

Genetic polymorphisms related to muscular strength and flexibility are associated with artistic gymnastic performance in the Japanese population

Hiroshi Kumagai^{1,2}, Tomoko Kaneko³, Yuko Shintake^{1,4},
Eri Miyamoto-Mikami¹, Hiroyuki Tomita¹, Makoto Fukuo¹,
Wataru Kawai¹, Mutsumi Harada¹, Naoki Kikuchi⁵,
Nobuhiro Kamiya⁶, Kosuke Hirata⁷, Hirofumi Zempo⁸,
Seiji Maeda^{4,7}, Naokazu Miyamoto¹, Noriyuki Fuku¹

¹ Juntendo University. ² University of Southern California. ³ University of Tsukuba. ⁴ University of Tsukuba.

⁵ Nippon Sport Science University. ⁶ Tenri University. ⁷ Waseda University. ⁸ Tokyo Seiei College..

Abstract

This study aimed to examine how genetic polymorphisms related to muscular strength and flexibility influence artistic gymnastic performance in an attempt to identify a novel polymorphism associated with flexibility.

In study 1, the passive straight-leg-raise (PSLR) score and aromatase gene *CYP19A1* rs936306 polymorphism, a key enzyme for estrogen biosynthesis, were assessed in 278 individuals. In study 2, athletes (281 gymnasts and 1908 other athletes) were asked about their competition level, and gymnasts were assessed using the difficulty score (D-score) for each event. Muscular strength- (*ACTN3* R577X rs1815739 and *ACE* *IID* rs4341) and flexibility-related (*ESR1* rs2234693 T/C and *CYP19A1* rs936306 C/T) genetic polymorphisms were analyzed.

In study 1, males with the *CYP19A1* CT + TT genotype showed significantly higher PSLR scores than those with the CC genotype. In study 2, male gymnasts with the R allele of *ACTN3* R577X showed a correlation with the floor, rings, vault, and total D-scores. In addition, male gymnasts with the C allele of *ESR1* T/C and T allele of *CYP19A1* C/T polymorphisms were correlated with the pommel horse, parallel bars, horizontal bar, and total D-scores. Furthermore, genotype scores of these three polymorphisms correlated with the total D-scores and competition levels in male gymnasts. In contrast, no such associations were observed in female gymnasts.

Our findings suggest that muscular strength- and flexibility-related polymorphisms play important roles in achieving high performance in male artistic gymnastics by specifically influencing the performance of events that require muscular strength and flexibility, respectively.

Highlights: Estrogen-related *CYP19A1* polymorphism is a novel determinant of flexibility in males. Muscular strength- and flexibility-related polymorphisms play important roles in high performance in male artistic gymnastics. Genotypes of *ACTN3* R577X, *ESR1* rs2234693, and *CYP19A1* rs936306 may contribute to training plan optimization and event selection in artistic gymnastics.