Variations of the Angiotensin converting enzyme (ACE) gene on the explosion performance of badminton athletes

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Abstract

The appropriate genetic potential of an athlete or prospective athlete determines the development of their future performance and achievement and reduces the risk of pathological conditions such as overtraining. This study aimed to determine the genotype variation thought to play a role in differences in exercise results and explosive power performance, namely the ACE gene. The research method used a cross-sectional design to describe the relationship between a factor and its effects on how genetic mutation variations play a role in an athlete's physical performance by involving 54 male and female badminton athletes with an average age of 18 years. The study was conducted by analysing the development of badminton skills with the same exercise routine, then being given an explosive power test in the form of a vertical jump through the Lewis nomogram assessment. The initial test was in the first month, and the second test was after six months. The results showed significant differences between the groups with variation II, ID and DD genotypes of the ACE gene. The DD genotype group showed better training adaptation in the explosive power test than genotype II and ID with a significant value ($P<0.05$). This study concludes that athletes with genotype DD variations adapt better to explosive power training than athletes with genotype II and ID. Athletes with genetic mutations II and ID in the ACE gene are more suitable for badminton sports requiring complex movement abilities and skills, which require good anaerobic and aerobic abilities.
Keywords: genetic variation, ACE, explosive power, athletes.

INTRODUCTION

Genes are containers that convey all hereditary factors from parents starting from physical characteristics such as a tall body, fast legs, long legs and so on (Ehrlich & Ehrlich, 2000). Research is now concentrating on identifying appropriate genetic profiles that may contribute to exercise performance. One of the main objectives of this research is to contribute to the world of health and coaching, helping doctors and coaches to identify and direct individuals with genetic potential.to become athletes. The performance of athletes with the appropriate genetic variation is expected to develop in their training better than other athletes who undergo the same training with the same motivation but do not have the right genetic variation. So far, we know that mutations or genetic variations are only related to the onset of the disease (Rasyid et al., 2012).

Rarely or maybe we never hear that genetic variation is also related to the variability of a person's physical strength and speed or his talent to become an athlete, for example in muscle strength which is apparently influenced by heredity, one example is variation in the type of muscle fiber, if more has type I muscle fibers (slow twitch), then the person is better able to carry out activities related to endurance, but it is difficult to increase muscle mass, on the contrary, people with type II muscle fibers (fast twitch) are easier to increase muscle mass (Arimbi & Muriyati, 2017; Melianita & Hardjono, 2005) but has difficulty with endurance, with that we can think that an athlete does not only need to be interested in a particular sport, undergo appropriate exercises and then monitor his performance just because of the expression that " an athlete is not born, but formed", this principle applies to It is important to remember, but it is also necessary to know that there are born talents that are brought by each individual, the birth talents in question are the genetic potentials possessed by each individual since they were born.

The insertion (I) or deletion (D) of 287bp in intron-16 of the angiotensin-converting enzyme (ACE) gene (rs1799752), which is one of the most intensively observed, studied and published genetic variations in several studies over the past ten years (Puthucheary et al., 2018). The ACE (Angiotensin Converting Enzyme) gene is one of several genes that affect a person's physical abilities (Wang et al., 2013).

Suppose this genetic potential is combined with a disciplined and well-directed coaching strategy. In that case, there is no doubt that Indonesia will regain its glory in a few years, even better than in the previous decades. The observations and results of this relatively new research need to be taken into account by the Ministry of Youth and Sports in determining the right strategy to find and develop young athletes in order to boost national sports achievements in general, whose achievements have been declining lately.

Until now, in Indonesia, there is no sports development approach, especially screening of young athlete seeds, using an approach that utilises genetic information on athletes or prospective athletes concerned in the field of sports, especially badminton. In fact, scientific developments that are the source of this information are very meaningful in providing input related to the working mechanism of each individual's body metabolism. The differences in the body's metabolic system in each individual greatly determine what sport is suitable to be developed for an athlete or prospective athlete (Agus, 2012; Candra & Setiabudi, 2021).

This problem then prompted this research, in this study, we analyse one of the genotype variations that are thought, which determines the role in the performance of an athlete, namely the Angiotensin Converting Enzyme (ACE) gene. The genetics of prospective athletes are obtained early, therefore the target of this research is prospective adolescent athletes who are fostered at the Yanti Jaya badminton club, which is one of the badminton clubs in the city of Makassar which has many young athletes with well-monitored coaching management, making it easier to make observations and control the response of athletes with genetic variations of the ACE gene to the training process that they routinely do and are expected to do through the genetic information obtained, it can later have a significant influence on sports performance, especially in badminton.

METHOD

This study consists of 2 variables, one independent variable and one dependent variable to be measured. The independent variable in this study is genetic mutation variation, while the dependent variable measures leg explosive muscle power. This study involved 54 male badminton athletes with an age range of 13-21 years who have joined the club for more than two years, so the number of subjects in the study, 54 were selected from a total population of 59 club athletes, but the genetic PCR results from 54 blood samples were only 52 samples. Blood can be read as the final result. There are several forms of measurement carried out related to the physical condition of badminton athletes, one of which will be discussed here is the measurement of the athlete's explosive power using a vertical jump test with the Lewis nomogram assessment norm (Garrett & Kirkendall, 2000). In badminton, explosive power is a dominant physical condition, especially the explosive power of the leg muscles. An athlete, in particular, needs to hit a sharp smash and dive into the opponent's field, which is the key blow to kill the opponent's game. The second was carried out after monitoring their training routines at the club for six months, the development of the training results was then associated with the results of the athlete's genetic variation. Genetic examination of ACE gene polymorphisms In this study, the conventional polymerase chain reaction (PCR) method was used to analyse the method with detection of the presence of (Handoyo & Rudiretna, 2000; Kusnadi & Arumingtyas, 2020; Yusuf, 2010) DNA carried out at the end of the reaction and observation of the presence of DNA in agarose gel after electrophoresis.

The type of research used is a retrospective cohort study using a cross-sectional design or approach to provide an overview of the correlation between a factor and its effects (Hidayat, 2015). This study has received approval from all samples by filling in the statement on the informed consent and the Health Research Ethics Commission at the Faculty of Medicine, Hasanuddin University, with the number: 01944/H4.8.4.5.31/PP36-KOMETIK. The duration of observation was carried out for 24 weeks (6 months), with a frequency of exercise 2 times a day in the morning and evening, 5-6 days a week, all samples are club athletes who are boarding house so that their entire training schedule and daily consumption are relatively the same because to conclude the results of the observations from the cross-sectional identification that.

RESULT

Based on the results of a genetic examination of the ACE gene polymorphism of the athlete group with genotype II as many as 30 people, genotype ID as many as 15 people and genotype DD as many as seven people, while samples with codes A.20 and A.49 were not legible. The light-coloured line is the marker, if it lights up at the 191 bp marker, it means the sample has a DD genotype (deletion or deletion), if it lights up at the 490 bp marker, it means the sample has genotype II (Insertion or insertion), while if it lights up at the 191 bp and 490 bp marker meaning that the sample has genotype ID (insert deletion) (Arimbi et al., 2017). These results can be seen in Figure 1-3 below:

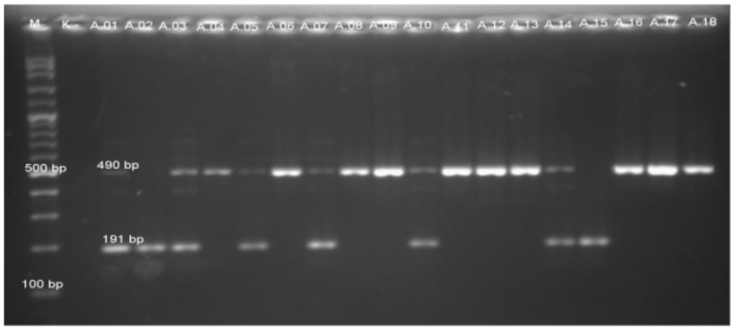

Figure 1. PCR sample A.01 – A.18

In figure 1, the bright line at code 191 bp in the sample code A02, A15 indicates the sample has the genetic mutation DD (deletion). The bright line at code 490 bp in the sample codes A04, A06, A08, A09, A11, A12, A13, A16, A17, and A18, indicates the sample has genetic mutation II (insertion), while if the bright line at code 191 and 490 bp, in the sample code A01, A03, A05, A07, A10, A14, indicates the sample has genetic mutation ID (insertion deletion).

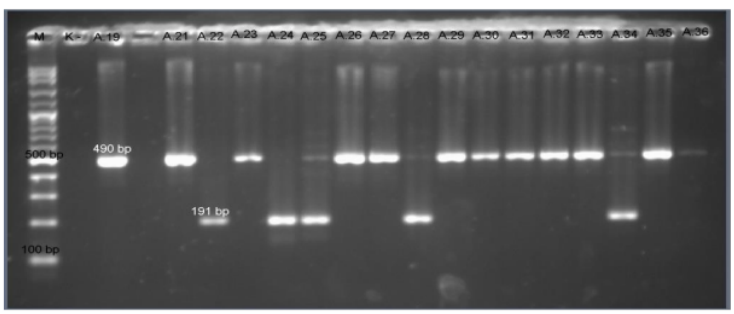

Figure 2. PCR sample A.19 – A.36

In figure 2, the bright line at code 191 bp in the sample codes A22, A24, and A28 indicates the sample has the genetic mutation DD (deletion). The bright line at code 490 bp in the sample codes A19, A21, A23, A26, A27, A29, A30, A31, A32, A33, and A36, indicates the sample has genetic mutation II (insertion), while if the bright line at code 191 and 490 bp, in the sample code A25, A28, A34, indicates the sample has genetic mutation ID (insertion deletion).

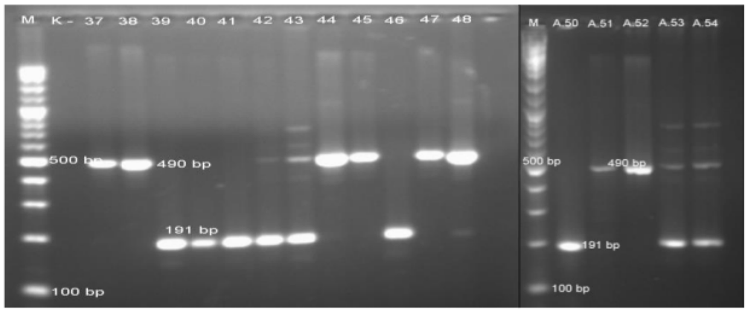

Figure 3. PCR sample A.37 – A.54

In figure 3, the bright line at code 191 bp in the sample codes A39, A40, A41, A46, and A50 indicates the sample has the genetic mutation DD (deletion). The bright line at code 490 bp in the sample codes A37, A38, A44, A46, A47, A51, and A52, indicates the sample has genetic mutation II (insertion), while if the bright line at code 191 and 490 bp in the sample code A42, A43, A48, A53, A54, indicates the sample has genetic mutation ID (insertion deletion).

Information :
M: Marker
K: Negative control
A: Sample code

Table 1. Changes in Explosive Power (Vertical Jump) After Undergoing a Routine Exercise Program for 6 Months

Genotype ACE gene	Mean (SD) Muscle Explosion/Vertikal Jump (kg-m/sec)			
	Before	After	Changes	
II (SD)	83,33(14,31)	86,62(13,80)	3,29	*<0,001*
ID (SD)	78,98(17,84)	81,08(18,63)	2,10	*0,016*
DD (SD)	75,11(21,17)	80,70(20,18)	5,59	*0,004*

The same superscript in the column for the magnitude of the increase showed that the results of the Mann-Whitney U test were not significantly different (p>0.05), and if they were different, they showed a significant difference ($p<0.05$). The results of the Spearman correlation test between variations in the ACE gene genotype with the magnitude of the change showing $r=-0.076$ and $p=0.295$.

After undergoing routine training for six months, it showed an increase in muscle explosive power performance with a significant vertical jump test in the three groups of athletes with genotype variations II, ID and DD (table 9). with genotype variations, DD was better than the group of athletes with genotype variations II and ID which was 5.59 kg-m/second ($P=0.004$). The group of athletes with genotype II variation showed an increase in explosive power response of 3.29 kg-m/second ($P=0.001$), while the group of athletes with genotype ID variation increased by 2.10 kg-m/second ($P<0.05$).

Changes in the average score on the muscle explosive power test (vertical jump) on the three variations of the ACE gene genotype can also be depicted in the following diagram:

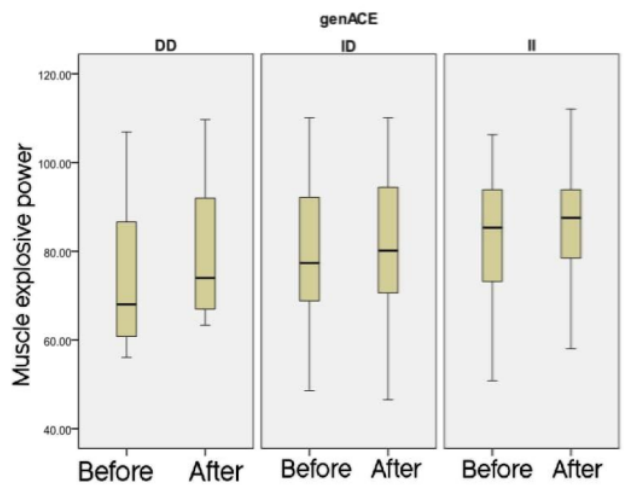

Figure 4. Athlete's Explosive Power Results Comparison Chart

DISCUSSION

Result of this study, the response of routine exercise for six months to muscle explosive power with a vertical jump test was significant in the 3 (three) groups of athletes with genotype variations II, ID and DD. The group of athletes with genotype II variation showed an increased response to the explosive power of 3.29 kg-m/sec (P=0.001), while the group of athletes with genotype ID variation increased by 2.10 kg-m/second (P<0.05). Athletes with genotype variations DD were better than the group of athletes with genotype variations II and ID, which was 5.59 kg-m/second (P=0.004).

Changes in the explosive power of leg muscles in the three groups of athletes with genotype II, ID and DD variations. In this study, the distribution of the highest genotype variation in the population was athletes with a different genotype II variation from several previous studies, which found the distribution of three variations of the angiotensin-converting enzyme gene, namely II, ID, and DD in the Caucasian population was found to be around 25%, 50%, and 25%. respectively (Ginevičienė et al., 2009; Gineviciene et al., 2014; Gineviciene et al., 2016). In another study, it was found that in the Asian population in Korea (23%, 66% and 11%, respectively) (Ma et al., 2013; Pitsiladis et al., 2013) shows that the population with genotype II variation is much less than with variations in ID and DD genotypes.

Genotypic variation of the angiotensin gene, contributes to performance in sports, especially those that require physical endurance because the ACE gene encodes an enzyme (angiotensin converting enzyme) that converts inactive angiotensin-I to active angiotensin-II. ACE is widely expressed in skeletal muscle and plays an important role in a series of metabolisms that occur during exercise (Thomas et.al., 2014). Angiotensin-II is important in triggering the narrowing of blood vessel diameter, which increases blood pressure. Angiotensin-II also plays a role in degrading substances that function to improve the diameter of blood vessels.

Angiotensin-II levels in athletes with ID and DD genotypes in this study were higher where angiotensin II would interact with angiotensin-II receptors in vascular smooth muscle which would affect peripheral blood vessel vasoconstriction, especially veins that will cause an increase in stroke volume so that subjects with ID and DD genotypes in this study were found to have a higher blood pressure than the group with genotype II (Afifah et al., 2021; Rasyid et al., 2012), but it is known that the ID genotype and DD the angiotensin gene is associated with fast-twitch muscle characteristics because muscle tissue in ID and DD subjects receives less blood and oxygen supply so that it is more suitable for sports that require strength and speed (explosive power). The workload intensity of badminton is quite heavy, the duration is ½ - 1 minute for one rally and requires high speed. From the nature of the workload, it can be estimated that the main energy system of badminton is anaerobic, the ATP-PC-lactic acid system, while the aerobic power system serves as support (Nugroho et al., 2021).

The results obtained are in line with previous studies, which revealed that genetic factors play an important role in physical performance, this study wanted to see the relationship of insertion/deletion polymorphisms to cardiovascular ability, which was followed by 154 male subjects and 85 female subjects. Maximal oxygen uptake and D allele are associated with anaerobic exercise (Holdys et al., 2013).

The results of other studies also revealed that the insertion/deletion polymorphism of the angiotensin gene affects maximal oxygen consumption (VO2max) and hemodynamics at maximal physical activity levels. Genotype II has a higher VO2max than the DD genotype (Hodeib et al., 2020).

CONCLUSION

The DD genotype of the angiotensin converting enzyme gene, when interacted with the vertical jump physical test, showed better muscle explosive power results after undergoing their routine exercise program for six months, compared to variations in genotype II and ID, the DD genotype contributed to peripheral vascular vasoconstriction so that although muscle tissue does not have an adequate supply of blood and oxygen but allows for brief activities that require maximum speed.

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