normality of distribution using the Kolmogrov-Smirnov test. The pairwise comparisons of non-normally distributed continuous variables data were performed using the Mann-Whitney U test, and the categorical variables data were compared using the chi-square test. Independent Sample T test was used to compare two groups of data were performed with normal distribution. Spearman Correlation Coefficient was used to evaluate non-parametric data in determining the relationship between variables. The correlation coefficient is evaluated according to the following classification: 0–0.10 negligible; 0.10–0.39 weak; 0.40–0.69 moderate; 0.70–0.89 strong; 0.90–1 very strong (Schober et al., 2018). Effect size (ES) was calculated using Cohen's d test to determine the meaningfulness of the difference. The magnitude of the ES was classified according to the Hopkins' Scale as trivial (< 0.2), small (> 0.2–0.6), moderate (> 0.6–1.2), large (> 1.2–2.0), and very large (> 2.0–4.0)(Hopkins et al., 2009). In addition, transformation formulas were used to calculate the effect size of data that did and did not comply with normal distribution (Lenhard and Lenhard, 2022). Statistical significance was set at p < 0.05.

RESULTS

The apprentice jockeys included in the study had a mean age of 16.91±0.91 years and the wrestlers had a mean age of 16.98±1.32 years, with no statistically significant difference between the groups (*p*=0.753, *p*>0.05). Wrestlers were found to have higher total fat percentages compared to apprentice jockeys, and apprentice jockeys were found to have higher muscle mass percentages compared to wrestlers.

Table 1. Body composition measurements by groups

	Apprentice Jockeys (n=31) M±SD (Median)	**Wrestlers (n=23)** M±SD (Median)	**p**	**Effect Size**	**Apprentice Jockeys (n=7)** M±SD (Median)	**Wrestlers (n=5)** M±SD (Median)	**p**	**Effect Size**
Height (cm)	164.54±5.20 (165.4)	179.43±6.26 (179)	0.000**a	.968	166.30±5.09 (165.7)	174.40±5.01 (179)	0.028*a	.871
Body Mass (kg)	49.10±4.82 (49.35)	82.81±14.67 (81.27)	0.000**a	.990	55.36±2.43 (54.52)	65.25±4.49 (66.68)	0.004**a	.980
BMI (kg/cm^2)	18.03±1.72 (17.94)	25.76±3.59 (25.24)	0.000**a	.979	19.95±1.54 (20.71)	21.30±0.88 (21.07)	0.167a	.766
Percent Body Fat (%)	9.19±2.67 (8.9)	20.43±9.03 (20.65)	0.000**a	.902	11.14±2.68 (10.3)	10.88±3.87 (10.9)	0.808a	.523
Fat Mass (kg)	4.51±1.44 (4.15)	18.27±11.09 (15.27)	0.000**a	.912	6.13±1.58 (5.66)	7.19±2.80 (7.38)	0.465a	.636
Fat Free Mass (%)	90.82±2.67 (91.21)	78.49±10.41 (79.35)	0.000**a	.894	88.94±2.75 (89.74)	89.09±3.88 (89.05)	0.808a	.513
Fat Free Mass (kg)	44.59±4.48 (45.71)	64.06±7.44 (63.40)	0.000**a	.990	49.23±2.56 (48.15)	58.06±3.32 (57.80)	0.004**a	.985
Lean Mass Percent (%)	86.48±2.59 (86.75)	74.93±8.69 (74.61)	0.000**b	.916	84.73±2.53 (85.17)	84.30±3.92 (84.40)	0.808a	.538
Lean Mass (kg)	42.46±4.26 (43.49)	61.19±6.16 (61.14)	0.000**a	.995	46.90±2.41 (45.92)	54.92±3.07 (54.72)	0.004**a	.982

Note: Abbreviations: BMI: Body Mass Index, Values are presented as mean ± SD and M±SD (Median).
a Mann-Whitney U test was used to compare two groups of non-normally distributed data;
b Student's t test was used to compare two groups of normally distributed data
**p* < 0.05; ***p* < 0.01.

The results for food and fluid intake are presented in Table 2. Nutritional status comparisons showed that apprentice jockeys had higher daily calorie intake per kg and higher carbohydrate and fat intake than wrestlers (*p*<0.05), while protein intake was similar in both groups (*p*>0.05). In terms of vitamin and mineral intake, vitamin D and vitamin C intake were statistically similar in both groups, while intake of other micronutrients was higher in wrestlers. Water consumption, expressed in milliliter per kilogram, was found to be higher in apprentice jockeys (*p*<0.05).

Table 2. Assessment of calorie and nutrient intake by groups

	Apprentice Jockeys M±SD (Median)	**Wrestlers** M±SD (Median)	**p**	**Effect Size**
Energy (kcal)	2581.85±399.25 (2541.12)	3666.04±839.48 (3611.65)	0.000**a	.890
Energy (kcal/kg)	53.10±10.14 (49.95)	44.21±6.88 (45.01)	0.002*a	.760
Carbohydrate (%)	44.97±3.62 (45)	42.27±5.10 (42)	0.029*b	.654
Carbohydrate (g/kg)	5.86±1.21 (5.66)	4.57±0.76 (4.65)	0.000**a	.808
Protein (%)	17.19±2.24 (17.00)	18.77±2.54 (18.50)	0.080a	.681
Protein (g/kg)	2.23±0.45 (2.17)	2.03±0.37 (2.14)	0.098b	.632
Fat (%)	37.87±2.46 (38.00)	38.95±4.28 (39.00)	0.176a	.591
Fat (g/kg)	2.27±0.47 (2.13)	1.95±0.44 (1.98)	0.017*a	.689
Vitamin A (µg)	1225.27±323.98 (1288.90)	2109.75±1637.42 (1654.16)	0.005*a	.719
Vitamin D (µg)	5.27±5.07 (4.69)	5.99±5.77 (4.72)	0.348 a	.538
Vitamin E (mg)	24±3.93 (24.70)	30.85±10.79 (30.57)	0.021* a	.739
Vitamin K	382.82±81.12 (377.78)	527.08±177.99 (516.66)	0.000**b	.784
B1 vit. / Thiamine (mg)	1.16±0.21 (1.14)	1.54±0.45 (1.41)	0.001*a	.792
Vitamin B2/ Riboflavin (mg)	1.61±0.32 (1.62)	2.53±0.72 (2.59)	0.000**a	.893
B6 vit. / Pyridoxine (mg)	1.86±0.34 (1.84)	2.68±0.72 (2.55)	0.000**a	.863
Folate (µg)	325.07±55.87 (325.9)	448.74±130.84 (424.23)	0.000**a	.823
Vitamin B12/Cobalamin (mg)	6.77±1.78 (6.87)	13.30±7.00 (11.34)	0.000**a	.837
Vitamin C (mg)	124.41±33.16 (127.57)	129.15±56.51 (127.77)	0.703b	.530
Sodium (mg)	4404.29±637.89 (4520.50)	7064.02±2105.96 (7023.19)	0.000**a	.905
Potassium (mg)	3133.50±557.12 (3169.17)	4199.24±1147.67 (3987.94)	0.000**a	.812
Calcium (mg)	904.46±182.11 (881.17)	1225.63±431.56 (1240.89)	0.002*a	.768
Magnesium (mg)	417.09±83.84 (416.12)	501.10±142.72 (492.77)	0.028* a	.702
Phosphorus (mg)	1547.56±256.63 (1522.95)	2347.44±598.17 (2315.76)	0.000**a	.905
Iron (mg)	16.01±3.44 (16.09)	21.21±4.87 (21.03)	0.000**b	.816
Zinc (mg)	16.98±3.59 (16.41)	24.07±6.05 (22.88)	0.000**a	.854
Water (ml)	3397.26±1069.16 (3333.34)	2989.61±1135.25 (2967.07)	0.121a	.604
Water (ml/kg)	69.80±23.08 (74.77)	35.49±9.77 (35.48)	0.000**b	.902

Note : a Mann-Whitney U test was used to compare two groups of non-normally distributed data;
b Student's t test was used to compare two groups of normally distributed data
*$p < 0.05$; ** $p < 0.01$.

Hydration analysis found similar urine specific gravity results in the groups. According to hydration classification, hydration values were found to be normal in 54.8% of the apprentice jockeys and 60.9% of the wrestlers. Data on hydration status are shown in Table 3.

Table 3. Hydration assessment by groups

	Apprentice Jockeys M±SD (Median)	**Wrestlers** M±SD (Median)	**p**	**Effect Size**
Urine Density (g/ml)	1.019±0.006 (1.020)	1.020±0.008 (1.020)	0.699b	.541
Normal ***n(%)***	***17 (54.8)***	***14 (60.9)***	0.038a	
Hypohydration ***n(%)***	***14 (45.2)***	***6 (26.1)***		
Severe Hypohydration ***n(%)***	***0 (0)***	***3 (13.0)***		

Note: a Chi-Square test used to compare qualitative data,
b Student's t test was used to compare two groups of normally distributed data
*$p < 0.05$; ** $p < 0.01$.

The results of BMD measurements are presented in Table 4. Bone mineral density measurements found lower Z-scores in apprentice jockeys compared to wrestlers (p<0.01). Similarly, wrestlers had higher values of total bone mineral mass (g) and bone mineral area. Bone mineral density measurements were also evaluated by partial evaluation with 12 athletes whose BMI and mean age were similar (p<0.05). Similar to the total athlete evaluation, the BMD values of the wrestlers were higher than the apprentice jockeys.

Table 4. Comparison of bone mineral density measurements by groups

	Apprentice Jockeys (n=31) M±SD (Median)	Wrestlers (n=23) M±SD (Median)	p	Effect Size	Apprentice Jockeys (n=7) M±SD (Median)	Wrestlers (n=5) M±SD (Median)	p	Effect Size
Head (g/cm2)	1.696±0.194 (1.681)	2.188±0.304 (2.225)	0.000**a	.928	1.709±0.162 (1.692)	1.951±0.373 (1.963)	0.223a	.739
Arms (g/cm2)	0.782±0.055 (0.778)	1.035±0.114 (1.051)	0.000**a	.985	0.818±0.039 (0.820)	0.945±0.098 (0.972)	0.028*a	.904
Legs (g/cm2)	1.113±0.082 (1.134)	1.469±0.131 (1.468)	0.000**a	.992	1.162±0.077 (1.200)	1.352±0.079 (1.365)	0.004**a	.958
Trunk (g/cm2)	0.884±0.056 (0.890)	1.222±0.130 (1.211)	0.000**a	.994	0.913±0.031 (0.912)	1.091±0.087 (1.087)	0.007**a	.982
Costa (g/cm2)	0.686±0.042 (0.692)	1.004±0.112 (1.010)	0.000**a	.998	0.705±0.032 (0.697)	0.897±0.102 (0.917)	0.007**a	.975
Spine (g/cm2)	0.934±0.067 (0.945)	1.346±0.170 (1.352)	0.000**a	.993	0.950±0.035 (0.945)	1.165±0.105 (1.198)	0.004**a	.983
Pelvis (g/cm2)	1.071±0.083 (1.076)	1.450±0.163 (1.435)	0.000**a	.988	1.113±0.052 (1.104)	1.300±0.087 (1.305)	0.012*a	.974
TB-BMD (g/cm2)	1.013±0.99 (1.018)	1.352±0.121 (1.366)	0.000**a	.987	1.062±0.037 (1.068)	1.226±0.084 (1.249)	0.007**a	.973
TB- BMC (g)	2133.40±266.04 (2172.20)	3772.76±570.97 (3728.90)	0.000**a	.997	2328.26±199.18 (2361.70)	3130.88±346.50 (3136.60)	0.007**a	.983
TB-BMA (cm2)	2068.65±156.91 (2051.00)	2777.64±212.70 (2789.00)	0.000**a	.997	2190.14±120.53 (2187)	2550.00±152.78 (2593)	0.004**a	.971
Z score	-1.32±0.74 (-1.3)	2.21±1.21 (2.05)	0.000**a	.995	-0.89±0.62 (-0.6)	1.04±0.92 (0.8)	0.006**a	.965

Note: Abbreviations: TB: Total Body, BMD: Bone Mineral Density, BMC: Bone Mineral Content, BMA: Bone Mineral Area
a Mann-Whitney U test was used to compare two groups of non-normally distributed data;
$^*p < 0.05$; $^{**} p < 0.01$.

The correlation between nutritional status and bone density is presented in Table 5. The analysis of correlation between total-body bone mineral density and calorie and nutrient intake showed that calcium and vitamin D had a weak and insignificant correlation with BMD (p>0.05).

Table 5. Correlation between total-body bone density and nutrient intake

	r	p
Protein	0.611	0.000**
Vitamin A	0.356	0.009**
Vitamin D	0.051	0.719
Vitamin K	0.378	0.005**
Vitamin C	0.556	0.000**
Calcium	0.387	0.004**
Magnesium	0.289	0.036*
Phosphorus	0.546	0.000**
potassium	0.501	0.000**
Zinc	0.537	0.000**

Note*: r: Spearman's Correlation Coefficient*
$^*p < 0.05$; $^{**} p < 0.01$.

Water consumption and urine density were found to have a weak negative correlation (r=-0.497, p<0.01). Also, total BMD was found to have a strong positive correlation with muscle mass (r=0.858, p<0.01), and a strong positive correlation with height (r=0.771, p<0.01).

DISCUSSION

The results of our study show that age-matched wrestlers had higher bone mineral density than apprentice jockeys. Wrestlers were found to have higher total-body BMD values. Regional assessments also showed wrestlers to have higher BMD values.

Studies have also found higher BMD values in combat sports athlethes. A study involving boxers and jockeys reported higher total-body BMD values in boxers (1.29±0.10 g/cm2) than in jockeys (1.09±0.06 g/cm2). (Dolan et al., 2012). In our study, the BMD values of wrestlers with similar BMI and average age were found to be higher than those of apprentice jockeys. The study results appear to be consistent with the current study. Another study found higher total BMD values in wrestlers (1.366±0.06 g/cm2) compared to judoka, endurance athletes and non-athletes (Sagayama et al., 2020). Our study also found higher BMD values in wrestlers (1.352±0.121 g/cm2), which are similar to the values reported in a study conducted by Sanfilippo et al. (2019) involving NCAA wrestlers (1.459±0.136 g/cm2). Overall, martial artists were found to have higher BMD values than other athletes (Santos et al., 2014).

Our study found the total-body BMD of apprentice jockeys to be 1.013±0.099. A study with Irish jockeys found their total-body BMD to be 1.134±0.056, while a similar study by Warrington et al. (2009) found jockeys' total-body BMD to be 1.050±0.07. Jeon et al. (2018) reported a total-body BMD of 1.155 ± 0.126 in professional jockeys. Similar studies found that total-body BMD values of apprentice jockeys and jockeys varied between 1.050 and 1.155, which are higher than the values found for the apprentice jockeys included in our study.

Our study found a Z-score of -1.32±0.74 in apprentice jockeys and 2.21±1.21 in wrestlers. A similar study found the Z-scores of professional jockeys to be 0.00±1.35 (Jeon et al., 2018). Another study by Wilson et al. (2015) investigating Z-scores in jockeys reported a lumbar spine Z-score of −1.32±0.76 and a total hip Z-score of −1.04±1.2. A study found the Z-score for total-body bone density to be 3.6±1.0 in wrestlers, and 0.3±1.5 in non-athletes (Sagayama et al., 2020). The results of our study are consistent with the results of other studies in this regard: apprentice jockeys have lower Z-scores than wrestlers.

This study found that apprentice jockeys had a mean BMI (kg/m2) of 18.03±1.72.Wrestlers, on the other hand a mean BMI (kg/m2) of 25.76±3.59. In addition, the apprentice jockeys who were partially evaluated the average BMI (kg/m2) was 19.95±1.54, while the average BMI(kg/m2) of the wrestlers was 21.30±0.88. A study with South African apprentice jockeys with a mean BMI of 19.2±1.1 kg/m^2 (Illidge et al., 2022). In similar studies, Cullen et al. (2015) reported that apprentice jockeys had a mean BMI of 19.2±1.1kg/m2, while Hitchens et al. (2011) reported that apprentice jockeys and jockeys had a mean BMI of 20.6±1.6 kg/m2. A study with wrestlers found their mean BMI to be 26.76±3.79 kg/m2 (Rahmani and Mirzaei, 2019). Our study found the mean BMI and weight of apprentice jockeys to be lower than in similar studies, which may be due to the lower mean age of the athletes in our study.

A study tracked 7-day food consumption in jockeys and found that they had a daily mean carbohydrate intake of 3.02 g/kg, protein intake of 1.06 g/kg, fat intake of 1.01 g/kg, and a daily total calcium intake of 557 mg (Wilson et al., 2013). A similar study found that Irish jockeys had a daily mean calorie intake of 1669±436 kcal, Carbohydrate(CHO) intake of 3.7±1.3 g/kg, protein intake of 1.3±0.5 g/kg, and a daily calcium intake of 619±295 mg (Dolan et al., 2011). Another study with Korean jockeys found that, during the non-weight loss period, average daily calorie intake was 2086.5±374.76 kcal, CHO intake was 251.6±95.98 g, protein intake was 89.3±36.26 g, fat intake was 61.8±26.59 g, and calcium intake was 385.3±157.56 mg (Jeon et al., 2018). Another study with professional jockeys reported that, during the racing period, average daily calorie intake was 805.86±255.8 kcal, CHO intake was 1.4±0.5 g/kg, protein intake was 0.9±0.4 g/kg, fat intake was 0.5±0.2 g/kg, calcium intake was 262.4±105.4 mg and vitamin D intake was 0.4±0.8 mg (O'Reilly et al., 2017). It has been reported that a daily CHO intake of 6 g/kg, protein intake of 1.2 g/kg and fat intake of 1 g/kg are sufficient for jockeys. A daily calorie intake between 2118.56 kcal and 2467.28 kcal are thought to be sufficient (Wilson et al., 2013). The results of our study showed that apprentice jockeys' calorie and nutrient intake was consistent with recommendations and higher than the values reported in other studies. The reason for being in compliance with the recommendations may be due to the fact that the apprentice jockeys are in the adolescence period and therefore their energy needs are higher. The low energy and nutrient intake in similar studies may be due to the fact that professional jockeys followed a restricted diet to reach their weight. A study with Greek adolescent wrestlers recorded their 4-day food consumption during a normal period and found their daily protein intake to be 1.6 g/kg (Papassotiriou, 2017). It is recommended that wrestlers have a daily carbohydrate intake of 5-7 g/kg, and a protein intake of 1.2-1.7 g/kg, up to 2.0 g/kg during periods of muscle mass gain (Stanzione and Volpe, 2019). The results of our study found that wrestlers' protein intake was in line with the recommendations, but their carbohydrate intake was lower.

Jeon et al. reported that total BMD and calcium intake in jockeys did not show a significant correlation (r=-0,540, p=0.108) (Jeon et al., 2018). Our study, however, found a positive and significant correlation between calcium intake and total-body bone density (r=0.387, p=0.004). This shows that calcium intake is important for bone development, especially during adolescence. The difference between studies may be due to age groups.

As for hydration status, a study with South African apprentice jockeys found that mean USG in habitual state of dehydration was 1.027 ± 0.003 g/ml (Illidge et al., 2022). A similar study found a mean USG of 1.017 ± 0.005 g/ml in Irish jockeys in a measurement performed on a non-race day (Cullen et al., 2015). A study with college wrestlers reported a mean USG of 1.027 ± 0.001 (Sommerfield et al., 2016). Our study obtained similar USG averages in apprentice jockeys and wrestlers, which is in line with other studies.

CONCLUSION

The results of this study demonstrate that apprentice jockeys have lower bone mineral density compared to age-matched wrestlers.

With regard to nutritional status, the results of this study showed that the group with low bone mineral density had lower calcium and vitamin D intake. Also, compared to wrestlers apprentice jockeys were found to have lower values in total intake of calorie and several nutrients. The group with more muscle mass was also found to have higher bone mineral density.

While higher mechanical loads in wrestling can be associated with bone density and muscle mass, continuous weight control in apprentice jockeys may have had a negative effect on bone mineral density and muscle mass. The results of our study suggest that further studies are needed to investigate this issue in greater detail.

In addition, a number of data below should be taken into consideration when evaluating study data. These are;

-When evaluating the findings, it should not be forgotten that the physical characteristics are different between the groups.
- It should be evaluated that anthropometric characteristics such as body fat percentage values may show changes specific to body weight and sports branch.

- Evaluating the amounts consumed per kilogram for energy and nutrient consumption in athletes will reduce the changes due to athlete weight differences.
- Urine density measurements are used to determine the hydration status of athletes. Urine density measurements should be evaluated together with fluid consumption records for fluid consumption monitoring of athletes.
- It is known that bone density measurements are related to nutritional status and training intensity.
- It has been determined that there is generally a positive correlation between bone mineral density and nutrient intakes. However, the lack of a relationship between vitamin D intake and bone mineral density may be due to the fact that dietary sources of vitamin D are limited and it can be synthesized by the body mostly with the help of sunlight. This situation should be taken into consideration when making the evaluation.

Limitations

In this study, the inability to evaluate vitamin D and calcium values by blood test was a limitation. This situation creates a limitation in the evaluation of Bone Mineral Density (BMD). The study was limited to the participation of a total of 31 apprentice jockeys and 22 wrestlers. The physical differences that arise depending on the type of sport was a limitation**.** The fact that some of the physical characteristics of the athletes in the compared sports branches were different caused parameters such as weight not to be generalized and compared. Due to the limited representativeness of the sample and the cross-sectional study design, there was a limitation in comparing and evaluating some data.

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REFERENCES

Baranauskas, M., Kupčiūnaitė, I., & Stukas, R. (2022, April). The association between rapid weight loss and body composition in elite combat sports athletes. In *Healthcare* (Vol. 10, No. 4, p. 665). MDPI.

Barley, O. R., Chapman, D. W., & Abbiss, C. R. (2018). Weight loss strategies in combat sports and concerning habits in mixed martial arts. *International journal of sports physiology and performance*, *13*(7), 933-939.

Belski, R. (2020). Weight category and aesthetic sport athletes. *In Nutrition for Sport, Exercise and Performance* (pp. 228-235). Routledge.

Burke, L. M., Close, G. L., Lundy, B., Mooses, M., Morton, J. P., & Tenforde, A. S. (2018). Relative energy deficiency in sport in male athletes: a commentary on its presentation among selected groups of male athletes. *International journal of sport nutrition and exercise metabolism*, *28*(4), 364-374.

Burke, L. M., Slater, G. J., Matthews, J. J., Langan-Evans, C., & Horswill, C. A. (2021). ACSM expert consensus statement on weight loss in weight-category sports. *Current sports medicine reports*, *20*(4), 199-217.

Capozzi, A., Scambia, G., & Lello, S. (2020). Calcium, vitamin D, vitamin K2, and magnesium supplementation and skeletal health. *Maturitas*, *140*, 55-63.

Cullen, S., Dolan, E., McGoldrick, A., Brien, K. O., Carson, B. P., & Warrington, G. (2015). The impact of making-weight on cognitive performance in apprentice jockeys. *Journal of sports sciences*, *33*(15), 1589-1595.

Cullen, S., O'Loughlin, G., McGoldrick, A., Smyth, B., May, G., & Warrington, G. D. (2015). Physiological demands of flat horse racing jockeys. *The Journal of Strength & Conditioning Research*, *29*(11), 3060-3066.

Dolan, E., Crabtree, N., McGoldrick, A., Ashley, D. T., McCaffrey, N., & Warrington, G. D. (2012). Weight regulation and bone mass: a comparison between professional jockeys, elite amateur boxers, and age, gender and BMI matched controls. *Journal of bone and mineral metabolism, 30*, 164-170.

Dolan, E., McGoldrick, A., Davenport, C., Kelleher, G., Byrne, B., Tormey, W., ... & Warrington, G. D. (2012). An altered hormonal profile and elevated rate of bone loss are associated with low bone mass in professional horse-racing jockeys. *Journal of bone and mineral metabolism, 30*, 534-542.

Dolan, E., O'Connor, H., McGoldrick, A., O'Loughlin, G., Lyons, D., & Warrington, G. (2011). Nutritional, lifestyle, and weight control practices of professional jockeys. *Journal of sports sciences*, *29*(8), 791-799.

Durguerian, A., Bougard, C., Drogou, C., Sauvet, F., Chennaoui, M., & Filaire, E. (2015). Weight loss, performance and psychological related states in high-level weightlifters. *International journal of sports medicine*, 230-238.

Herbert, A. J., Williams, A. G., Hennis, P. J., Erskine, R. M., Sale, C., Day, S. H., & Stebbings, G. K. (2019). The interactions of physical activity, exercise and genetics and their associations with bone mineral density: implications for injury risk in elite athletes. *European journal of applied physiology, 119*, 29-47.

Hitchens, P., Blizzard, L., Jones, G., Day, L., & Fell, J. (2011). Are physiological attributes of jockeys predictors of falls? A pilot study. *BMJ open*, bmjopen-2011.

Hopkins W, Marshall S, Batterham A, Hanin J (2009) Progressive statistics for studies in sports medicine and exercise science. Med Sci Sports Exerc 41(1):3–13. https://doi.org/10.1249/MSS.0b013e31818cb278

Illidge, E., Biggs, C., Krog, K., Mason, T., & Read, M. (2022). Determining percentage body fat of male South African jockey apprentices irrespective of hydration status. *South African Journal of Clinical Nutrition, 35*(1), 32-38.

Jeon, S., Cho, K., Ok, G., Lee, S., & Park, H. (2018). Weight loss practice, nutritional status, bone health, and injury history: a profile of professional jockeys in Korea. *Journal of Exercise Nutrition & Biochemistry*, *22*(3), 27.
Krugh, M., & Langaker, M. D. (2021). Dual Energy X-ray Absorptiometry.

Lakicevic, N., Mani, D., Paoli, A., Roklicer, R., Bianco, A., & Drid, P. (2021). Weight cycling in combat sports: revisiting 25 years of scientific evidence. *BMC sports science, medicine and rehabilitation, 13*(1), 1-6.

Lenhard, W. & Lenhard, A. (2022). Computation of effect sizes. Retrieved from: https://www.psychometrica.de/effect_size.html. Psychometrica. DOI: 10.13140/RG.2.2.17823.92329

Neyzi, O., Günöz, H., Furman, A., Bundak, R., Gökçay, G., & Darendeliler, F. (2008). Türk çocuklarında vücut ağırlığı, boy uzunluğu, baş çevresi ve vücut kitle indeksi referans değerleri. *Çocuk Sağlığı ve Hastalıkları Dergisi*, *51*(1), 1-14.

O'Reilly, J., Cheng, H. L., & Poon, E. T. C. (2017). New insights in professional horse racing;"in-race" heart rate data, elevated fracture risk, hydration, nutritional and lifestyle analysis of elite professional jockeys. *Journal of sports sciences*, *35*(5), 441-448.

Papassotiriou, I. (2016). Dietary Intake and Body Composition of Greek Adolescent Wrestlers During Preseason. *International Journal of Wrestling Science*, *6*(2), 127-130.

Poon, E. T. C., O'Reilly, J., Sheridan, S., Cai, M. M., & Wong, S. H. S. (2018). Markers of bone health, bone-specific physical activities, nutritional intake, and quality of life of professional jockeys in Hong Kong. *International journal of sport nutrition and exercise metabolism*, *28*(4), 440-446.

Rahmani, F., & Mirzaei, B. (2019). Anthropometric profile of elite Azerbaijani senior greco-roman wrestlers. *Pedagogics, psychology, medical-biological problems of physical training and sports*, (4), 196-201.

Reale, R., Slater, G., & Burke, L. M. (2017). Acute-weight-loss strategies for combat sports and applications to Olympic success. *International journal of sports physiology and performance*, *12*(2), 142-151.

Reale, R., Slater, G., & Burke, L. M. (2017). Individualised dietary strategies for Olympic combat sports: Acute weight loss, recovery and competition nutrition. *European journal of sport science*, *17*(6), 727-740.

Ryan, K. D., Brodine, J., Pothast, J., & McGoldrick, A. (2020). Medicine in the sport of horse racing. *Current sports medicine reports*, *19*(9), 373-379.

Ryan, K., & Brodine, J. (2021). Weight-making practices among jockeys: An update and review of the emergent scientific literature. *Open Access Journal of Sports Medicine*, 87-98.

Sagayama, H., Kondo, E., Tanabe, Y., Ohnishi, T., Yamada, Y., & Takahashi, H. (2020). Bone mineral density in male weight-classified athletes is higher than that in male endurance-athletes and non-athletes. *Clinical nutrition ESPEN*, *36*, 106-110.

Sale, C., & Elliott-Sale, K. J. (2019). Nutrition and athlete bone health. *Sports Medicine*, *49*(Suppl 2), 139-151.

Sanfilippo, J., Krueger, D., Heiderscheit, B., & Binkley, N. (2019). Dual-energy X-ray absorptiometry body composition in NCAA Division I athletes: Exploration of mass distribution. *Sports health*, *11*(5), 453-460.

Santos, D. A., Dawson, J. A., Matias, C. N., Rocha, P. M., Minderico, C. S., Allison, D. B., ... & Silva, A. M. (2014). Reference values for body composition and anthropometric measurements in athletes. *PloS one*, *9*(5), e97846.

Schober, P., Boer, C., & Schwarte, L. A. (2018). Correlation coefficients: appropriate use and interpretation. *Anesthesia & analgesia*, 126(5), 1763-1768.

Silver, A. (1988). History of Wrestling. *Ankara: Türk Spor Vakfı Yayınları*.

Sommerfield, L. M., McAnulty, S. R., McBride, J. M., Zwetsloot, J. J., Austin, M. D., Mehlhorn, J. D., ... & Utter, A. C. (2016). Validity of urine specific gravity when compared to plasma osmolality as a measure of hydration status in male and female NCAA collegiate athletes. *Journal of strength and conditioning research/National Strength & Conditioning Association*, *30*(8), 2219.

Stanzione, J. R., & Volpe, S. L. (2019). Nutritional considerations for wrestlers. *Nutrition Today*, *54*(5), 207-212.

Ülker, M. T., Çolak, G. A., Baş, M., & Erdem, M. G. (2024). Evaluation of the effect of gluten-free diet and Mediterranean diet on autoimmune system in patients with Hashimoto's thyroiditis. *Food Science & Nutrition*, 12(2), 1180-1188.

Waldron-Lynch, F., Murray, B. F., Brady, J. J., McKenna, M. J., McGoldrick, A., Warrington, G., ... & Barragry, J. M. (2010). High bone turnover in Irish professional jockeys. *Osteoporosis international*, *21*, 521-525..

Warrington, G., Dolan, E., McGoldrick, A., McEvoy, J., MacManus, C., Griffin, M., & Lyons, D. (2009). Chronic weight control impacts on physiological function and bone health in elite jockeys. *Journal of sports sciences*, *27*(6), 543-550.

Wilson, G., Fraser, W. D., Sharma, A., Eubank, M., Drust, B., Morton, J. P., & Close, G. L. (2012). Markers of bone health, renal function, liver function, anthropometry and perception of mood: a comparison between Flat and National Hunt Jockeys. *International journal of sports medicine*, 453-459.

Wilson, G., Pritchard, P. P., Papageorgiou, C., Phillips, S., Kumar, P., Langan-Evans, C., ... & Close, G. L. (2015). Fasted exercise and increased dietary protein reduces body fat and improves strength in jockeys. *International journal of sports medicine*, 1008-1014.