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Evaluation of the soldier's physical fitness test results (strength endurance) ın relation to genotype: longitudinal study

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Abstract

Background: The aim of this study is to determine the effect of ACE gene polymorphism on the parameters studied (push-up & sit-up) in a long-term study, which has been carried out for many years and to find out whether the differences in ACE gene's metabolism due to the influence of parameters such as outside impacts and lifestyle (active or sedentary life) have a role in the development of strength endurance or not.

Main text: 59 male army officers made up the research team. A follow-up study of strength endurance (push-up and sit-up) test was conducted in the gym. The exam took two minutes to complete, and each application was tested separately. In both 2004 and 2019, persons with genotype ID had the best mean sit-up and push-up outcomes, followed by participants with genotype DD, and finally participants with genotype II (*P* 0.05). Compared to the original rates in 2004, all genotype groups showed a significant reduction in push-up and sit-up scores in the test.

Conclusion: The findings of this study may reveal if strength and lifestyle choices affect the metabolic implications of the genetic polymorphism in the body. Particular varieties actuated by genes, on either hand, don't result in significant improvements without any changes in individuals' practices or ways of living, as per the conclusions.

Keywords: Polymorphism, Strength endurance, Way of life

Background

DNA sequences of varying lengths on chromosomes carry the genetic characteristics of cells, the codes for proteins, and other atoms and atoms' characteristics. They are the basic structures that encode the formation and development of metabolism from the first moment of its formation to the end of life. Contrasts between people can be found in the subtle differences in the data transmitted from generation to generation. To further characterize the differences between people, the DNA groupings can also be used to identify the limits of physical capacity [1].

As of late, the relationship between workout and hereditary qualities are acknowledged as a new approach that uncovers the relationship between athletic execution and physical capacity. Progress in research and advances in technology have enabled more studies to be conducted on the genetic relationship with performance-related traits, and more than hundred genes have been identified in the recently published human gene [2]. The results of the research conducted in this framework have determined that muscle strength is affected by heredity by 30–80%. Most extreme oxygen take-up and anaerobic control were detailed to be innate in 40–70% and 30% in 90%, respectively [3]. Likewise, the similarity of cardiorespiratory endurance phenotypes in sedentary groups was found to be higher in monozygotes than dizygotes and the effect of heredity in this similarity was calculated to be between 25 and 66% [4–7].

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The most comprehensive data on the role of genetic factors in the development of muscular endurance have been obtained from family studies [8–10]. In long-term studies conducted within the framework of physical fitness, heritability estimates were found to be 37–41% for sit-ups, 44–52% for push-ups under the most ideal circumstances [11]. Significant familial similarity was observed in the performance of both muscle adaptations, and they explained the genetic transmission as 21% for muscular endurance and 30% for muscle strength [12, 13].

Along with environmental factors such as training, genetic factors may also explain some of the interpersonal differences in physical performance. It is frequently observed that people who do the same training cannot achieve the same sportive performance. Learning individual genotype properties can be a utilizable instrument for the constitute of individual-regulated workout programs [14]. Following the introduction of human DNA sequences with the Genome Project in 2000, the number of studies that reveal the relationship between athletic performance and genes has started to increase [2–15]. There are more than a hundred genes related to athletic capacity [16]. The top well-known gene related to the physical capacity is the Angiotensin-Converting Enzyme (ACE) gene. The gene is capable of managing and balancing blood pressure and body liquids. Within the Pro gene, an implantation/extraction polymorphism at 287 base sets could be a utilized change. Alleles DD, ID, and II make up this polymorphism. The closeness of the 287-bp part results in significant changes in serum levels. Subjects with II genotypes had the lowest ACE levels, while those with DD genotypes had the highest ACE levels [17]. Due to expanded vasoconstriction in individuals with high ACE activity there's not sufficient blood stream to the muscle tissue [18]. People with low ACE activity have a high level of endurance performance and long duration of exercise efficiency due to the wealthy blood circulation [1–19]. In people with high ACE enzyme activity, long-term endurance performance (exertion levels that can be sustained for more than 30 min) is low because of the increased vasoconstriction due to insufficient blood flow to the muscle tissue; on the other hand, short-term endurance (exertion levels that can be sustained for 2–8 min) [20], strength and power development are observed at medium and high levels. In individuals with low ACE enzyme activity, high levels of endurance performance and exercise efficiency stand out due to the richness of circulating blood. Due to the effects of the ACE gene on serum ACE levels and ACE being involved in the metabolism of substances related to vascular compliance, it was assumed that ACE I and D polymorphisms could explain the different responses of individuals to the same training [21–23].

The relationship between ACE genotype and sportive execution (speed, power, strength and endurance) has been emphatically assessed in numerous of the considers conducted so distant [24, 25]. Up to present, some considered on the subject range has completely clarified the relationship between gene and strength endurance development. Strength endurance may be a biomotor capacity that's straightforwardly actuated by slow and fast-twitch muscle fibers (use aerobic & anaerobic energy systems) intending to deliver strength or resistance over an amplified period [22]. It is generally defined as the capacity or ability of muscle groups to perform repeated contractions against a load [26]. Speed and endurance and the ability of muscles or vitality frameworks to resist physical exertion, such as lactate threshold training [24] for a maximum of 2 min, determine the level of strength endurance that reveals military capability [3–25]. Military disciplines make it nearly impossible for a warrior to be both very fast and able to resist long-term endeavors simultaneously [22–27].

Testing for physical well-being in the military is used to determine a soldier's long-term (exertion levels that can be sustained for more than 30 min) and medium-term (exertion levels that can be sustained for 12–15 min) endurance capacity as well as muscle strength endurance (exertion levels that can be sustained for 1–2 min) capability [28]. Physical fitness test that measures military capabilities are used for the purpose of identifying medium and long-term endurance ability and strength endurance abilty. When the average professional lifespan is between 25 and 30 years, these characteristics are essential to ensuring a long and successful career [22]. Having to sprint and walk long distances in difficult conditions, lift heavy loads for extended periods, and manage operations under pressure requires strength endurance abilities over force/power and speed execution. Control execution with long duration and low intensity has entered military field operations [27–29]. The operation's success and the individual's execution depend on troopers' selection with the necessary physical execution level.

The aim of this study is to determine the effect of ACE gene polymorphism on the parameters studied (push-up & sit-up) in a long-term study, which has been carried out for many years and to find out whether the differences in ACE gene's metabolism due to the influence of parameters such as outside impacts and lifestyle (active or sedentary life) have a role in the development of strength endurance or not.

Main text

Methodology

Participants

An add up to 59 male armed force officers shaped up the inquire about gather (in 2004, add up to 186 subjects took portion within the research) [30]. Amid the 15 years, no contact with the subjects was made. The individuals included in the study did not engage in any sports activities on a regular basis. The essential concepts observed were beneath the task's concentrated and scope and taking portion in physical capacity tests (push-ups and sit-ups for two minutes; pull-ups, & Cooper test) and orderly yearly physical well-being check-ups. The average age of the members was 40 ± 1.4, body composition was 73 ± 2.2 kg, and body estimate was 175 ± 2.4 cm. Each specific subject was provided with composed consent to require an intrigued inside the significant and fitting ethics committee underwriting has as well been permitted.

Exercise tests

Strength endurance performance measurement tests (push-ups & sit-ups) comes about have been gotten with in the gym. Strength endurance tests were recorded by deciding the most extreme number of redundancies performed exclusively inside 2 min.

Push-ups test procedure

The starting position begins with the hand and toes touching the floor. Arms can be shoulder-width apart, legs together or 30 cm apart. The hands or feet cannot be lifted off the ground. In the pushing position, the elbows should be locked in full stretch. Body tension is maintained from the shoulders to the ankles. The body should be held in a line from the heel to the head. The eyes look forward, the hips are definitely not lifted, the body smoothness is not deteriorated. With the starting position, the chest is touched to the ground and the first position is taken by stretching the elbows again [31–33].

Sit-up test procedure

The starting position is lying on the back with the knees bent at approximately 90 degrees. Feet can be adjacent or at most 30 cm. A helper just holds the ankles with their hands. Hands are in a clasped grip on the neck. The torso is lifted until the minimum back is perpendicular to the ground. Heels and hips must be in contact with the ground at all times. When lying on the floor, the back and shoulders should touch the floor. In the starting position, the upper part of the body is bent from the waist area and the movement is continued until the chest touches the knee, and the starting position is resumed [34, 35].

Genetic analysis

"Throughout the study conveyed in 2004, the genotype analysis of the subjects involved in the current study was evaluated" [30], further down, the approach used in this assessment is explained. People who were acknowledged had their intravenous blood collected on K2EDTA cutters and hatched at -20° C until DNA was isolated. The Atomic Pharmutical Inquire about Research facility of the Office of Pediatrics, Ege College Restorative Staff Healing center, performed whole genomic assessments. The genomic DNA from 200 L of EDTA-anticoagulated venous blood-resistant cells was extracted using the QI Amp Blood Unit (QIAGEN, Ontario, Canada, Cat. no: 51,106). To further investigate the ACE I/D transformations using polymerase chain response (PCR), a 15-L batch of DNA was upgraded using 200 mM dNTP blend, 1.5 mM MgCl2, 1£ Buffer, and one unit of AmpliTaq® polymerase (PE Connected Bio frameworks) along with 10 pmol of each layout. 5-CTGGAGACCACTCCC ATCCTTTCT-3 and 5-ATGTGG CCATCACATTCG TCAGAT-3 have been passed down to cover the phenotypic portion of the Pro [36]. The DNA's heightened in 35 cycles, with each cycle comprising 30 s of crystallization at 94 °C, 30 s of welding at 50 °C, 1 miniature of expansion at 72 °C, and a closing intensification in time of 7 min. At 95 °C for 5 min, the initial adjusting preparation was completed. Ethidium-bromide recoloring was utilized to recognize the prohibited PCR groupings on a 2.5 percent agarose gel. To guarantee each DD hereditary variation, moreover, a moment PCR with groundworks particular for the addition grouping was used" [37]. "Components with II and DD homozygote genetic variations, as well as ID heterozygote hereditary transformations, were chosen at disconnected frequencies. The test comes about were at that point handled through the ABI 310 Innate Analyzer (ABI Prisma PE Associated Biosystems) and basically analyzed by the ABI 310 Genetic Analyzer (Genomics, Montage PCR, Millipore)" [38]. In expansion, each individual was doled out a marked consent to take part within the examination and the reasonable ethics committee authorization.

Statistical analysis

SPSS for Windows form 10 was utilized to conduct measurable examinations (SPSS Inc., Chicago, IL, USA). Frequencies, expressive insights, and implies were utilized as strategies. The $P < 0.05$ level of measurable importance was utilized. The harsh contrasts between the two within-subject components, ACE genotype and time, were examined using a two-way repeated-measures ANOVA.

The post hoc analysis was conducted with Least Significant Difference method (LSD). Lastly, the differences between 2004 and 2019 values within each ACE genotype group were observed and analyzed by box-plot and paired *t*-test, respectively.

Results

In 59 individuals, the ACE genotype was assessed. The genotype dispersion within the bunch of individuals was not altogether distinctive from the Hardy–Weinberg adjusts gauges (16.90 percent II, $n=10$; 44.10 percent ID, $n=26$; 39.00 percent DD, $n=23$). Members with genotype ID had the most noteworthy cruel sit-up, and push-up comes about in both 2004 and 2019, taken after by subjects with genotype DD, but instep subjects with genotype II (P 0.05). Within the test, most other ACE genotype bunches uncovered a diminish in push-up and sit-up scores compared to the starting levels in 2004. Strength endurance test performance is affected by genetics. The changes in sit-up & push-up are presented Tables 1 and 2.

In both 2004 and 2019, the average sit-up scores realized were most noteworthy for members with genome ID, halfway for subjects with genotype DD, and least for members with genome II. It has too been recognized that all genotypes have a critical diminishment in sit-up execution on normal ($P<0.00$). Despite this, there are a few qualifications. A one-way ANOVA ($P<0.353$) demonstrated that none of the three genotypes were emphatically exact. To put it in point of view, the genotype does not affect how this diminishes changes. Besides, the P level for the interaction between the diminished sit-up score and the genome is 0.572, which is unimportant.

Through both 2004 and 2019, the most noteworthy approximated push-up execution was measured for members with genome ID, halfway for subjects with genome DD, and the least for subjects with genome II. It has been recognized that all genotypes incorporate a considerable drop in push-up execution ($P<0.00$). Despite this, there are a few qualifications. A one-way ANOVA ($P<0.326$) affirmed that none of the three genotypes were emphatically precise. Besides, the P esteem for the interaction between lesser sit-up score and genome is 0.038, which is substantial.

A combined *t*-test is utilized to look at the distinction in each parameter over time. It has been set up that the usual number of sit-up and push-up scores have dropped significantly ($P<0.00$). The changes depicted over are outwardly spoken to within the graph below. There is a descending drift in sit-up and push-up scores over time regularly.

The following plot represents the changes defined above visually. It is seen that there is a decreasing trend over time for sit-up, push-up scores on the average. However, there is an increasing trend over time rest of them on the average. In 2004, it had a positive relation whereas, in 2019, it incorporates a typical scattering. In 2019, there is moreover an independent assessment (Fig. 1).

Table 1 The influence of the genome on sit-up performance over time

Genome	*N*	2004	2019	The impact of time (within the task)	Genome Outcome (between each of the two)
				P value	*P* value
II	10	52 ± 8.86	36.5 ± 9.22	0.00	0.353
ID	26	58.5 ± 7.19	39.77 ± 8.58		
DD	23	58.09 ± 11.31	38.6 ± 8.51		

$P<0.05$

Table 2 The influence of the genome on push-up performance over time

Genome	*N*	2004	2019	The impact of time (within the task)	Genome Outcome (between each of the two)
				P value	*P* value
II	10	57.6 ± 17.57	26.1 ± 8.88	0.00	0.326
ID	26	64.04 ± 19.35	32.58 ± 8.88		
DD	23	57.74 ± 17.12	31.78 ± 11.45		

$P<0.05$

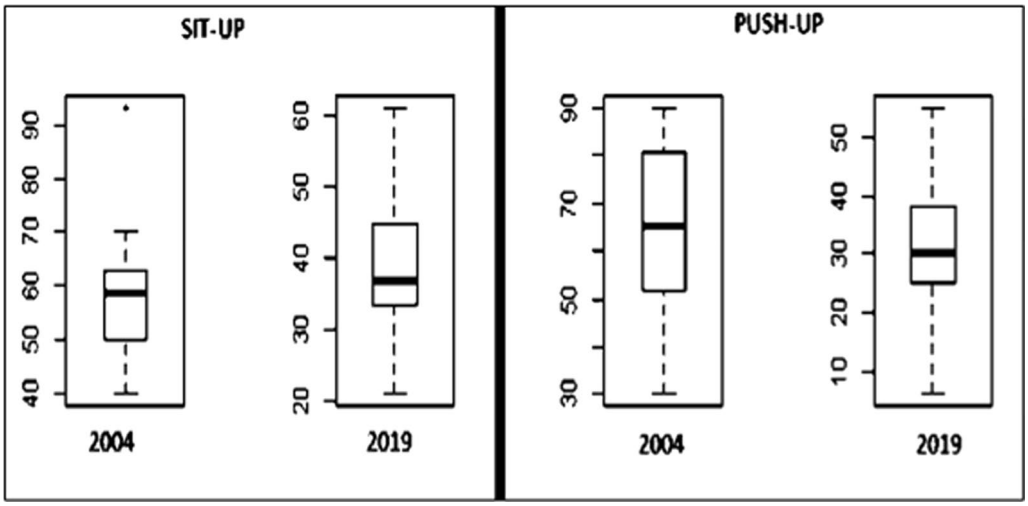

Fig. 1 The changes in sit-up and push-up scores between 2004 and 2019

Discussion

We analyzed the impact of ACE genotypes in this inquire on the strength endurance among the army officers. A cross-sectional and a follow-up study were secured within the inquire about extend. We re-tested (push-up & sit-up) the people who, in addition, took portion within the research performed in 2004 [30] to find out the role of ACE gene and its implications on the changes of participants' escalated strength endurance execution by taking into consideration the unmanageable contrasts in outside conditions, way of life (active or sedantery), and other perspectives such as work out, aging, sustenance and having to live status between the two tests over a time of 15 years.

The human hereditary structure might alter emphatically or adversely over time owing to the impacts of different components (social and outside factors) and way of life choices. Intending to uncover people's physical capacities, preparing ought to be connected concurring to individuals' hereditary structure [39, 40]. Comparative preparing strategies and exercises will deliver more or less comparative outcomes about people. In any case, the accomplishment outcomes about the diverse genotypes in comparable preparing loads may not surrender the anticipated alter. In each genotype, preparation of boosts or behaviors offered to people will progress, but the improvement observed in genotypes that provide proper adjustment will be a little more advanced [30–43].

Mental and intellectual proficiency is as much a part of the military way of life as physical ability, and all three are required in equal measure. In terms of military well-being and commercial execution productivity, it is critical to determine which officer is faster, more grounded and has a better persistence ability. In order to achieve significant results by considering genotype contrasts and sporting execution improvement, working with officers (homogenous) is a must [30–43].

The length and escalation of a workout are two factors that affect the amount of energy expended. Anaerobic vitality frameworks are used in high-intensity and short-term training. APFT (Army Physical Fitness Test) is used to measure strength endurance of soldiers in many countries consists of pull-ups, push-ups and sit-ups, which can be done in 2 min considering the maximum number of repetitions [27] and is used in many countries to measure soldiers' quality of life. Short-term anaerobic applications are used in strength endurance physical capacity assessments (1–2 min). When the intensity of exercise is 60%-85 or more, the fast-twitch muscle fiber (FTa, FTb) is activated, when the exercise is 60% or below the maximum heart rate, slow-twitch muscle fiber is activated [28]. The duration of the workout and its intensity are the most critical considerations right now. In these tests (not more than 2 min exercise duration), it is generally agreed that the ACE ID & DD genotypes are preferable to the II genotype [30–41].

It should be understood that the most crucial parameter determined by a strength endurance test is solid local persistence, taking into account the kind of muscle fibers and the duration of the workout. During the anaerobic endurance test, the prime mover muscles (pectoral, abdomen, and latissimus dorsi) are assessed for their lactic corrosive aggregation resilience (weakness). Local muscular endurance is defined as the resistance of muscle or muscle groups to the accumulation of lactic acid in short-term activities [44]. Push-ups, sit-ups, and pull-ups

demand anaerobic vitality from the oxygen-consuming framework to progress to the next level of development. Because of the weight or compression that dynamic muscles are subjected to during exercise, blood flow to muscle cells is often wholly blocked. Type I muscle fibers are activated with low and moderate exercise loads, whereas type II muscle fibers are activated by low repletion-high intensity loads [45–47]. Moderate heaving muscular filaments are activated at the commencement of a workout when the intensity of the workout reaches 60% of the maximum heart rate (fast-twitch muscle fibers are involved in the contraction). Because of the increased fatigue level and the increased workout length, fast-twitch muscle fibers are involved in the contraction have less of a tendency to engage in the activity [45].

A person's genetic makeup determines skeletal muscle fiber proportions. The ACE II, ID & DD genotypes were shown to have the distinctive muscle tissue of type I, type II a, and type II b [41–46]. The D allele has been linked to improved muscle quality, volume, and the proportion of fast-twitch fibers [46–48]. In order to determine if long-term muscle activity can be supported by delaying the collection of lactic acidity at its highest level, strength endurance estimation tests are conducted. Hereditary muscle fiber structure influences the rate of slow-twitch muscle fiber [46], whereas the rate of fast-twitch muscle fiber enables the strength athletes to be successful in short-term activities [30–46].

We found that participants with ID and/or DD genotypes were more valuable than those with II genotypes (Tables 1 and 2) for the strength endurance tests. From a comparative perspective, the findings of Sonna et al. research's have shown that the ACE ID polymorphism muscle resistance for young American adults did not significantly impact physical achievement. According to a study of USA Army recruits, a more excellent muscle strength was not linked to a higher rank [22]. In our study, those with genotype ID have the highest overall rating, those with genotype DD have the middle rating, and those with genotype II have the lowest overall rating at the beginning of the preparatory execution. Furthermore, follow-up scores were the highest for subjects with genotype ID, intermediate with DD, and lowest for subjects with genotype II (Tables 1 and 2). However, researchers found no significant differences between the II, ID, and DD genotypes in the physical well-being (push-up 1 min.) and curl-ups improvement in Indian military triathletes [48, 49]. Similar to this study, Sonna et al. evaluated the relationship between ACE genotype and strength endurance by observing the results of US army recruits' baseline and final push-up and sit-up exercise (Army Physical Fitness test-APFT) results [22]. They noticed that the contrast between the scores of distinct genotypes was exceptionally little and not measurably noteworthy compared to these researches; we revealed that the general strength endurance was the most prominent for members with genotype ID, medium for members with genotype DD, and most minor for members with genotype II in both 2004 [43] and 2019. On average, there is a decreasing trend in sit-up and push-up scores over time, in our follow-up study results (Fig. 1). These have shaped that all genotypes have a sensational diminish in strength endurance developed compared to the standard Our study showed that ID and DD genotypes have significantly greater strength endurance performance compared to genotype II. To put it in viewpoint, genotype contains a genuine impact on diminishment. After all, the included esteem P for the usefulness between the diminishment in push-up & sit-up scores and genotype is 0.572 and 0.038 separately, which is immaterial (Tables 1 and 2). In our considered research, all genotype bunches have appeared lower scores within the test than the cross-sectional ponder in 2004 ($P<0.05$). On the other hand, the genotype has no coordinated impact on this decrease in 2019 ($P<0.05$; Table 3). Besides, not one or the other does the cross-sectional or the follow-up inquiries about whether the application has any significant impacts of ACE genotype on athletic wellness, as per Frederiksen et al. [50].

Person contrasts in an assortment of factors, alongside muscle mass, can be decided due to action control, speed & strength of the muscles, oxidative and non-oxidative capacity, skeletal composition and body-build [39–51]. Adaptation to physical workouts may change significantly, intending to reply to physical workout mediation more than the others. As a result, there is no appropriate stability between people's

Table 3 Matched *t*-test

	Paired samples test					
	Mean	**Std. Deviation**	**Std. Error Mean**	***t***	***df***	**Sig. (2-tailed)**
Sit-up 2004–2019	18.47458	11.45810	1.49172	12.385	58	.000
Push-up 2004–2019	29.32203	19.06381	2.48190	11.814	58	.000

$P<0.05$

responses; a few can discover common ground in one range, whereas others have to note any changes [52].

Developmental instruments are included in 20–80% of the qualifications in imperative athletic specialized determinations [53]. Analyses of the genetic contribution to physical performance phenotypes provide not only insight into the importance of genetic factors but also in the contribution of environmental factors [54], lifestyle and training continuity [55]. Moreover, genetic contrasts in body structure and skeletal muscle fiber type ratio may have a collective or backhanded impact on full workouts. To productive utilization of vitality, there was, in addition, a design that was consecutive in the brief term, such as ACE DD > ID > II [30]. That also tends to be particularly heritable, in component depending on the constituents of different muscle fiber types (the type I and type II).

Within the outline of reference of so numerous of these analytical studies, in an exertion to induce the results of strength endurance scores of the indistinguishable subject group (59 officers) to see on the off chance that parameters influencing individual viability are being connected to genetic changes or not being at all. ACE action level (circulation) is significantly connected with muscle strength [30]. Due to the fact that ACE ID and DD genotypes have high level of ACE level in the tissue and anabolic structure (using high rate of fast-twitch muscle fibers) in comparison with II genotype, it is assessed that they may have much more power & strength capacity and that's why they lost strength endurance performance less than individuals with II genotypes [56, 57].

We were able to get the gathered information of strength endurance ahead of plan, intending to analyze the effect of ACE genetic mutations on the regions of study's achievement in cross-sectional and check-out considers on strength endurance. To track varieties in strength endurance exhibitions by re-testing (push-up & sit-up distinctive). About 59 people from the same test group (186 members) as within 2004 inquire were found 15 a long time afterward after the data accumulated from the 2004 research due to the adjusting metabolic forms of individuals owing to the fashion of living and natural components (social and outside factors, aging and health status) [30–41].

Limitations

Few studies that determine the relationship between strength endurance and genetic interactions. Failure to reach a large number of subjects in the follow-up study.

Conclusion

The discoveries supported that the goal of this paper is to see whether the chance that the metabolic impacts in a being started as a result of varieties within the gene polymorfizm influenced or not so much as a result of an adjusted slim down and different pieces of training. We conclude that genotype has noteworthy impacts on strength endurance scores on the subjects for the cross-sectional and the investigation of keeping track, and this change is unaffected by the phenotype.

Abbreviations

DNA: Deoxyribo nucleic acid; ACE: Angiotensin-converting enzyme; PCR: Polymerase chain response; APFT: Army physical fitness test.

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Author contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by DSY, ME, MD, CB, and MC. The first draft of the manuscript was written by DSY and MC, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Alldata used during this report are included in this published article. Furtherdata are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consentto participate

Ethicalapproval was obtained. (Ege University, Faculty of Sport Sciences,15/April/2005, Ethical approval no:14.598).

Consentfor publication

Writtenconsent was taken from the participate for publication.

Competinginterests

The authors declare that they have no competing interests.

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