

Gene transfer technology to improve athletic performance

Farzad Nobakht*¹ & Fatemeh Meamarbashi²

1. Assistant professor in sport marketing & entrepreneurship, Department of Physical Education and Sport Science, University of Mohaghegh Ardabili, Ardabil, Iran

2. BSc student in cellular and molecular biology, Faculty of Basic Science, University of Mohaghegh Ardabili, Ardabil, Iran

ABSTRACT

In recent years there has been a great advancement in molecular biology techniques, which enabled the researches on influence of genetics on human performances in particular athletic performance. The role of genetic in sport has been discussed and ethical issue is considerable for every one that uses this technology to enhance sport performance. Talent identification, injury susceptibility and success in this field are the positive role but there is challenge to detect gene cheating. This report is a big question for technology developer to understand the end of this field and preventing any abuse of science in gene doping.

Keywords: Gene, Athlete, Gene Doping, Exercise performance.

Introduction

Current advances in biotechnology and molecular biology techniques have facilitated a rapid increase in the identification of structural genetic variations capable of exerting some influence on the phenotypes related to athletic performance [8]. Gene transfer is a technique to effectively and stably introduce foreign genes into the genome of target cells and then produce of the protein encoded by the gene. Currently, there are a number of available gene transfer technologies. Gene doping is the non-therapeutic use of genes, genetic elements and/or cells that have the capacity to improve athletic performance. World Anti-Doping Agency (WADA) and International Olympic Committee (IOC) warned about gene doping by some athletes and coaches. WADA states that the best way to combat with this issue is combination of regulation, education and research. Misuse of gene transfer technology in sport may lead to misuse of this technology for doping [8].

Gene doping would involve the use of gene transfer to increase or decrease gene expression and protein biosynthesis of a specific human protein. This method could be implemented by directly injecting the gene carrier into the person, or by taking cells from the person, transferring the cells, and administering the cells back to the person [5]. Two gene variants, *ACE I/D* and *ACTN3 R577X*, have been consistently associated with endurance (*ACE I/I*) and force generation (*ACTN3 R/R*) performance [3].



Table 1. Gene and athletic performance researches.

Researcher	Findings
Montgomery HE, Marshall R, Hemingway H, et al,1998 Rigat B, Hubert C, Alhenc-Gelas F, et al.1990 Puthucheary Z, Skipworth JRA, Rawal J, et al. 2011 Scott RA, Moran C, Wilson RH, et al. 2005 Ma F, Yang Y, Li X, et al. 2013 Chiu L-L, Wu Y-F, Tang M-T, et al. 2011	The ACE I/I genotype was specifically associated with performance in endurance, but not power, athletes, supporting the general consistency in the literature for an association of ACE I/D genotype with endurance performance [4,7,10-12]. The association of the ACTN3 genotype with performance has also been studied in children. Boys with ACTN3 RR genotype tended to swim faster (25m and 100m)
Pompeo N. 2011	Identification of promising athletes at a young age allows for an earlier adoption of dedicated training [1]. Most coaches, parents, and athletes lack the scientific background required to understand the limitations of these tests or the implications of the results. However, some professional sports teams are already using the results of these tests to partially direct training prescriptions [9].
Vlahovich N, Fricker PA, Brown MA, et al. 2017	There are, however, valid roles for genetic research and the AIS supports genetic research which aims to enhance understanding of athlete susceptibility to injury or illness. Genetic research is only to be conducted after careful consideration of a range of ethical concerns which include the provision of adequate informed consent [13].
McCrorry P. 2003	The threat of gene transfer technology to elite sport [6].

Australian Institute of Sport on genetic research and testing of Australian athletes adopted some positions to prevent none ethical issue in talent identification.

- Athletes have the right to decline a genetic test.
- There will be no discrimination against athletes who decline genetic testing.
- The management of, and confidentiality pertaining to, genetic testing results will be clearly articulated to the athlete, prior to the participation in research.
- The results of genetic testing will remain confidential unless otherwise explicitly stated.
- Genetic testing for the purpose of research in sport will not be conducted on athletes under the age of 18 years.
- Athletes participating in genetic research have the right to withdraw from research at any time and/or have all of their material and/or results destroyed at any time during the process of testing or research.
- Athletes participating in genetic research have the right to have their material and/or results sent to a third party.
- Genetic testing for research in athletes will involve the least invasive method of sample collection required to deliver the research outcomes.
- Genetic manipulation will not be used for performance enhancement.
- Direct-to-consumer genetic testing in relation to sports performance is strongly discouraged.
- Genetic testing will not be used to include or exclude athletes from a high-performance program.
- Genetic testing will not be used as a method of talent identification.
- Directing evidence-based interventions to reduce injury and improve health is a legitimate and valid use of genetic information.
- Clear guidelines must define the dissemination of genetic information before a research study or testing regimen is started.

Conclusion

Gene doping or gene transfer technology to improve athletic performance heralds a significant threat to the integrity of anti-doping initiatives [6]. Difficult future of Olympic and antidumping policies is inevitable. Genetic technology in other field is challenging issue too. So researching should be limited to predicting performance and prevention is essential for cheating. Detecting gene cheating technology is critical for Olympic and other sport organization.

Researchers, athletes and coaches should be conscious about the implications of the misuse of the genetic information and gene doping.

References

1. Chiu, L.L., Wu, Y.F., Tang, M.T., Yu, H.C., Hsieh, L.L. & Hsieh, S.S. *ACTN3 Genotype and Swimming Performance in Taiwan*. International journal of sports medicine. 2011; **32**(06):476–80.
2. Danser AH, Schalekamp MA, Bax WA, van den Brink AM, Saxena PR, Riegger GA & Schunkert H. *Angiotensin-converting enzyme in the human heart. Effect of the deletion/insertion polymorphism*. Circulation. 1995; **92**(6):1387–8.
3. Guth, L. M., & Roth, S. M. *Genetic influence on athletic performance*. Current Opinion in Pediatrics, 2013; **25**(6), 653–658.
4. 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), e54685.
5. Momaya A, Fawal M & Estes R. *Performance-enhancing substances in sports: a review of the literature*. Sports Medicine. 2015; **45**(4): 517–531.
6. McCrory P. Super athletes or gene cheats? British Journal of Sports Medicine 2003; **37**(3): 192-193.
7. Montgomery, H. E., Marshall, R., Hemingway, H., Myerson, S., Clarkson, P., Dollery, C. & Thomas, E. L. *Human gene for physical performance*. Nature. 1998; **393**(6682):221–2.
8. Ostrander EA, Huson HJ, Ostrander GK. Genetics of athletic performance. *Annual review of genomics and human genetics*. 2009; **10**:407-29.
9. Pompeo N. *DNA to Play: Major League Baseball's Use of DNA Testing on Central and South American Prospects in the Age of the Genetic Information Nondiscrimination Act of 2008*. Health Matrix Clevel. 2011; **21**(2):627–53.
10. Puthuchery, Z., Skipworth, J. R., Rawal, J., Loosemore, M., Van Someren, K., & Montgomery, H. E. *Genetic influences in sport and physical performance*. Sports medicine, 2011; **41**(10), 845-859.
11. Rigat B, Hubert C, Alhenc-Gelas F, et al. *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.
12. Scott, R. A., Moran, C., Wilson, R. H., Onywera, V., Boit, M. K., Goodwin, W. H., & Pitsiladis, Y. P. *No association between Angiotensin Converting Enzyme (ACE) gene variation and endurance athlete status in Kenyans*. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 2005; **141**(2), 169-175.
13. Vlahovich, N., Fricker, P. A., Brown, M. A., & Hughes, D. *Ethics of genetic testing and research in sport: a position statement from the Australian Institute of Sport*. British journal of sports medicine, 2017; **51**(1), 5-11.

Corresponding Author: Farzad Nobakht, Department of Physical Education and Sport Sciences, University of Mohaghegh Ardabili, Ardabil 5619911367, Iran. Email:nobakht.farzad@yahoo.com.