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# ACTN3 R577X gene polymorphism may play a role to determine the duration of judo matches

TOSHIO ITAKA<sup>1</sup>, YUICHI TOMIZAWA<sup>2</sup>, KOSEI INOUE<sup>3</sup>, KENICHIRO AGEMIZU<sup>3</sup>,  
SEIJI ARUGA<sup>4</sup>, SHUICHI MACHIDA<sup>1</sup>

### Abstract

**Introduction.** The alpha-actinin-3 (ACTN3) and angiotensin-converting enzyme (ACE) genes are associated with sports performance and physical fitness. In particular, gene polymorphisms in ACTN3 and ACE are reportedly related to the duration of athletic activity and swimming. Variability in the duration of judo matches may be related to genetic factors. We hypothesized that these gene polymorphisms are associated with the duration of judo contests. **Aim of Study.** The purpose of this study was to investigate the association between the ACTN3 and ACE gene polymorphisms and the duration of judo matches. **Material and Methods.** The study included 129 Japanese male athletes in the judo club of T University. The frequency of the ACTN3 R577X (rs1815739) and ACE I/D (rs1799752) polymorphisms were determined with polymerase chain reaction (PCR) or PCR–restriction fragment length polymorphism analysis. We also surveyed 13 judo instructors who had taught the study subjects. The instructors rated the speed to decide the match outcomes of the subjects. Using this data, we then divided the subjects into a fast match-decider group and a slow match-decider group and compared the genotype frequencies of these groups by using the chi-square test. **Results.** Genotype frequencies of the ACTN3 R577X gene polymorphism but not the ACE gene polymorphism were significantly different between fast match-decider and slow match-decider groups. The ACTN3 R577X gene polymorphism was associated with the duration of judo matches. **Conclusions.** The ACTN3 R577X gene polymorphism, but not the ACE I/D gene polymorphism, may be associated with the duration of judo matches.

**KEYWORDS:** alpha-actinin-3 gene, angiotensin-converting enzyme gene, the duration of judo match.

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Corresponding author: machidas@juntendo.ac.jp

<sup>1</sup> Juntendo University, Graduate School of Health and Sports Science, Tokyo, Japan

<sup>2</sup> Tokai University, Graduate School of Physical Education, Tokyo, Japan

<sup>3</sup> Tokai University, School of Physical Education, Tokyo, Japan

<sup>4</sup> Tokai University, Sports Medical Science Research Institute, Tokyo, Japan

### Introduction

Recent studies have indicated that genetic factors contribute to sports performance and physical fitness [3, 2]. Bray et al. [2] identified more than 200 gene variants associated with fitness-related phenotypes. Among these variants, the genes associated with sports performance are the alpha-actinin-3 (ACTN3) gene and angiotensin-converting enzyme (ACE) gene. Many studies have identified an association between ACTN3 R577X gene polymorphism and sports performance. A study by Yang et al. [11] was the first to show that nearly all top Olympic sprinters and power athletes have either the RR or RX genotype. Moreover, muscle strength, power, mass are significantly higher in the RR+RX genotype than in the XX genotype [4, 6, 8, 12]. Therefore, there is consensus that the ACTN3 gene, the so-called speed gene, is associated with sports performance and physical fitness.

Judo is one of the most widely practiced sports in the world. Since the 1964 Olympics Games in Tokyo, the Japanese judo team has won 39 gold medals. With the exception of golden score contests, judo matches last a maximum of 5 min for men and 4 min for women, but the duration of judo matches varies.

Until now, factors related to this variability have not been examined; however, genetic factors such as ACTN3 R577X and ACE I/D gene polymorphisms may play a role. Knowing the genotype of an athlete may allow training to be tailored to his or her physical strengths. The purpose of this study was to investigate the association between ACTN3 and ACE gene polymorphisms and the duration of judo matches.

## Material and Methods

### Subjects

The study included 129 Japanese male athletes belonging to the judo club of T University, which has produced many international-level judo competitors. The study was approved by the Ethics Committee of Tokai University in Japan and was conducted according to the principles of the Declaration of Helsinki. The objectives and methods of the study were explained to the subjects, and written informed consent was obtained from each.

### Genotyping

Saliva samples were collected from all subjects and frozen at  $-80^{\circ}\text{C}$  until experimentation. DNA was extracted from the samples using a QIAamp DNA Mini Kit (QIAGEN, Milano, Italy) according to the manufacturer's protocol. The frequencies of the ACTN3 R577X (rs1815739) and ACE ID (rs1799752) gene polymorphisms were determined with polymerase chain reaction or polymerase chain reaction–restriction fragment length polymorphism analysis [5, 6].

### Survey on the duration of judo matches

We conducted a survey on the duration of judo matches with 13 instructors who taught judo to the study subjects. The survey asked the instructors to indicate the duration of the judo matches of the subjects (both winning and losing) at five levels: fast, relatively fast, neither, relatively slow, and slow. The speed to decide the outcomes of the matches was measured only in matches between college students. We told the instructors to consider both impressive matches and general matches comprehensively. If they had not seen the matches of certain subjects or did not remember them, we instructed them to choose “unknown”.

### Analysis and statistics

We included in our analysis only subjects who were identified in the survey responses of more than five instructors. We regarded the level chosen by the most instructors to be the match duration of the subject. When two different levels were chosen by the same number of instructors, we considered the duration to be “neither”. Then, we divided the subjects into two groups: a fast match-decider group (which included subjects with durations designated by the instructors as fast and relatively fast) and a slow match-decider group (which included subjects with durations designated slow and relatively slow).

We then compared the genotype frequencies of the groups by using the chi-square test. All statistical analyzes were conducted using the Statistical Package for the Ekuseru-Toukei 2012 (Social Survey Research Information Co. Ltd., Japan). The level of significance was set to  $p < 0.05$ .

## Results

Tables 1 and 2 show the genotype frequencies of the ACTN3 and ACE gene according to the duration of judo matches. The frequency of the ACTN3 gene polymorphism in winning matches in the fast match-decider group was 65.4% for RR and 34.6% for RX. The frequency of the ACTN3 gene polymorphism in the slow match-decider group was 4.8% for RR, 23.8% for RX, and 71.4% for XX. There were significant differences in the frequencies of the ACTN3 gene polymorphism between the two groups with respect to winning matches (Figure 1-A). No significant differences were found between the two groups with respect to losing matches (Figure 1-B). There were no significant differences in the frequency of the ACE gene polymorphism between the two groups in case of winning or losing matches (Figure 2-A, B).

## Discussion

This study is the first to examine the association between gene polymorphism and the duration of judo matches. The results indicate that the ACTN3 gene polymorphism, but not the ACE gene polymorphism, may be associated with the duration of judo matches. Athletes who are homozygous for the 577X allele of ACTN3 gene cannot produce alpha-actinin-3 protein in muscle [9], and the absence of this protein reduces strength, mass, and fast-twitch fiber diameter in human muscle. In a recent study, we found that ACTN3 gene polymorphism is associated with power in judo athletes but not with judo status or grip strength [1, 6].

**Table 1.** Genotype frequencies for ACTN3 gene divided into the duration of judo match

All	n	RR	RX	XX
	129	24 (18.6%)	64 (49.6%)	41 (31.8%)
In case of 'winning'				
Fast	5	5 (100%)	0 (0%)	0 (0%)
Relatively fast	21	12 (57.1%)	9 (42.9%)	0 (0%)
Neither	82	6 (7.3%)	50 (61.0%)	26 (31.7%)
Relatively slow	9	1 (11.1%)	3 (33.3%)	5 (55.6%)
Slow	12	0 (0%)	2 (16.7%)	10 (83.3%)
In case of 'losing'				
Fast	1	1 (100%)	0 (0%)	0 (0%)
Relatively fast	9	2 (22.2%)	3 (0%)	4 (0%)
Neither	81	16 (19.8%)	41 (0%)	24 (0%)
Relatively slow	12	1 (8.3%)	5 (0%)	6 (0%)
Slow	25	4 (16.0%)	14 (0%)	7 (0%)

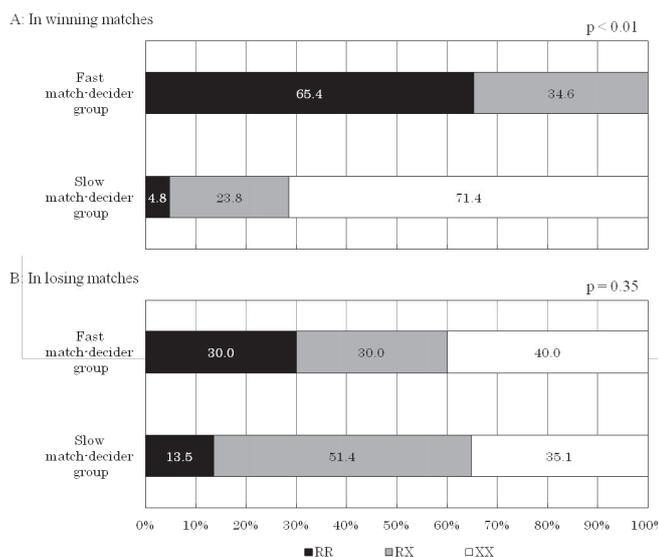
Competitive judo requires a high level of muscle power and muscle strength [7]. A meta-analysis provided evidence for the strong association between the ACE II genotype and endurance events in whites [12]. However, Tobina et al. [10] found no association between the ACE II genotype and endurance in elite Japanese runners. Thus, there are ethnic differences in the influence of

the ACE I/D polymorphism in Japanese and Caucasian controls.

The present study had limitations. First, the results were likely limited by the relatively small sample size of each group and low statistical power. Second, we were unable to measure the duration of judo matches. Moreover, the duration of judo matches may depends

**Table 2.** Genotype frequencies for ACE gene divided into the duration of judo match

All	n	II	ID	DD
	129	49 (18.6%)	57 (49.6%)	23 (31.8%)
In case of 'winning'				
Fast	5	2 (40.0%)	2 (40.0%)	1 (20.0%)
Relatively fast	21	10 (47.6%)	9 (42.9%)	2 (9.5%)
Neither	82	33 (40.2%)	36 (43.9%)	13 (15.9%)
Relatively slow	9	3 (33.3%)	4 (44.4%)	2 (22.2%)
Slow	12	1 (8.3%)	6 (50.0%)	5 (41.7%)
In case of 'losing'				
Fast	1	0 (0%)	1 (100%)	0 (0%)
Relatively fast	9	4 (44.4%)	3 (33.3%)	2 (22.2%)
Neither	79	32 (39.5%)	36 (44.4%)	13 (16.0%)
Relatively slow	12	3 (25.0%)	6 (50.0%)	3 (25.0%)
Slow	25	10 (40.0%)	10 (40.0%)	5 (20.0%)



**Figure 1.** Genotype frequencies for ACTN3 gene divided into two groups

on the skill level of opponents, kumite, and differences in weight and conditioning, and we did not control for these variables in our analysis.

Genetic factors may be worth considering when selecting strategies and tactics for judo instruction in the future. The results of this study present a possible explanation for the observations reported by judo instructors with respect to the duration of judo matches.

**Conclusions**

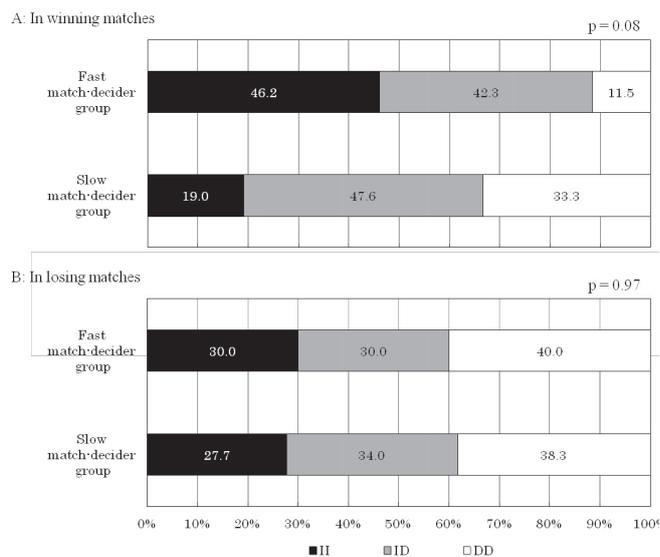
The purpose of this study was to investigate the association between the ACTN3 R577X and ACE I/D gene polymorphisms and the duration of judo matches. We found that the ACTN3 gene polymorphism, but not the ACE gene polymorphism, may be associated with the duration of these contests.

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**Figure 2.** Genotype frequencies for ACE gene divided into two groups

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