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Correlation between angiotensin converting enzyme gene polymorphism and endurance performance of novice adolescent wrestlers

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Abstract

Background: Gene polymorphisms are related to athletic performance. Angiotensin converting enzyme gene polymorphism is essential in identifying talent and guiding adolescents to appropriate sports.

Aim: The aim was to investigate the relationship between the angiotensin gene and endurance performance of novice adolescent wrestlers in Ardabil.

Materials and Methods: Subjects were 15 Amateur adolescent wrestlers in Ardabil (age: 13.07±1.53 years, height: 164.60±10.68 cm, weight: 60.14±6.32 kg, BMI: 22.22±4.98 kg/m^2) with three-year wrestling. Chest and thigh muscle endurance, abdominal fat percentage and cardiovascular endurance, chest press, and squat muscle endurance were measured. ACE polymorphism was determined using tetra-ARMs polymerase chain reaction (PCR) and compared direct DNA sequencing in salivary samples. Chi-square and ANOVA were used to compare frequencies and their relationship with performance indicators.

Results: ACE DD genotype frequency was higher in novice adolescent wrestlers, and there was a significant difference between ACE polymorphism frequency (*P*=0.008). There was a significant difference between ACE genotype distribution with endurance performance of pectoral and triceps (*P*=0.004) muscles, body composition (*P*=0.0001), and Vo_2max (*P*=0.0001). There was a significant difference between body composition and Vo_2max of Amateur adolescent wrestlers with ACE DD (*P*=0.0001), ACE II (*P*=0.0001), and between body composition and Vo_2max with ACE II (*P*=0.0001), ACE DD (*P*=0.0001), and ACE ID (*P*=0.0001). In body composition, ACE II was significantly higher compared to ACE DD (*P*=0.0001) and compared to ACE ID (*P*=0.0001). Also, in Vo_2max, ACE II was significantly higher compared to ACE DD (*P*=0.0001) and compared to ACE ID (*P*=0.0001).

Conclusion: Findings showed the superiority of ACE DD polymorphism and its relationship with the endurance performance of novice adolescent wrestlers in Ardabil. ACE DD polymorphism is probably essential in wrestler success. Other research with more subjects and other genes is important.

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1. Introduction

Sports performance is a very complex multi-factor phenomenon. It is determined by many internal factors (genetics, motor behavior, physiological and psychological profile) and external factors (education, nutrition, growth opportunities, and general health conditions), and the interaction between them [1]. Recently, the development of DNA sequencing and genotyping methods have made it possible to identify some individual genetic variations that indicate athletic performance [2]. Genetic factors play an essential role in athletic performance and related phenotypes such as strength, power, aerobic capacity, flexibility, coordination, and mood [3]. Genetic polymorphisms are frequently associated with athletic performance in various sports because some genes may influence phenotypes such as muscle strength or endurance capacity [4].

One of the functional genes that are frequently examined are the Angiotensin-converting enzyme (ACE) insertion/deletion gene polymorphism (ADE I/D) [5, 6, 7]. The ACE gene contains polymorphisms (DD, ID, and II alleles) in which the availability (insertion, I) or absence (deletion, D) of a 287 bp sequence in intron 16. Studies show the importance of angiotensin-converting enzyme (ACE) I/D gene polymorphism in athletic performance. The ACE gene has the most gene response in response to exercise when assessing the physical function of the human body. ACE Alleles are most prevalent in endurance runners, triathletes, endurance cyclists, endurance swimmers, and endurance boatmen [5].

In contrast to allele I, the D allele is more common in people involved in strength or power-based sports, such as speed skaters, skiers [6], and wrestlers [7, 8]. Physiological features related to fatigue compensation in endurance performance among individuals with allele I include an increase in oxygenated blood delivery to working muscles [9], more cardiac output [10], and maximum oxygen uptake [11] compared to those who have the D allele.

The ACE gene is the most studied gene in response to exercise when assessing the physical function of the human body. The ACE gene affect muscle strength and fatigue (aerobic endurance) and adaptation to training sessions [12]. ACE plays a metabolic role during exercise. It is found in various human tissues, such as skeletal muscle. The ACE gene is located on chromosome 17 (23 P 17) and contains 26 exons in humans, the approximate length of which is 21 kb, with 52 introns separating them [13]. ACE is an enzyme that integrates the renin-angiotensin-aldosterone (AARS) system, and is essential for regulating arterial pressure [14]. Its main activity is the breakdown of the two amino acid residues of angiotensin I (Ang I), it converts to angiotensin II (Ang II), a potent vasoconstrictor that binds to the angiotensin 1 (AT1) receptor, thus absorbing more sodium and Water enters the renal tubules [15].

Angiotensin converting enzyme gene polymorphism, gene conversion enzyme polymorphism is one of the genetic variants that has been widely studied in sports science [16]. Nevertheless, studies have presented controversial results.

Oliveira et al. (2010) examined the relationship between I-D gene polymorphism (ACE) and its effect on group or individual exercise to identify the dominant gene polymorphism in group and individual exercise. The results showed significant correlations for I-D gene polymorphism (ACE). The genotypic I-D and allelic frequencies of the ACE gene do affect performance in the group or individual exercise [16].

Cerit et al. (2020) investigated the effect of ACE-I/D gene polymorphism on athletic status and physical performance of well-trained Malaysian athletes. The researchers showed genotypes II and DD were more common among endurance athletes and strength athletes. Nevertheless, VO_2max was not significantly associated with the ACE genotype in the athlete. However, athletes with the DD genotype had higher results for leg strength (113.8 ± 36.2) than those with genotype II and ID (28.0± 96.2) [17].

Chaabene et al. (2017) investigated the relationship between the ACE I/D gene polymorphisms and performance comparison of 3000 m running with and without equipment during basic military training. In contrast, the best performance between running with complete equipment and running without equipment in individuals observed with DD, ID, and II genotypes, respectively. It also observed that individuals with ACE DD genotype seem to have a more significant advantage in response to fully-equipped performance without 3000 m running equipment (ACE DD genotype) [18].

According to our knowledge, no research has been done about the relationship between ACE gene and endurance performance in beginner wrestlers in order to find their right sports talent. Also, little research has been done in other fields and in other countries.

Wrestling is a martial art that involves repetitive high-intensity activity sessions of 6 minutes (two 3-min rounds with 30 seconds rest between rounds) [19]. Wrestling requires high capacities of strength, power, and endurance [19]. Examination of the performance of influential coaches of the Iranian wrestling league showed that they believe that muscle strength, endurance, and strength testing are necessary to evaluate their wrestlers [20].

Some studies show the importance of ACE gene I/D polymorphism in athletic performance [7]. This makes it possible to compare them with previous studies and direct them right towards the recruitment of wrestling. Understanding the genes that lead people to higher levels of physical success is a topic that has received much attention. Genetic tests, with relevant information can help athletes decide which type of exercise to choose. So, researchers should look for genes whose polymorphism is related to sports performance. Due to the lack of information in this area, the findings of this research are very important.

The information obtained from genetic tests can help athletes in deciding to choose the type of sport and achieve better exploitation of their abilities [21, 22]. This will save a lot of time and financial resources, and psychologically, teenagers will fail less [21, 22]. There is growing evidence that the I/D gene polymorphism of angiotensin-converting enzyme (ACE) is the most important in sports performance. It has been found that the ACE gene has an effect on muscle strength and fatigue (aerobic endurance) and adaptability to training sessions. The D allele is more common among people involved in strength or strength-based sports such as speed swimmers, skiers, and wrestlers [20, [21, 22]]. However, no study has been conducted to investigate the relationship between the ACE gene and endurance performance in beginner wrestlers in order to find their correct athletic talent. Little research has been done in other fields and in other countries. Therefore, the aim of this study is to investigate the relationship between the angiotensin gene and the endurance performance of novice adolescent wrestlers in Ardabil.

2. Materials and Methods

The research method is applied; and causal-comparative strategy is performed in the field. The statistical population in the present study were all-male adolescent wrestlers in Ardabil aged 11-16 years who had at least three years of wrestling experience. The statistical samples of the study were19 adolescent male wrestlers in Ardabil, who were purposefully and accessibly selected. Four subjects were withdraw from cooperation due to the inability to participate in the tests or incomplete tests. Finally, the results of 15 people were wholly collected and analyzed. Inclusion criteria were age group 11-16 years, at least three years of training experience, no previous history of cardiovascular disease, asthma, diabetes, kidney disease [21], and anemia; during the last six months, and not using medication or effective drugs during the study. Exclusion criteria include non-compliance with the necessary conditions during the research, dissatisfaction with participation in the research, having underlying internal diseases, having surgery in the last three months, having anatomical, biomechanical, or pathological problems of the musculoskeletal system, any type suspicions of having lung, cardiovascular disease, any febrile illness, and having a fever on the test were an inability of subjects contract for a saliva test.

Subjects and their parents first completed and signed the consent form, health questionnaire, and physical activity readiness questionnaire (PAR-Q standard questionnaire).

From the stopwatch or timer of the Jemis model with an error rate of 0.06, a caliper (HARPENDEN) made in England with an accuracy of 0.2 mm to determine the percentage of body fat and body composition, dynamometer (SAEHA) and free weights and A barbell and body bench and a test checklist used to determine muscle strength. In Chest press movement, the subject first touched the barbell to the chest and when his hands were completely straight, the movement was complete. The maximum amount of weight that a person could move for one time was recorded as a test score [21]. In Squat movement, subject, in a standing position, placed the barbell behind his neck and on his shoulders. Then he bent the knees to about 90 degrees and then completely straightened the knees. The maximum weight that a person could do for one time was recorded as that person's score [21]. VO_2max was measured by Cooper's 12 min test.

DNA extraction kits are also used from saliva samples, including methods and tools of thermocycler gradient, transilluminator, electrophoresis tank, safe gel, and cyber green materials (super master mix).

At first, a briefing session was held for the subjects, and they were introduced to the research objectives. Then, health and wellness questionnaires were completed, preparation and consent to participate in the study and to collect general information such as height, weight, BMI, and body fat percentage in the exercise physiology laboratory of Mohaghegh Ardabili University Health Center. Chest and triceps muscle endurance test, chest press test, and Squat test are was used for measuring lower torso muscle endurance. Anthropometric variables, including chest circumference, thigh, hip, and shoulder width, also were measured with a China rubber band meter, with a sensitivity of one millimeter.

Chest circumference was measured while the subject was standing anatomically, and the arms were slightly distant, from the Sternum in the fourth sternal joint in the anterior part and a point passed at the same horizontal plane in posterior part and the chest circumference. Hip circumference was measured while the subject was standing anatomically, the waist circumference was measured at the navel level. Thigh circumference was measured while the subject was standing anatomically, the vastest part of the sternal hump was on a horizontal surface. Shoulder width, the distance between the two acromion processes at posterior on a horizontal surface, was measured while the subject was standing anatomically.

The percentage of body fat from a caliper (HARPENDEN) made in England with an accuracy of 0.2 mm and the three-point chest method (2.5 cm distance from the armpit line), abdomen (2.5 cm on the right side of the navel), The thigh (between the hip joint and the closest margin to the patella) were used with a generalized regression equation to estimate body composition using the total thickness of subcutaneous fat measured [22].

The Jackson-Pollock formula calculated the percentage of fat in men is:

$$\text{Bone density: } (0.00028826 * \text{age}) - (0.00000055 * \text{SUM7}^2) + (\text{SUM7}) - 1/112$$

$$\text{Fat percentage: } [4.5 - \text{bone density}/4.95)] * 100$$

BMI ratio of weight in kilograms to height squared (in meters), was used [23].

The subject lay horizontally on his back, minimizing the lumbar arch for measuring the chest press test. The subject held the bar slightly higher than the shoulders with open arms and lowered to touch the chest. Then, he moved the bar away from the body as far as the arm's length. The helpers helped lift the bar from the support rack [24]. All repetitions performed without the barbell jumping from the chest, without intentional pause in the transition phase between the eccentric and concentrated phases, and without raising the lower back off the bench [25]. The subject was acquainted with how to perform the test and the equipment used before measuring muscular endurance. To perform the squat leg test, the person placed the barbell on the back of the neck and his shoulders while standing. Then bend the knees to about 90 degrees, straighten the knees entirely, and complete the movement. Only repetitions completed with the correct technique counted. Test personnel observed the subjects' technique [23].

12 min Cooper test, including running-walking, used to measure cardiorespiratory fitness.

2.1. DAN extraction and genotype determination of samples

After the necessary coordination and completion of research sampling satisfaction questionnaires and measuring health and disease history, saliva sampling performed. 5mL Saliva samples collected and transferred to -80°C refrigerated in sterile containers. DNA extraction of 200 Landa from each sample was performed with a specialized kit.

ACE gene polymorphisms were determined and compared using Tetra-ARMs polymerase chain reaction (PCR) and direct DNA sequencing. For Tetra-ARMs PCR, three primers were designed and used for each sample. The PCR product consisted of 2 Landa primers (4 * 0.5 = 2) + 10 Landa Supermex + 10 Landa Water + 3

Landa DNA. The PCR thermocycler gradient program consisted of three minutes of temperature 94 degrees, 20 seconds of 94 degrees, 30 seconds of 59 degrees, 40 seconds of 94 degrees, and 5 min of 72 degrees, with the final product on a 2% gel in an electrophoresis tank.

2.2. Tetra-ARMs PCR method

Tetra-ARMs PCR, also was known as tetra-primer amplification refractory mutation system- subjects' polymerase chain, was a PCR-based method for detecting the presence of single nucleotide polymorphisms (SNPs) in the genome[23].

1. The first case: genotype with two healthy alleles (wild homozygous)
2. The second case: genotype with two mutant alleles (homozygous mutant).
3. The third case: the genotype has a healthy and a mutant allele (heterozygous).

The present study has been approved and registered by the ethics committee of University of Mohaghegh Ardabili (IR.UMA.REC.1401.029).

2.3. Statistical Method

The Shapiro-Wilk test was used to determine the normality of data distribution. Chi-square test was used to evaluate the frequency of ACE gene polymorphisms; One-way analysis of variance (ANOVA) was used to investigate the relationship between ACE gene polymorphism and function and compare the mean difference between the relationship between ACE gene polymorphism and functions. All calculations were performed using SPSS version 25, and the significance level of the tests was considered P <0.05.

3. Results

Mean±standard deviation of research variables including age (13.07±1.53 years), height (164.60±10.68 cm), weight (60.14±6.32 kg), percentage of breast fat (16.07±7.44), percentage of abdominal fat (24.33±10.42), percentage of thigh fat (20.75±9.23), BMI (22.22±4.98), number of chest press tests (28.25±2.84), the number of foot tests was Scott (21.57±1.89) and VO_2max (28.97±1.21). The number of DD, ID, and II genotypes were 8 (53.33%), 2 (13.33%), and 5 (33.33%), respectively.

In statistical analysis, the results of the chi-square test (chi-square) showed that there is a significant difference in the frequencies of angiotensin gene (ACE) polymorphism in novice adolescent wrestlers in Ardabil (P<0.05). Table 1 shows that 70% of the ACE DD gene, 10% of the ACE ID gene, and 20% of the ACE II gene are present in the distribution of ACE gene polymorphisms in novice juvenile wrestlers in Ardabil who have vital muscular endurance function of upper muscles. Also, in the distribution of ACE gene polymorphisms in novice wrestlers in Ardabil who have vital lower extremity muscle endurance function, there is 57.1% of the ACE DD gene, 14.3% of the ACE ID gene, and 28.6% of the ACE II gene.

Chi square and Anova tests show a significant relationship between the distribution of ACE gene genotypes and the endurance function of chest and triceps muscles of novice adolescent wrestlers in Ardabil. However, there is no significant relationship between the distribution of ACE gene genotypes and the endurance performance of lower-body junior wrestlers in Ardabil. Chi-square test showed that here was a significant difference between ACE genotype distribution with endurance performance of pectoral and triceps muscles

(*P*=0.004). Table 2 shows a significant difference between the distribution of ACE gene genotypes with body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers in Ardabil.

Scheffe’s post hoc test was used to examine the differences within the group. Table 3 shows a significant difference between body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers with ACE DD gene with ACE II gene and between body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers with ACE II from ACE DD gene and ACE ID gene; However, there was no significant difference between body composition and cardiovascular endurance (VO_2max) of ACE DD and ACE ID genes in novice adolescent wrestlers. In general, the frequency of the DD genotype was higher than other genotypes in novice adolescent wrestlers in Ardabil.

Table 1. Expected and observed frequency of ACE gene genotype distribution with endurance function of pectoral and triceps muscles and endurance function of lower torso muscles of novice adolescent wrestlers in Ardabil

Functional indexes		Observed Frequency				Expected Frequency			
	Gene Type	ACE DD	ACE ID	ACE II	Total	ACE DD	ACE ID	ACE II	Total
Strong muscular endurance in pectorals and triceps	Frequency	7	1	2	10	5.3	1.3	3.3	10
	Percentage	70	10	20	100	70	10	20	100
Weak muscular endurance in pectorals and triceps	Frequency	1	1	3	5	2.7	0.7	1.7	5
	Percentage	20	20	60	100	20	20	60	100
Total	Frequency	8	2	5	15	8	2	5	15
	Percentage	53.3	13.3	33.3	100	53.3	13.3	33.3	100
Strong muscular endurance in lower limpbs	Frequency	4	1	2	7	3.7	3.1	3.2	7
	Percentage	57.1	14.3	28.6	100	57.1	14.3	28.6	100
Weak muscular endurance in lower limpbs	Frequency	4	1	3	8	4.3	1.1	2.7	8
	Percentage	50	12.5	37.5	100	50	12.5	37.5	100
Total	Frequency	8	2	5	15	8	2	5	15
	Percentage	53.3	13.3	33.3	100	53.3	13.3	33.3	100

Table 2. Results of one-way analysis of variance to compare the distribution of ACE gene genotypes with body composition and cardiovascular endurance (Vo2max) of adolescent wrestlers

		SS	Df	MS	F	Sig
Comparison of ACE gene genotype distribution with body composition	Between group	8.435	1	8.435	12.65	0.0001*
	Within group	39.798	13	3.061		
	Total	48.233	14			
Comparison of ACE gene genotype distribution with Cardiovascular endurance	Between group	11.985	1	11.985	14.62	0.0001*
	Within group	46.251	13	3.557		
	Total	58.236	14			

*Statistically significant differences were observed.

Table 3. Scheffe post hoc test results to investigate within-group differences

Group (I)		Group (J)	Mean Difference (I-J)	Standard deviation	Sig.
Body Composition	ACE DD	ACE ID	0.24327	0.37534	0.088
		ACE II	1.58333	0.13626	0.0001 *
	ACE ID	ACE DD	0.24327	0.37534	0.088
		ACE II	1.04006	0.98619	0.001 *
	ACE II	ACE DD	1.58333	0.13626	0.0001 *
		ACE ID	1.04006	0.98619	0.001 *
Cardiovascular endurance (VO_2max)	ACE DD	ACE ID	0.96854	0.96521	0.565
		ACE II	1.89541	0.89654	0.0001 *
	ACE ID	ACE DD	0.96854	0.96521	0.565
		ACE II	1.25894	0.98021	0.0001 *
	ACE II	ACE DD	1.89541	0.89654	0.0001 *
		ACE ID	1.25894	0.98021	0.0001 *

*Statistically significant differences were observed.

There was a significant difference in the frequency of angiotensin gene (ACE) polymorphism in novice adolescent wrestlers in Ardabil. There was a significant difference between the distribution of ACE gene genotypes with endurance function of pectoral and triceps muscles, body composition, and cardiovascular endurance (VO_2max) of novice adolescent wrestlers in Ardabil. However, there was no significant relationship between the distribution of ACE gene genotypes and the endurance performance of lower-body junior wrestlers in Ardabil. Between body composition and cardiovascular endurance (VO_2max) of beginner adolescent wrestlers with ACE DD gene with ACE II gene, and between body composition and cardiovascular endurance (VO_2max) of beginner adolescent wrestlers with ACE II with ACE DD gene and The ACE ID gene were significantly different; However, no significant difference observed between body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers with ACE DD and ACE ID genes.

4. Discussion

The present study showed there was difference in the frequency of angiotensin gene (ACE) polymorphism in novice adolescent wrestlers in Ardabil. The highest frequency was related to the DD genotype, and the lowest was related to the ID genotype. This result was consistent with Hazwani and Ahmad (2001), which showed genotype II and DD was more prevalent among endurance athletes and strength/power athletes than other groups [12].

Cam et al. (2007) showed that allele I most pronounced in endurance runners, triathletes, endurance cyclists, endurance swimmers, and endurance boatmen [5]. Wrestling was also a strength sport and was influenced by this genotype. The accepted principle of individual differences showed that identifying talented people was one of the main pillars of championship sports [11, 26, 27, 28, 29]. Strengthening physical fitness factors, including muscle strength, muscle strength, muscular endurance, and cardiorespiratory endurance, were essential requirements for the success of wrestlers in high-level competitions [29]. Human physical function was strongly influenced by genetic factors. Inheritance of the status of athletes, regardless of sport, was estimated at 66% [30, 31, 32, 33].

The present study showed a significant relationship between the distribution of ACE gene genotypes and endurance performance of pectoralis major muscles, body composition, and cardiovascular endurance (VO_2max) of novice adolescent wrestlers in Ardabil. However, there was no significant relationship between the distribution of ACE gene genotypes and endurance performance of lower body muscles of novice adolescent wrestlers in Ardabil. There was a significant relationship between the distribution of ACE gene genotypes and endurance function of pectoralis major muscles, body composition, and cardiovascular endurance (VO_2max) of novice adolescent wrestlers in Ardabil with the results of Franchichi et al. (2011) [34], MacArthur and North (2007) [31], and Yang et al. (2003) [2] were consistent.

Franchichi et al. (2011) showed that the ACT gene of heavyweight judokas was more genotypically abundant than non-athletes. Judokas needed more muscle strength and power, especially in the upper body, more claw strength, more muscle mass, and lower fat percentage [34]. In contrast, Gabriel and Alvesson (2013) showed no significant difference in the gene polymorphism of Spanish elite judokas, and it did not affect their endurance performance [35].

Genetic factors were crucial in athletic performance and related phenotypes such as strength, power, aerobic capacity, flexibility, coordination, and mood [3]. The ACE gene affected muscle strength, fatigue (aerobic endurance), and adaptation to training sessions. Physiological features associated with impaired endurance performance among people with allele I included increased oxygenated blood delivery to working muscles, greater cardiac output, and maximal oxygen uptake compared to those with the D allele. The problem was that the angiotensin-converting enzyme (ACE), which plays a metabolic role during exercise, was found in various human tissues, such as skeletal muscle [9, 11].

The present study also showed a significant difference between body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers with the ACE DD gene and ACE II gene. Also, there was a significant difference between body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers ACE II with ACE DD gene and ACE ID gene. However, no significant difference was observed between body composition and cardiovascular endurance (VO_2max) of novice adolescent wrestlers with ACE DD, and ACE ID genes. This finding was consistent with the findings of Ben-Zaken et al. (2019) [36], Papadimitrio et al. (2016) [20], Ildus et al. (2016) [3], Mirzaei et al. (2020) [24], and Fallah et al. (2019) [22] showed that different ACE polymorphisms had discovered a significant relationship with cardiovascular endurance performance and power performance of professional and novice athletes. Ben-Zaken et al. (2019), in several studies, showed more expression of allele I ACE gene associated with elite endurance performance and improvement of exercise-induced athletic performance [36].

Talent identification in any sport is often made by assessing anthropometric characteristics, body composition, and motor abilities. Genetic tests can also help athletes choose the type of sport to use their abilities better. Therefore, genetic tests are important in sports talent identification [36, 37]. Genetics has a significant role in the size and cross-section area of muscles, the type of muscle fiber (fast or slow contraction), and muscle strength. In addition, genetics may determine the response to exercise. Genetic and epigenetic environmental factors such as nutrition play an essential role in developing people prone to successful sports. Along with genetic factors, the characteristics of athletes, such as hard work, discipline, and high motivation, regardless of the nature of the sport, should be examined [36, 37].

The DD genotype seems to impart an advantage in the development of short duration aerobic performance [38]. Moreover, subjects with at least one D allele have shown greater strength gains and muscle volume after isometric strength training in quadriceps muscles [39]. Several reports proved that the D allele was associated with elite power athlete status.

On the other hand, an excess of the I allele has been associated with some aspects of endurance performance [40]. The allele I and II genotypes were related to greater improvements in medium duration aerobic performance [36, 38] as well as being associated with an increase in the endurance and effectiveness of muscles and were also responsible for an increase in the proportion of free fibers (type I muscle fibers) [36]. Nevertheless, some studies do not confirm these observations [36, 41].

Understanding genetic composition can predict performance and genetics screening in elite athletes or other populations, but more research is needed to investigate this relationship among athletes. Also, it is suggested that in future studies examine the genetic pattern in individuals and investigate the relationship between physical performance and gene profile in different groups.

Researchers should consider the similarities and differences of geographical conditions, weather, level of athletes, age differences, sex, number of suitable subjects and differences considered an ethnic group that some of these limitations can be seen in the present research, and considering the existence of different ethnic groups in Iran. It seems that the effect of this component is obvious.

Controllable restrictions included gender, age, nutritional status of subjects, time and place of exercise protocols, exercise history, test performance, ambient temperature, required heating, history of cardiovascular disease, and drug use.

Due to the existence of a small number of subjects, not taking into account genetic conditions, examining the frequency in both sexes and subjects from different ethnicities and regions, it cannot be definitely said that the DD allele was more expressed among wrestlers. But it can be said that the relationship between angiotensin gene polymorphisms and sports performance in the selection of sports fields in the three-level bases has an impact on the decision regarding the selection of sports fields that are a person’s innate talent, and affects the athletes to reach elite level. Uncontrollable limitations were the sleep status and psychological characteristics of subjects and their production and secretion of various hormones.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The author has completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

All research processes and methods have been approved by the Ethics Committee in the Research of the Mohaghegh Ardabili University (Code: IR.USWR.REC.1397.092).

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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References

[1] Baker J, Wilson S, Johnston K, Dehghansai N, Koenigsberg A, Vegt S, et al. "Talent research in sport 1990–2018: A scoping review". *Frontiers in Psychology*. 2020; 1(1): 1-11. https://doi.org/10.3389/fpsyg.2020.607710.

[2] Yang N, MacArthur DG, Gulbin JP, Hahn AG, Beggs AH, Easteal S, North K. "ACTN3 genotype is associated with human elite athletic performance". *The American Journal of Human Genetics*. 2003; 73(3): 627-31. doi: 10.1086/377590.

[3] Ildus IA, Emiliya SE, Leysan JG, Olga NF. "Genes and athletic performance: An update". *Medicine and Sport Science*. 2016; 61: 41-54. doi: 10.1159/000445240.

[4] Ahmetov II, Naumov VA, Donnikov AE, Maciejewska-Karłowska A, Kostryukova ES, Larin AK, et al. "SOD2 gene polymorphism and muscle damage markers in elite athletes". *Free Radical Research*. 2014; 48(8): 948-55. doi: 10.3109/10715762.2014.928410.

[5] Cam S, Colakoglu M, Colakoglu S, Sekuri C, Berdeli A. "ACE I/D gene polymorphism and aerobic endurance development in response to training in a non-elite female cohort". *The Journal of Sports Medicine and Physical Fitness*. 2007; 47(2): 234-8. PMID: 17557065.

[6] Nazarov IB, Woods DR, Montgomery HE, Shneider OV, Kazakov VI, Tomilin NV et al. "The angiotensin converting enzyme I/D polymorphism in Russian athletes". *European Journal of Human Genetics*. 2001; 9(10): 797-801. doi: 10.1038/sj.ejhg.5200711.

[7] Paulauskas A, Danileviciutė A, Povilaitis T, Poderis J. "Genetic variability associated with angiotensin converting enzyme (ACE) gene polymorphism in sportsmen pursuing different sports. Proceedings of the Latvian Academy of Sciences. Section B". *Natural Exact and Applied Sciences*. 2009; 63(1-2): 9-13. doi: https://doi.org/10.2478/v10046-009-0012-y.

[8] Costa AM, Silva AJ, Garrido ND, Louro H, Marinho DA, Marques MC and et al. "Angiotensin-converting enzyme genotype affects skeletal muscle strength in elite athletes". *Journal of Sports Science and Medicine*. 2009; 8(3): 410-8. PMID: 24150005.

[9] Rigat B, Hubert C, Alhenc-Gelas F, Cambien F, Corvol P, Soubrier F. "An insertion/deletion polymorphism in the angiotensin I-converting enzyme gene accounting for half the variance of serum enzyme levels". *Journal of Clinical Investigation*. 1990; 86(4): 1343-6. doi: 10.1172/JCI114844.

[10] Hagberg JM, McCole SD, Brown MD, Ferrell RE, Wilund KR, Huberty A, et al. "ACE insertion/ deletion polymorphism and submaximal exercise hemodynamics in postmenopausal women". *Journal of Applied Physiology*. 2002; 92(3):1083-8. doi: 10.1152/japplphysiol.00135.2001.

[11] Goh KP, Chew, K, Koh A, Guan M, Wong YS, Sum CF. "The relationship between ACE gene ID polymorphism and 295 aerobic capacity in Asian rugby players". *Singapore Medical Journal*. 2009; 50(10): 997-1003. PMID: 19907891.

[12] Hazwani AY, Ahmad MCM. "Angiotensin-converting enzyme (ACE) insertion/deletion gene polymorphism across ethnicity: A narrative review of performance

gene". *Sport Sciences for Health*. 2001; 17(2): 1-24. doi: 10.1007/s11332-020-00712-9.

[13] Koitka A, Cooper ME, Thomas MC, Tikellis C. "Angiotensin converting enzyme 2 in the kidney". *Clinical and Experimental Pharmacology and Physiology*. 2008; 35(4): 420-25. doi: 10.1111/j.1440-1681.2008.04889.x.

[14] Ma F, Yang Y, Li X, Zhou F, Gao C, Li M, Gao L. "The association of sport performance with ACE and ACTN3 genetic polymorphisms: A systematic review and meta-analysis". *Plos One*. 2013; 8(1): 1-9. e54685. doi: 10.1371/journal.pone.0054685.

[15] Puthucheary Z, Skipworth JRA, Rawal J, Loosemore M, Someren KV, Montgomery HE. "Genetic influences in sport and physical performance". *Sports Medicine*. 2011; 41(10): 845-59. doi: 10.2165/11593200-000000000-00000.

[16] Oliveira Rocha AW, Nascimento WM, Costa Oliveira CM, Pereira Neto JM, Nascimento OV, Santos JOL, et al. "Frequency of gene ACE I polymorphism I-D in athletes of different sports". *Revista Brasileira de Medicina do Esporte*. 2010; 26(2): 107-12.

[17] Cerit M, Dalip M, Yildirim DM. "Genetics and athletics performance". *Research in Physical Education, Sport and Health*. 2020; 9(2): 65-76. doi: https://doi.org/10.46733/PESH20920065c.

[18] Chaabene H, Negra Y, Bouguezzi R, Mkaouer B, Franchini E, Julio U, et al. "Physical and physiological attributes of wrestlers: An update". *The Journal of Strength & Conditioning Research*. 2017; 31(5): 1411-42. doi: 10.1519/JSC.0000000000001738.

[19] Jamshidi FS, Mirzeai B, Damirchi A. "Strength and conditioning practices of Iran Wrestling League strength and conditioning coaches". *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports.* 2014; 18(8): 34-45. https://doi.org/10.5281/zenodo.9761.

[20] Papadimitriou ID, Lucia A, Pitsiladis YP , Pushkarev VP, Dyatlov DA, Orekhov EF, et al. "ACTN3 R577X and ACE I/D gene variants influence performance in elite sprinters: a multi-cohort study". *BMC Genomics*. 2016 Apr; 17(1): 285. doi: 10.1186/s12864-016-2462-3.

[21] Grenda A, Leońska-Duniec A, Kaczmarczyk M, Ficek K, Król P, Cięszczyk P, Żmijewski P. "Interaction between ACE I/D and ACTN3 R557X polymorphisms in polish competitive swimmers". *Journal of Human Kinetics*. Section II- Exercise Physiology and Sports Medicine. 2014; 42: 127-36. doi: 10.2478/hukin-2014-0067.

[22] Fallah A, Fallahmohammad Z, Behmanesh M, Gharakhanlou R, Alinaghizadeh M. "The ACTN3 R577X polymorphism is associated with judo status in Iranian elite judo athletes". *Journal of Applied Exercise Physiology*. 2019; 14(28): 151-8. doi: 10.22080/JAEP.2019.13297.1705.

[23] Eynon N, Hanson ED, Lucia A, Houweling PJ, Garton F, North KN, et al. "Genes for elite power and sprint performance: ACTN3 leads the way". *Sport Medicine*. 2013; 43(9): 803-17. doi: 10.1007/s40279-013-0059-4.

[24] Mirzaei SH, Siahkohian M, Afrounde R. Investigate the Relationship between ACTN3 Gene Polymorphism and Talent Identification Indices in Boy Adolescent Weightlifters in Ardabil City. Thesis for the degree of M.A., Department of Physical Education and Sports Sciences Applied Physiology. University of Mohaghegh Ardabili. 2020.

[25] Desgorces FD, Berthelot G, Dietrich G, Testa M. "Local muscular endurance and prediction of 1 repetition maximum for bench in 4 athletic populations". *Journal of Strength and Conditioning Research*. 2010; 24(2): 394-400. doi: 10.1519/JSC.0b013e3181c7c72d.

[26] Isear JAJ, Erickson JC, Worrell TW. "EMG analysis of lower extremity muscle recruitment patterns during an unloaded squat". *Medicine and Science in Sports and Exercise*. 1997; 29(4): 532-9. doi: 10.1097/00005768-199704000-00016.

[27] Charbonneau D. Association between ACE Genotype and Skeletal Muscle Strength and Volume, and Their Response to Strength Training in Older Adults. Masters of Arts, University of Maryland Thesis. 2007.

[28] Shleptsova VA, Malyuchenko NV, Kulikova MA, Timofeeva MA, Shchegolkova JV, Vedjakov AM, et al. "Role of renin-angiotensin system in the formation of emotional state in humans". *Bulletin of Experimental Biology and Medicine*. 2008; 145(4): 391-4. doi: 10.2174/092986652766191223144000.

[29] Voroshin IN, Astratenkova IV. "Dependence of endurance performance on ACE gene polymorphism in athletes". *Human Physiology*. 2008 Jan; 34(1): 117-9. doi: 10.1134/s0362119708010180.

[30] Arakawa H, Yamashita D, Arimitsu T, Sakae K, Shimizu S. "Anthropometric characteristics of

elite Japanese female wrestlers". *International Journal of Wrestling Sciences*. 2015; 5(1): 13-21. doi: 10.1080/21615667.2015.1028123.

[31] MacArthur DG, North KN. "ACTN3: A genetic influence on muscle function and athletic performance". *Exercise Sport Sciences Reviews*. 2007; 35(1): 30-4. doi: 10.1097/JES.0b013e31802d8874.

[32] MacArthur DG, North KN. "Genes and human elite athletic performance". *Human Genetics*. 2005; 116(5): 3319. doi: 10.1007/s00439-005-1261-8.

[33] Hubner-Wozniak E, Kosmol A, Lutoslawska G, Bem EZ. "Anaerobic performance of arms and legs in male and female free style wrestlers". *The Journal of Science and Medicine in Sport.* 2004; 7(4): 473-80. doi: 10.1016/s1440-2440(04)80266-4.

[34] Franchini E, Del Vecchio FB, Matsushigue KA, Artioli GG. "Physiological profiles of elite judo athletes". *Sports Medicine*. 2011; 41(2): 147-66. doi: 10.2165/11538580-000000000-00000.

[35] Gabriel Y, Alvesson M. "Beyond formulaic research: In praise of greater diversity in organizational research and publications". *Academy of Management Learning and Education*. 2013; 12(2): 245-63. doi: 10.5465/amle.2012.327.

[36] Ben-Zaken S, Eliyakim A, Nemet D, Meckel Y. "Genetic variability among power athletes: The stronger vs, the faster". *Journal of Strength and Conditioning Research*. 2019; 33(6): 1505-11. doi: 10.1519/JSC.0000000000001356.

[37] Aidar M, Line SRP. "A simple and cost-effective protocol for DNA isolation from buccal epithelial cells". *Brazilian Dental Journal*. 2007; 18(2): 148-52. doi: 10.1590/s0103-64402007000200012.

[38] Cam S, Colakoglu M, Colakoglu S, Sekuri C, Berdeli A. "ACE I/D gene polymorphism and aerobic endurance development in response to training in a non-elite female cohort". *The Journal of Sports Medicine and Physical Fitness*. 2007; 47(2): 234-8. PMID: 17557065.

[39] Charbonneau DE, Hanson ED, Ludlow AT, Delmonico MJ, Hurley BF, Roth SM. "ACE genotype and the muscle hypertrophic and strength responses to strength training". *Medicine and Science in Sports and Exercise*. 2008; 40(4): 677-83. doi: 10.1249/MSS.0b013e318161eab9.

[40] Bray MS, Hagberg JM, Pérusse L, Rankinen T, Roth SM, Wolfarth B, Bouchard C. "The human gene map for performance and health-related fitness phenotypes: The 2006-2007 update". *Medicine and Science in Sports and Exercise*. 2009; 41(1): 35-73. doi: 10.1249/mss.0b013e3181844179.

[41] Kraemer WJ, Fry AC, Rubin MR, Triplett-McBride T, Gordon SE, Koziris LP, et al. "Physiological and performance responses to tournament wrestling". *Medicine and Science in Sports and Exercise*. 2001; 33(8): 1367-78. doi: 10.1097/00005768-200108000-00019.