Journal of Yoga and Physical Therapy

Sonksen, J Yoga Phys Ther 2019, 9:1
DOI: 10.4172/2157-7595.1000293

Commentry Open Access

The Determination and Regulation of Body Composition in Elite Athletes

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Received date: November 06, 2018; **Accepted date:** January 05, 2019; **Published date:** January 12, 2019

Abstract

There is much misunderstanding about the important issues regulating adult body composition in man and in particular elite athletes. History and science have clearly documented the key role played by breeding and inheritance. Spontaneous medical conditions have provided further insight into other important factors through 'nature's experiments' such as isolated growth hormone or testosterone deficiencies or excess. The androgen insensitivity syndrome illustrates the key role of testosterone in utero, in determining the male phenotype. In this condition where a mutation that inactivates the testosterone receptor leads to the birth of a phenotypically 'normal' female baby (who matures into a normal but infertile woman) despite having XY chromosomes, testes and a high testosterone level. Misunderstanding of these complex issues has led to the introduction of nonsensible rules in elite sport.

Keywords Body composition; elite sport; genetics; breeding, hormones; growth hormone; testosterone

Introduction

In 2011 the IAAF and IOC introduced a 'hyperandrogenism' rule that excluded women with a serum testosterone greater than 10nmol/l from participating in elite sport. This rule was based on the false premise that the greater lean body mass in men was solely a consequence of their higher serum testosterone. This rule did not have scientific backing and the Court of Arbitration for Sport subsequently rescinded the rule following an appeal from an Indian athlete barred from the Commonwealth Games. This review [1] covers the scientific knowledge about the development and regulation of body composition in humans but also considerers the lessons learnt from evolution and breeding in animals over countless generations. The importance of genes and heredity has been well-documented in animals, for example the breeding of race horses and cattle [2] such as the Belgian Blue which has a mutated gene for myostatin (Figure 1), a protein which as its name implies, normally limits muscle growth.

Figure 1: Belgian Blue, the super cow.

There are as well studies of families and twins where classical anthropomorphic measurements clearly demonstrated the importance of inheritance [3]. The roles of growth hormone and sex-steroids are reviewed and the essential role of growth hormone illustrated dramatically by the stature of people with genetically-determined isolated growth hormone deficiency [4].

Figure 2: Mercy Lavinia Warren Bump: A girl with growth hormone deficiency.

Growth hormone is essential for achieving normal height. Families with isolated growth hormone deficiency like those illustrated above (Figure2), rarely achieve height greater than 48 inches (122 cm) but are otherwise perfectly proportioned. They respond well to treatment with growth hormone and can reach normal adult height if the diagnosis is made at a young age and if given appropriate replacement with growth hormone.

The Androgen Insensitivity Syndrome (AIS) may also be considered as nature's model illustrating the role of testosterone in the development of body composition [5]. Here the foetus, in the absence of any testosterone action as a consequence of a mutation in the testosterone receptor, develops as a phenotypically normal girl and despite lack of testosterone action develops a normal height and lean body mass. Women with this condition are over-represented amongst elite athletes, they have high circulating testosterone levels but because of the mutation in the testosterone receptor, they are unable to benefit from it. This condition also provides evidence of the importance of other factors carried on the Y-chromosome that are of prime importance in regulating body composition but have been systematically ignored [6]. Finally, the key factors determining body composition are considered and placed in a suggested order of importance (Figure3).

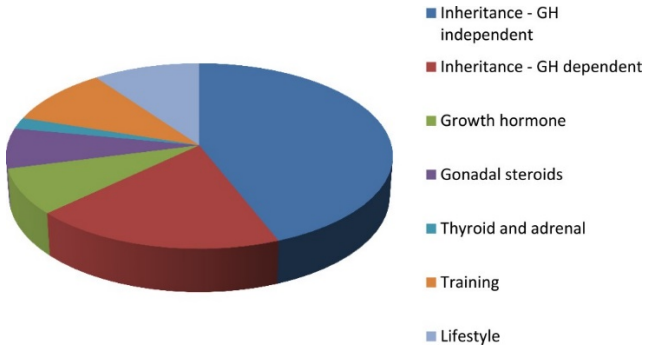

Figure 3: A subjective assessment of the relative importance of factors determining body composition in an elite athlete. GH (growth hormone).

Conclusion

There is a misunderstanding about the key factors regulating body composition in elite athletes with too much credence being given to testosterone and this has led to the introduction of scientifically unsupportable rules that infringe basic rights.

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