ORIGINAL ARTICLE

TRENDS in
Sport Sciences
2025; 32(**4**): 245-251
ISSN 2299-9590
DOI: https://doi.org/10.23829/TSS.2025.32.4-4

Body composition and anaerobic exercise capacity in elite adolescent track athletes

SOO-HAN KIM, KI-JUN PARK

Abstract
Introduction. **Relative age significantly impacts adolescent track athletics. Therefore, identifying and developing adolescent athletes to compete effectively in track events is essential.** Aim of Study. **This study aimed to compare the body composition and anaerobic capacity of adolescent track athletes, specifically sprinters and long-distance athletes, by sex, and to identify factors influencing these variables.** Material and Methods. **The study involved 96 athletes undergoing intensive training in preparation for various high-level competitions in 2024. The athletes measured several aspects of body composition, including leg length, body fat percentage (BFP), lean body mass (LBM), and body mass index (BMI). Anaerobic capacity was assessed using the Wingate test, conducted on a cycle ergometer. A t-test was performed to compare body composition and anaerobic capacity of the two groups. Additionally, simple linear regression analysis was utilized to identify factors affecting the measured variables.** Results. **The leg lengths of sprinters and long-distance athletes were similar for both male and female athletes. However, significant differences were observed in BFP, LBM, and BMI between sprinters and long-distance athletes, across both sexes. Male and female sprinters showed an increase in BMI and anaerobic peak power with a rise in LBM. Additionally, as BMI increased, anaerobic peak power also tended to rise. In contrast, for long-distance athletes, anaerobic mean power decreased as both LBM and BMI increased. Interestingly, as BFP increased, there was a corresponding increase in anaerobic mean power.** Conclusions. **These findings should be integrated into training programs to enhance track athletes' performance.**

KEYWORDS: performance, body composition, athlete, anaerobic capacity, track athlete.

Received: 17 February 2025
Accepted: 8 April 2025

Corresponding author: Ki-Jun Park, koc-pt@sports.or.kr

Kaya University, Department of Physical Therapy, Gimhaesi, Gyeongsangnam-do, Korea (South)

Introduction

Track and field is among the oldest sports and has a rich Olympic tradition [1]. Track events have been included as official competitions since the first Summer Olympics in Athens in 1896, initially featuring only sprint (100 m, 200 m, and 400 m) and middle-distance events (800 m and 1,500 m) [2]. At the 5th Summer Olympics in Stockholm in 1912, long-distance events of 5,000 and 10,000 m were recognized as official competitions [2]. These track events focus on speed to determine the best performance, with the fastest athlete being declared the champion [3]. The relationship between distance and time defines speed. Since the inception of various competitions, a significant amount of time data has been recorded, and performance times continue to improve each year, leading to numerous broken records [3]. While track events are popular worldwide, Asian track sports do not dominate globally; in fact, the level of Asian track sports does not align with the title of a sports powerhouse [4].

The relative age effect significantly influences adolescent track athletes, supporting the maturation selection hypothesis as a mechanism for this phenomenon [5]. Consequently, there is an increasing emphasis on identifying and nurturing adolescent athletes to enhance competitiveness in track events [5].

A clear relationship exists between chronological age and performance on tests of basic motor skills that underlie track and field events, including sprinting speed, endurance running, and jumping distance. Moreover, sprinters rely on anaerobic energy due to their sport's high-intensity, short-duration nature, which emphasizes power and speed [6]. In contrast, endurance athletes depend on aerobic energy for long-distance running [7]. Consequently, sprinting involves maximizing all abilities, including starting speed, sprinting technique, and finishing techniques, to assess performance time, and long-distance running, which covers a much greater distance and typically begins from a standing position, requires a high level of skill and energy exertion over a relatively short period [3].

Track athletes are influenced by various physiological, psychological, and biomechanical factors, along with the specific technical characteristics of the sport. As a result, there is an increasing emphasis on conducting studies to accurately identify athletes' physical and psychological attributes [8, 9]. Understanding factors such as athletes' physical composition and mental attributes is essential for enhancing the performance of both sprint and long-distance competitors [8].

Track athletes must carry their body weight, which means overcoming gravity over various distances. This necessitates a specific body composition to achieve effective and economical performance in each event. Significant body composition factors include leg length, body fat percentage (BFP), lean body mass (LBM), and body mass index (BMI), along with anaerobic capacity, all of which are crucial in determining a track athlete's performance [10].

However, most research on adolescent track athletes has focused primarily on psychological factors [11], with limited studies addressing body composition and anaerobic capacity. While there have been studies on the body composition and anaerobic capacity of sprinters and long-distance athletes, these have predominantly involved adult athletes [12]. Furthermore, no studies have simultaneously identified and compared the leg length, body composition, and anaerobic capacity of sprinters and long-distance athletes. Therefore, additional research is needed to better support and train adolescent track athletes.

Aim of Study

In track athletes, factors such as leg length, body composition (BFP, LBM, and BMI), and anaerobic capacity play a critical role in determining performance. Additionally, the relative age effect significantly influences adolescent track athletes. Therefore, this study aimed to compare the body composition and anaerobic capacity of sprinters and long-distance athletes by sex among adolescent track athletes expected to represent Korea in the future and to identify factors that influence body composition and anaerobic capacity. We believe that our findings will assist adolescent track athletes in enhancing their performance and developing systematic training programs.

Material and Methods

Participants

The study involved 96 elite adolescent track athletes, all above 16, undergoing intensive training to participate in various advanced competitions in 2024. The participants included 48 athletes specializing in sprint events (100 m, 200 m, and 400 m) and 48 in long-distance events (5,000 m and 10,000 m), with equal representations of men and women (Figure 1). The study protocol adhered to the Declaration of Helsinki. All athletes were provided with a clear explanation of the purpose and necessity of the study, and participation was entirely voluntary.

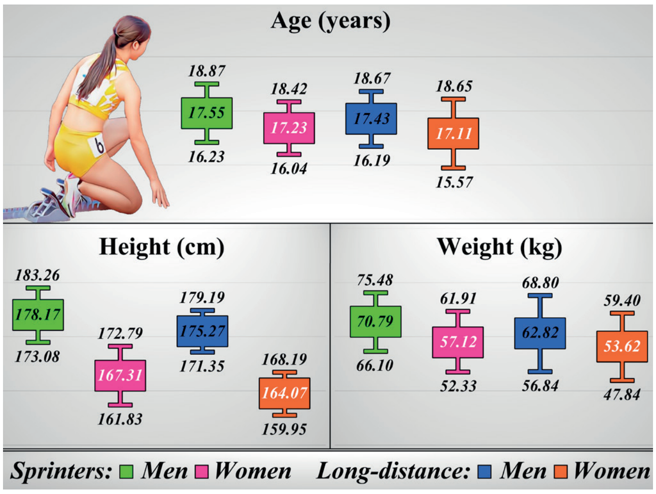

Figure 1. General characteristics of elite adolescent track athletes

Data collection and analysis

In this study, we measured leg length, body composition (BFP, LFP, and BMI), and anaerobic capacity in adolescent sprinters and long-distance track athletes. All athletes participated in two measurement sessions. Part 1 was conducted in the morning, while Part 2 took place in the afternoon. On the first day, sprinters were measured during Part 1, and long-distance athletes were measured during Part 2. On the second day, this order was reversed: sprinters were measured during

Part 2, and long-distance athletes were measured during Part 1. To ensure consistency, all athletes underwent measurements in the same manner. Upon arriving at the measurement room, each athlete took a 30-minute break in a comfortable chair to help reduce tension before beginning the assessments. Measurements were conducted in the same way and repeated twice at two-month intervals. Each athlete was measured once on the first day (either Part 1 or Part 2) and once on the second day (also either Part 1 or Part 2), resulting in a total of four measurements. The final data were then collected as an average of these measurements.

The leg length was measured using Martin anthropometer GMP 101 (GPM Instruments GmbH, Switzerland). The athletes were barefoot, positioned at the heel of both feet and angled open at the front end by 30°~40°. Marker tape was attached to the anterior superior iliac spine and the medial malleolus of each leg, and the distance between the two marker tapes was measured to 1 mm unit. The measurement was taken from the dominant leg.

BFP, LBM, and BMI were measured using an InBody device (InBody770S, Korea). All athletes were measured while standing barefoot, with their legs slightly apart to allow for proper contact with the electrodes attached to the soles of the device. They held the electrodes with both hands, keeping their arms slightly open to avoid contact with their trunks.

Anaerobic capacity was assessed using the Wingate test, which was conducted on a cycle ergometer (Lode Excalibur Sport, The Netherlands). The load for each athlete was set at 0.75 Nm per kilogram of body weight. All athletes began their warm-up by pedaling lightly for 2 minutes. At the start signal, they then pedaled at maximum power for 30 seconds while maintaining a set load. Peak power represents anaerobic power, while mean power indicates endurance.

Statistical analysis

The general characteristics of track athletes were analyzed using technical statistics. An independent samples t-test was conducted to compare sprinters' and long-distance athletes' body composition and anaerobic capacity. Additionally, a simple linear regression analysis was performed to identify the factors affecting body composition and anaerobic capacity. All statistical analyses were carried out using SPSS version 27.0 for Windows, with a significance level set at $\alpha \leq 0.05$.

Results

Our study found that leg lengths were similar between sprinters and long-distance athletes, both male and female, among elite adolescent track athletes ($p > 0.05$). However, the BFP, LBM, and BMI significantly differed between sprinters and long-distance athletes, both males and females ($p \leq 0.05$; respectively) (Figure 2). Additionally, the peak and mean power outputs of sprinters and long-distance athletes also showed significant differences for both males and females ($p \leq 0.05$; respectively) (Figure 2).

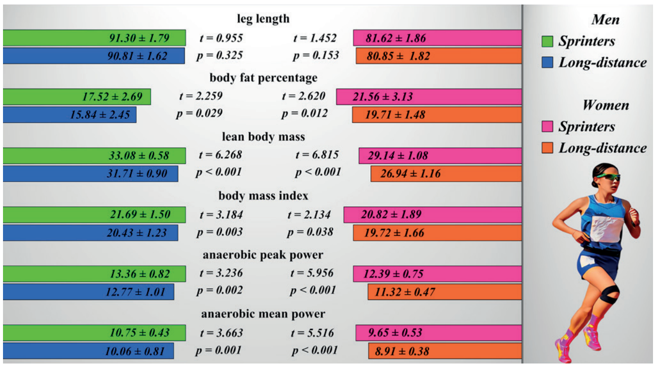

Figure 2. A comparison of body composition and anaerobic capacity between sprinters and long-distance athletes

A simple regression analysis revealed that both male and female sprinters experienced an increase in BMI and anaerobic peak power as their LBM increased ($p \leq 0.05$; respectively) (Table 1). This association was statistically significant. Furthermore, as BMI increased, anaerobic peak power also rose, and this relationship was also statistically significant ($p \leq 0.05$; respectively) (Table 2).

In contrast, in both male and female long-distance athletes, BMI increased as LMB increased, while anaerobic mean power decreased ($p \leq 0.05$; respectively). This relationship was statistically significant (Table 3). Additionally, as BFP increased, there was a corresponding rise in anaerobic mean power ($p \leq 0.05$; respectively) (Table 4). In contrast, an increase in BMI led to

Table 1. Simple regression analysis of sprinters A

	B	Beta	t	p
Men				
Body mass index	0.165	0.427	2.231	0.038
Anaerobic peak power	0.326	0.461	2.438	0.023
Women				
Body mass index	0.421	0.740	5.159	<0.001
Anaerobic peak power	0.751	0.524	2.885	0.009

Dependent variable: lean body mass

a decrease in anaerobic mean power, and this association was also statistically significant ($p \leq 0.05$; respectively) (Table 4).

Table 2. Simple regression analysis of sprinters B

	B	Beta	t	p
Men				
Anaerobic peak power	0.889	0.486	2.306	0.016
Women				
Anaerobic peak power	1.123	0.445	2.333	0.029

Dependent variable: body mass index

Table 3. Simple regression analysis of long-distance athletes A

	B	Beta	t	p
Men				
Body mass index	0.416	0.571	3.262	0.004
Anaerobic mean power	–0.607	–0.552	–3.102	0.005
Women				
Body mass index	0.311	0.443	2.315	0.030
Anaerobic mean power	–1.681	–0.556	–3.137	0.005

Dependent variable: lean body mass

Table 4. Simple regression analysis of long-distance athletes B

	B	Beta	t	p
Men				
Anaerobic mean power	1.414	0.471	2.505	0.020
Women				
Anaerobic mean power	2.010	0.522	2.874	0.009
Dependent variable: body fat percentage				
Men				
Anaerobic mean power	–0.867	–0.574	–3.287	0.003
Women				
Anaerobic mean power	–3.277	–0.760	–5.489	<0.001

Dependent variable: body mass index

Discussion

This study aimed to compare the leg length, body composition, and anaerobic abilities of sprint and long-distance athletes, focusing on differences between sexes among adolescent track athletes who are expected to represent Korea in the future. Additionally, the study sought to identify the factors that influence these variables. This research can provide valuable theoretical insights for enhancing the performance of adolescent track athletes.

Generally, height is one of the most inherent physical factors influencing track athletes, with leg length being particularly significant in their performance [13]. However, our study found that the leg lengths of sprinters and long-distance athletes were similar when considering sex.

Yu et al. [14] reported that sprinters typically have longer legs because the acceleration phase is critical in sprinting. Shorter legs have a lower moment of inertia, resulting in less energy available for acceleration [15]. Additionally, longer legs can lead to a reduced stride rate, and relatively shorter thighs imply that the resistance arm on the upper leg is shorter [15]. As a result, the thigh moves closer to the axis of rotation of the leg, which decreases the energy cost of locomotion. Therefore, it is also possible for long-distance athletes to have relatively long legs. Studies by Vuceti et al. [16] also indicate that the leg length of adult track athletes does not significantly differ among sprinters, middle-distance athletes, and long-distance athletes.

Meanwhile, Zinevich et al. [17] highlighted that the leg lengths of track athletes are related to their performance. In our study, all participants were elite adolescent athletes expected to represent Korea in the future and had excelled in various national championships. Consequently, we may not have observed any differences in leg lengths between sprinters and long-distance athletes due to these reasons.

BFP, LBM, and BMI are fundamental metrics for analyzing body composition. They significantly influence physical strength and performance, making body composition a crucial factor in identifying outstanding athletes [18].

Our study observed that BFP, LBM, and BMI were significantly higher in sprinters than long-distance athletes, for both men and women. Mishra and Chahal [19] reported that anaerobic exercise generally increases LBM, while aerobic exercise typically lowers BFP and BMI [20]. In sprinting athletes, who engage in anaerobic exercise, energy is generated by breaking down glycogen stored in their muscles [21, 22]. This process allows them to produce energy even when oxygen levels are limited, enabling powerful bursts of activity [23]. As a result, sprinters can increase their LBM. In contrast, long-distance athletes participate in aerobic exercise, which breaks down both glycogen and fat to produce energy [21, 22]. This process utilizes oxygen to generate energy, resulting in a higher overall energy output compared to anaerobic exercise, and increasing endurance capacity [24]. Consequently, long-distance athletes may experience a lower BFP. In general, BMI is calculated by dividing body weight (kg) by the square of height (m) [16]. This means that a higher BMI typically indicates a higher LBM, assuming a similar BFP [16]. Athletes often have a higher BMI due to increased muscle mass [25]. However, traditional BMI measurements may overlook important factors unique to athletes, such as the ratios of bone, muscle, and fat [26]. To address this, our study utilized the highly reliable InBody770S, which estimates the internal and external moisture of cells based on six different frequencies [27]. The BMI measurements from the InBody770S indicated that both male and female distance athletes had lower BMIs compared to sprinters. This may be due to the higher LBM and BFP of sprinters compared to long-distance athletes in our study.

The Wingate test is a method used to measure anaerobic capacity, which evaluates cardiopulmonary function and physiological motor ability based on the fatigue index [11].

Our study found that sprinters had higher anaerobic peak power, while long-distance athletes showed higher anaerobic mean power. This distinction may be attributed to the nature of the exercises: short distances typically involve anaerobic activity, whereas long distances are primarily aerobic. Most anaerobic exercises engage type II skeletal muscle fibers, which generate explosive power over a short duration [22]. In contrast, most aerobic exercises utilize type I skeletal muscle fibers, characterized by a high density of capillaries that help minimize fatigue and enhance endurance [22]. Accordingly, in our study also, we found that both male and female sprinters exhibited an increase in anaerobic peak power as their LBM and BMI increased. In contrast, for male and female long-distance athletes, anaerobic mean power decreased with increased LBM and BMI but increased with an increased BFP. Additionally, previous studies have shown that these factors are typically between 25% and 40% for genetic influences [28], while external environmental influences, such as training, can account for a larger percentage [29]. This suggests that body composition is more heavily influenced by environmental influences than by genetics. This observation may help explain why our study found more pronounced results among sprinters and long-distance athletes. Therefore, effective body composition management tailored for sprinters and long-distance athletes is crucial for enhancing performance. Meanwhile, the Kim and Park [30] study indicated that body composition is linked to both the incidence and severity of sports injuries. As a result, it is important for adolescent track athletes to systematically incorporate body composition management into their training programs.

Our study has several strengths and limitations. With respect to the strengths, first, we included elite adolescent track athletes who are expected to represent Korea in international competitions in the future. Second, we closely examined both male and female athletes' body composition and anaerobic capacity. Finally, we analyzed factors influencing body composition and anaerobic capacity, contributing to new research questions within the sports science community. As to the limitations, first, we lacked information on training loads that could impact body composition and anaerobic capacity. Second, we could not assess how body composition and anaerobic capacity influence actual performance. We did not divide short- and long-distance events into smaller categories due to concerns that this might yield smaller sample sizes. Lastly, our findings cannot be generalized to other groups, as the study exclusively focused on Korean adolescent track athletes.

Conclusions

This study investigated the leg length, body composition, and anaerobic capacity of elite adolescent track athletes, analyzing sprinters and long-distance athletes by sex. In both male and female sprinters, a higher LBM and BMI are associated with greater anaerobic peak power. Conversely, in both male and female long-distance athletes, lower LBM and BMI, along with a higher BFP, are linked to increased anaerobic mean power. These findings should be integrated into training programs to enhance the performance of these track athletes.

Funding

No external funding.

Conflict of Interest

The authors declare no conflict of interest.

Reference

1. Henriksen K, Stambulova N, Roessler KK. Successful talent development in track and field: considering the role of environment. Scand J Med Sci Sports. 2010;20(2):122-132. https://doi.org/10.1111/j.1600-0838.2010.01187.x
2. Ivan C, Constantin AA. Pole vaulting – the influence of somatic and motor indices on performance. Discobolul Phys Educ Sport Kinetotherapy J. 2018;2(52):10-15.

3. Hidayah N, Tafqur M, Rosdiana F. Prediction of the optimal performance of running athletes. J Educ. 2024; 6(2):14320-14328. https://doi.org/10.31004/joe.v6i2.5281
4. Li H. Research on the status quo and countermeasures of scientific training of track and field sports. Insight-Sports Sci. 2023;5(1):1-4. https://doi.org/10.18282/iss.v2i2.385
5. Brazo-Sayavera J, Martínez-Valencia MA, Müller L, Andronikos G, Martindale RJJ. Identifying talented track and field athletes: the impact of relative age effect on selection to the Spanish National Athletics Federation training camps. J Sports Sci. 2017;35(22):2172-2178. https://doi.org/10.1080/02640414.2016.1260151
6. Kumar CS, Rajavelu M. Relative effect of speed agility and quickness training versus sprint interval training on anaerobic power of male sprinters. Int J Physiol Nutr Phys Educ. 2019;4(1):1418-1421.
7. Barbosa LP, Santos PA, Aguiar SS. Alternative method to evaluate performance improvement rate in athletics middle distance events. J Sci Sport Exerc. 2020;4(2):128-134. https://doi.org/10.1007/s42978-021-00132-2
8. Muñoz CS, Muros JJ, López-Belmonte Ó, Zabala M. Anthropometric characteristics, body composition and somatotype of elite male young runners. Int J Environ Res Public Health. 2020;17(2):674. https://doi.org/10.3390/ijerph17020674
9. Vernacchia RA, Henschen KP. The challenge of consulting with track and field athletes at the Olympic Games. Int J Sport Exerc Psychol. 2008;6(3):254-266. https://doi.org/10.1080/1612197X.2008.9671870
10. Stanković D, Pavlović R, Petković E, Raković A. The somatotypes and body composition of elite track and field athletes and swimmers. Int J Sports Sci. 2018;8(3):67-77. https://doi.org/10.5923/j.sports.20180803.01
11. Jaafar H, Rouis M, Coudrat L, Attiogbé E. Effects of load on Wingate test performances and reliability. J Strength Cond Res. 2014;28(12):3462-3468. https://doi.org/10.1519/JSC.0000000000000575
12. Wong JE, Nick F, Noela W. Somatotypes of young Malaysian track and field athletes. Asian J Exerc Sport Sci. 2007;4(1):29-35.
13. Onyewadume IU, Amusa L, Owolabi E. Physique, anaerobic power and pulmonary measures of Botswana track athletes. Kineziologija. 2004;36(2):205-209.
14. Yu J, Sun Y, Yang C, Wang D, Yin K, Herzog W, et al. Biomechanical insights into differences between the mid-acceleration and maximum velocity phases of sprinting. J Strength Cond Res. 2016;30(7):1906-1916. https://doi.org/10.1519/JSC.0000000000001278
15. O'Connor H, Olds T, Maughan RJ. Physique and performance for track and field events. J Sports Sci. 2007; 25(1):49-60. https://doi.org/10.1080/02640410701607296
16. Vuceti V, Matkovi BR, Sentija D. Morphological differences of elite Croatian track-and-field athletes. Coll Antropol. 2008;32(3):863-868.
17. Zinevich I, Pastukhova V, Nazymok Y, Korobeynikova L, Glazyrin I, Arhypenko V, et al. Estimation of anthropometric parameters of track and field athletes at different stages of long-term preparation. J Phys Educ Sport. 2017;17(2):643-647. https://doi.org/10.7752/jpes.2017.02096
18. Solaja A, Milankov A, Pejakovic, Edita S. Body composition of the Serbian national track and field team. Med Pregl. 2017;70(3-4):87-94. https://doi.org/10.2298/MPNS1704087S
19. Mishra N, Chahal A. Relationship of muscle mass with anaerobic power of national level male throwers. PESY. 2013;2(2):9-11.
20. Sharma M, Kamal RB, Chawla K. Correlation of body composition to aerobic capacity: a cross sectional study. Int J Appl Res. 2016;2(1):38-42.
21. Swanwick E, Matthews M. Energy systems: a new look at aerobic metabolism in stressful exercise. MOJ Sports Med. 2018;2(1):15-22. https://doi.org/10.15406/mojsm.2018.02.00039
22. Wilson JM, Loenneke JP, Jo E, Wilson GJ, Zourdos MC, Kim JS. The effects of endurance, strength, and power training on muscle fiber type shifting. J Strength Cond Res. 2012;26(6):1724-1729. https://doi.org/10.1519/JSC.0b013e318234eb6f
23. Akazawa N, Ohiwa N, Shimizu K, Suzuki N, Kumagai H, Fuku N, et al. The association of ACTN3 R577X polymorphism with sports specificity in Japanese elite athletes. Biol Sport. 2021;10;39(4):905-911. https://doi.org/10.5114/biolsport.2022.108704
24. Artioli GG, Bertuzzi RC, Roschel H, Mendes SH, Lancha Jr AH, Franchini E, et al. Determining the contribution of the energy systems during exercise. J Vis Exp. 2012;20(61):3413. https://doi.org/10.3791/3413
25. Jonnalagadda SS, Skinner R, Moore L. Overweight athlete fact or fiction?. Curr Sports Med Rep. 2004;3(4):198-205. https://doi.org/10.1249/00149619-200408000-00005
26. Provencher MT, Chahla J, Sanchez G, Cinque ME, Kennedy NI, Whalen J, et al. Body mass index versus body fat percentage in prospective National Football League athletes: overestimation of obesity rate in athletes at the National Football League Scouting Combine. J Strength Cond Res. 2018;32(4):1013-1019. https://doi.org/10.1519/JSC.0000000000002449
27. McLester CN, Nickerson BS, Kliszczewicz BM, McLester JR. Reliability and agreement of various InBody body composition analyzers as compared to dual-energy X-ray absorptiometry in healthy men and

women. J Clin Densitom. 2020;23(3):443-450. https://doi.org/10.1016/j.jocd.2018.10.008

28. Bouchard C. Genetics of human obesity: recent results from linkage studies. J Nutr. 1997;127(9):1887-1890. https://doi.org/10.1093/jn/127.9.1887S
29. Johnson W, de Ruiter I, Kyvik KO, Murray AL, Sørensen TIA. Genetic and environmental transactions underlying the association between physical fitness/physical exercise and body composition. Behav Genet. 2015;45(1):84-105. https://doi.org/10.1007/s10519-014-9690-6
30. Kim HC, Park KJ. Correlation analysis of sports injuries and body composition and bone density in national water pool players. J Korean Soc Phys Med. 2019;14(3):134-141. https://doi.org/10.13066/kspm.2019.14.3.13