

Gene transfer technology to improve athletic performance

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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 Puthuchery 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].
Pompeo N. 2011	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)
Vlahovich N, Fricker PA, Brown MA, et al. 2017	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].
McCrorry P. 2003	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]. 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.

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چکیده فارسی

فناوری انتقال ژن برای بهبود عملکرد ورزشی

فرزاد نوبخت و فاطمه معمارباشی

پیشرفتهای اخیر در زمینه فناوریهای زیست‌شناسی مولکولی موجب شده تا محققان بتوانند تاثیر ژنتیک را بر عملکرد ورزشی مورد بررسی قرار دهند. نقش ژنتیک در ورزش سالهاست که مورد بحث قرار گرفته و نکات اخلاقی آن برای کاربرد این فناوری در بهبود عملکرد ورزشی مورد توجه قرار گرفته است. استعدادیابی، مستعد بودن به آسیبهای ورزشی و نیز موفقیت در عرصه‌های ورزشی نقش مثبت علم ژنتیک در ورزش هستند اما چالش فرارو دوپینگ و استفاده کاذب از این علم است. این مقاله سوال اساسی را برای محققین و استفاده‌کنندگان از فناوری ژنتیک در خصوص افق فرارو و چگونگی پیشگیری از سوءاستفاده از علم ژنتیک و انتقال ژن را برای دوپینگ ژن مطرح می‌سازد.

واژه‌های کلیدی: ژن، ورزشکار، دوپینگ ژن، عملکرد ورزشی.