Letter to the editor: Are the doors opened to a genetic-based algorithm for personalized resistance training?

AUTHORS: Monnerat-Cahli G[1*], Paulúcio D[2,3*], Moura Neto RS[4], Silva R[1], Pompeu FAMS[2,3], Budowle B[5,6], Santos CG[1,7]

[1] Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro
[2] Pós-Graduação em Educação Fisica, Escola de Educação Fisica e Desportos, UFRJ
[3] Laboratorio de Biometria, Escola de Educação Física e Desportos, UFRJ
[4] Instituto de Biologia, Universidade Federal do Rio de Janeiro
[5] University of North Texas - Health and Science Center, Molecular and Medical Genetics
[6] Center of Excellence in Genomic Medicine Research (CEGMR), King Abdulaziz University, Jeddah, Saudi Arabia
[7] Instituto de Biologia do Exército - IBEx

*These authors contributed equally to this work

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Corresponding author:
Caleb Guedes Santos
Instituto de Biologia do Exército - IBEx
Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro
E-mail: calebguedes@gmail.com

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COMMENT

Professional athletes, amateur athletes, and people in general benefit from routine exercise, barring some health conditions that would put people at health risk. However, obtaining the greatest benefit by applying precision medicine is beginning to become a reality, in which the type of resistance training with the greatest benefit is dictated based on the genotype of an individual. Studies involving physical training based interventions and the possibility of different responses depending on intra-individual characteristics represented by genetic polymorphisms have been described. Classic twin studies that presented heritability rates associated with performance in various sports disciplines support the value of genetics in determining the response to different forms of resistance training [1]. Next, important and well-controlled family genetic studies (HERITAGE) demonstrated how heredity could impact the capacity of sedentary individuals to respond to controlled training, contributing to the important concept of trainability [2–4]. However, deciphering the genetic influence among the many candidate genes proved to be very difficult. Simultaneously, advances in molecular detection techniques enabled a series of studies that linked genetic polymorphisms and their molecular phenotypes involving proteins, enzymes, cofactors and cell or DNA damage [5–9]. Those phenotypes showed different responses to physical training in relation to trained or untrained individuals. Additionally, numerous trials involving physiological responses such as hypertrophy, energy expenditure, vasodilation, cardiac output, VO_2max, and recovery [10–15] supported the possibility of genomic predictors impacting trainability.

In recent years, the heritability of muscle phenotypes has been studied extensively, particularly the nonsense polymorphism in the gene ACTN3, its distinct physiological phenotypes and its associations with endurance and sprint/power elite sports activities [16,17]. To better identify genetic contributions, larger, well-defined samples were needed, and some consortia were formed such as FAMuSS. Studies rely on these resources to obtain data related to the response to interventions related to exercise [18,19]. Indeed, the possibility to identify genes and their allelic states that could determine which individuals would perform better in some sports disciplines brought the concept of genetic scores based on a personal genetic profile [20].

In addition, recently, the advances in genetic technologies have substantially improved the knowledge and applications in field athletic performance. The next generation sequencing (NGS) technologies, as well as DNA microarrays and genome-wide association studies (GWAS), have improved the coverage, quality and throughput of the sequencing of the human genome, leading to an impressive increase of the knowledge in genomics applied to sports science. The ready access of high throughput genetic analyses has fomented novel evaluations of multiple regions of the genome and its gene expression. Distinct genomic expression in response to different training has given important support of the value of potentially involving individual physical training and individual genomics. Furthermore, molecules, such as miRNAs and lncRNAs [21,22], and epigenetic modifications, which also are a result of the advances

of genomics-related technologies, are very promising when applied to the personalization of physical training [23].

Approaches involving training responses and a few variants already have been presented and revised [24–26]. However, Jones et al. [27] were the first to present the application of genetics to different customized training interventions, using genetic profiles in which a score was given for each allele based on the cumulative literature reports about polymorphisms (Figure 1). Although several genetic polymorphisms have been associated with particular physiological phenotypes, changes in metabolic pathways molecularly measured or even considered in silico using bioinformatic tools [28], evaluation of a multigenic prior genetic profile had never been used as a variable of physical training itself [29]. The aim of the authors was to compare the chronic effects of strength training using high or low intensity aerobic performance and power programmes, for athletes with power/endurance genotypes. Their results are quite interesting and may have applicability in training programmes, especially in team sports in which these physical attributes are decisively important for ultimate performance. The results of Jones et al. [27] strongly support the hypotheses cited in the study, validating the algorithm created by the group.

While respecting the ethical aspects related to the proposed genetic predisposition to performance which is discussed in the consensus on "direct-to-consumer" genetic testing [30], the potential to benefit from specific training and/or perform athletically is in part due to individual features with a well-established genetic component. The use of genetics to prescribe an exercise regimen could allow an individual to reach his/her highest potential. Thus, it is likely the doors will open for new studies correlating in a direct way "molecular concepts" and sports. From this initial approach, groups working with large cohorts of athletes, as well as recent international consortia formed as "The athlome consortium" "GENATHLETE" or "GAMES" [31], could include a prior genetic profiling to prescribe

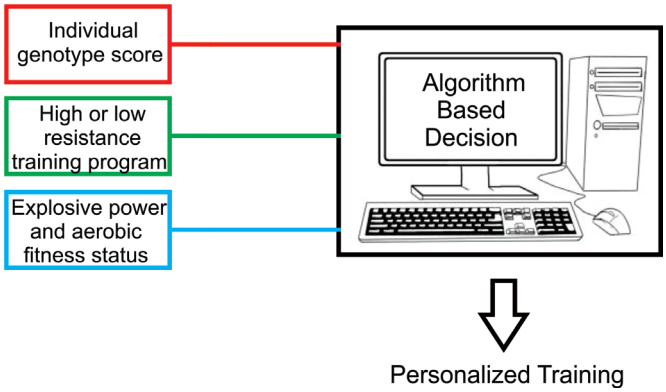

FIG. 1. Genetic based algorithm for Personalized Training

training programmes and continue to validate and refine candidate genes that provide the best positive predictive value.

All researchers in genomics of exercise have worked diligently to contribute to supporting the genetic component that now could be used for precision athletics. Thus, the results described by Jones et al. [27] open doors to new research and applications using personalized exercise training programmes and personal scores based on genetic variability. Possibly, additional and novel polymorphisms investigated in larger cohorts as well as applying total load equalization of physical training will help to better understand the influences of training protocols in relation to individual genetic profiles and contribute to new discoveries. A genuine assessment of genetic influences demands greater methodological rigor as the specifications and protocols relating to physical tests become more readily used and the field of genetics and physical training matures.

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