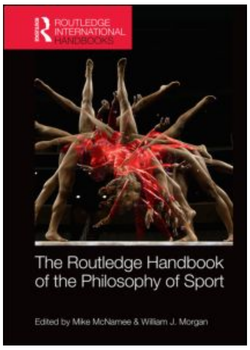

Routledge Handbook of the Philosophy of Sport

Mike McNamee, William J. Morgan

Bioethics and Sport

Publication details
https://www.routledgehandbooks.com/doi/10.4324/9780203466261.ch6
Silvia Camporesi
Published online on: 27 Mar 2015

6
BIOETHICS AND SPORT

Silvia Camporesi

Elite sport has long been the laboratory for the introduction of biomedical technologies aimed at health optimization and performance enhancement (Hoberman 1992). In parallel, the body of the elite athlete has been the locus of experimentation of these technologies. Now, more than ever, with the advancement of biomedical technologies, elite sport is an arena where ethical questions are raised by the application of these technologies to the human body. Such questions arising at the intersection of elite sport and ethics are addressed in this chapter.

This chapter is divided into five sections: direct-to-consumer genetics for talent identification in sport; issues of confidentiality, disclosure and conflict of interest in sport medicine (including examples of return to play issue); gender issues in sport, specifically the case of Caster Semenya and subsequent discussion of the guidelines for eligibility with women with hyperandrogenism; the role played by technology in the Paralympics: essential for performance, or performance enhancement? I conclude with a discussion on future directions for research at the intersection of sport and bioethics. I eschew discussion of doping (see Chapter 21) and genetic technologies (see Chapter 23) that are discussed elsewhere in this volume.

Direct-to-consumer genetics for talent identification in sport

In the last 5 years, the United States has witnessed a boom of direct-to-consumer (DTC) companies that sell online genetic tests for sports performance or related traits. At least seven companies, including X Factor Sports Training, Atlas Sports Genetics, Geneffect and another company aptly named Warrior Roots, are available on the internet (Roth 2012). The prices for these tests vary between US$80 and US$200. These affordable prices have been made possible by the ever-increasing lower cost of whole-genome sequencing, which in turn was made possible by the new developments in sequencing approaches usually referred to as the 'next generation sequencing'.

It is not exactly clear how many people use these tests, because such data are proprietary (Brooks and Tarini 2011) but we can speculate that (at least) several thousand parents and coaches use them. The products offered vary. Some companies test for a group of what they call 'performance-enhancing polymorphisms' (PEPs), others only for one trait (Koboldt *et al.* 2013). Each of them tests for the alfa-actinin 3 (ACTN3) polymorphism, which was the first PEP to be demonstrated to have an association with the formation and function of skeletal muscles. Yang *et al.* (2003) found that both male and female elite sprinters have a significantly higher frequency of the functional 477R genotype, where R stands in place of an arginine 'R' rather than a stop codon in the ACTN3 gene. Alfa-actinin belongs to a large family of actin-binding proteins, where actin is a fundamental component of the contractile unit of muscle fibres. Polymorphism in ACTN3 is thought to contribute to the heritability of fibre-type distribution in the muscle, where type-I muscle fibres are slow-twitch fibres that use aerobic metabolism and are used in endurance races, whereas type-II muscle fibres are fast-twitch fibres that use anaerobic metabolism to create energy and are used in sprints (Berman and North 2010).

The test for the 'ACTN3 sports gene' is sold as a genetic 'power and speed performance test' and, as we can read on the website of Atlas Sports Genetics,[1] with the aim of giving 'parents and coaches early information on their child's genetic predisposition for success in team or individual speed/power or endurance sports'. They suggest that the results of the tests will be 'valuable in outlining training and conditioning programs necessary for athletic and sport development'. As argued by Caulfield (2011), these tests are examples of the widespread phenomenon of the exploitation of science or, using his neologism, of 'scienceploitation', defined as the 'exploitation of legitimate fields of science and, too often, patients and the general public, for profit and personal gain' (Caulfield 2011: 4). A case in point for scienceploitation: the tests for ACTN3 variant claim to assess the predisposition to athletic ability and prowess, whereas the ACTN3 gene accounts for only two per cent of the total variance in muscle performance (Eynon *et al.* 2011). There is also a general remark to be made about the wide discrepancy between the aim of research into genetics and sports and the claims that these DTC companies typically make. On the one hand, the aim of research in genetics and sport is to identify the influence of genes within the performance environment, whether it is in determining risk of injuries or indicating predispositions to talent. On the other hand, we saw above what kind of far-fetched claims certain companies are making about the predictive power of their tests. This shift from experimental or therapeutic applications (the aim of research in genetics and sport) to enhancement intervention (the aim of the DTC genetic tests for athletic performance) must address substantial scientific problems, not least the extrapolation of data obtained under different experimental designs. Aggressive marketing claims like those made by DTC companies represent a clear overstatement of the predictive ability of the tests. Moreover, the tests offered by DTC companies do not address the problem of 'externality' – the fact that the results obtained on a set of subjects (for example, elite athletes in the case of ACTN3) are being applied to a completely different set of subjects; that is, children. Profound as these epistemological challenges are, there are yet more problems with these tests. Although many genes and allelic variants have been tentatively associated with performance-related traits, these associations have not reached a conclusive level. As Roth (2012) pointed out: 'This is not a judgment against the existing science, but rather a recognition of the infancy of the field of exercise and sports performance genomics' (Roth 2012: 250). Moreover, these tests pose the potential problem of false negatives, with unwarranted exclusion of individuals from certain sports on the basis of the results of these tests. Moreover, genetic tests for predictive purposes, such as talent identification for performance, are potentially in breach of the Council of Europe's Bioethics Convention Article 12 (McNamee *et al.* 2009: 341). The European Society of Human Genetics (ESHG) has also expressed concerns regarding the possibly inadequate consent process in which individuals are enrolled in research conducted by the DTC companies with their samples or data. The ESHG recommends that a separate consent procedure different from the consent procedure for research should be implemented (European Society of Human Genetics 2010). In addition, there are specific problems of confidentiality and consent in elite sports medicine, also highlighted by McNamee *et al*. (2009) and by Rudnik-Schoeneborn (2012):

> Following the guidelines of the ESHG commercially available tests for genetic variants in the context of general health purposes, lifestyle and sport performance should only be offered if the clinical utility and validity of the analysis is proven, if informed consent is given, and if privacy and confidentiality are secured
>
> *(Rudnik-Schoeneborn 2012: 17)*

It seems, therefore, that these kinds of tests present scholars, scientists, policymakers and practitioners (such as coaches) serious food for thought concerning the meaning and significance of sports for children, especially elite sports and talent development systems. Youth sports should not be framed exclusively as goal-directed activities (directed to victory). Sports at developmental levels must be understood differently from what it is for the amateur or professional athlete. The meaning of sport for the child must be pluriform: to stay healthy, to enjoy the company of friends, to enjoy the discovery of the possibilities of one's own body, to learn how to relate with a team, to learn the importance of rules, and so on (Sherwin 2007, Sandel 2009). It does not have to be, nor should it necessarily be, related to talent scouting and talent development (Camporesi 2013).

Issues of confidentiality, disclosure and conflict of interest in sport medicine

Elite athletes find themselves at the nexus of a web of interest that has repercussions for traditional issues in clinical research as they are translated to elite sport context, such as confidentiality, disclosure, and conflict of interest (Nixon 1993). At the core of these discussions seems to be the concept of the conflict of interest, which is explicated in different manifestations, as rehearsed below. Conflicts of interest originate when the athlete's short-term health, their ability to compete and their long-term health are not promoted by the same medical intervention.

Disclosure and confidentiality

In sports medicine, a distinction needs to be made between an athlete's personal physician, a team physician, a physician performing a pre-contract fitness test and a national team physician, although at times these roles are represented in the same person (Holm *et al*. 2011). For example, the team doctor is an agent of the club or team and, as such, has a contract and duties towards the team. Sports doctors are *de facto* employees (of the team, of the athletes) and athletes find themselves at the centre of a conflict of interest between the ethical norms of the medical profession (the patient's best interests first) and the ethical norms of sport medicine (excellence, victory first), where often short-term-health goals, such as a too-swift return to play are privileged over long-term health goals. In addition, more often than not, the athlete's income is controlled by their employer (team, sponsor) and the degree of control that the athlete has over the decision to play or compete may be very limited (Holm 2007).

While, in most cases, the dual nature of the obligations of the sports doctor (towards the athlete and towards the team) is understood by the athlete, there may be cases in which sensitive information is disclosed by the athlete to the sports doctors who find themselves then in a conflict between the duty of care towards the athlete and the duty to disclose sensitive and relevant information to the team doctor. Anderson *et al*. (2008) reports that 50 per cent of the doctors in their survey thought that their duty of care towards the athlete was the overriding consideration, and decided not to disclose this sensitive information to the team, therefore *de facto* breaching their contractual obligations to their employer. It seems that there is no consensus on what doctors should do in such conflict of interest dilemmas, which seem to be unavoidable in the current structure, where the sports physician is employed by the team or club and, as such, has an obligation to them. One possible solution, at least to make things more transparent, is the proposal put forward by (Holm *et al*. 2011), who suggested that the contract between athlete and club should always contain information about disclosure.

According to Holm (2007), the only possible long-term solution to the conflict of interest dilemmas inherent in elite sport is a drastic change in the economic and financial relations in the sport matrix. Such changes would ensure that sports physicians would no longer find themselves in the position of being employed by a team or sport association, and that the athletes would consequently not find themselves torn between their long-term health goals and their short-term gains for the team and for their athletic career. Even in this changed sport matrix, though, there would still be incentives to keep at least some unethical practices secretive to preserve exclusive use and competitive advantage. I discuss a possible solution to this problem in the final section of this essay. Another possible solution in this vein would be not only to have a contract between the sports physician and the team or club and the athlete and the team or club but also between the sports physician and the athlete, thus leaving less room for misunderstandings.

Concussions and return to play issues

Cases of athletes who opt for a swifter return to play at the expense of their long-term health are countless. One recent example is Kobe Bryant of the Los Angeles Lakers, who recently publicly challenged teammate Dwight Howard to play through a torn labrum in his shoulder: 'We don't have time for [Howard's shoulder] to heal', said Bryant.[2] Cases like these abound because high-performance athletes are focused more on their athletic achievements now than their future health status later. They adopt therefore a 'win at all costs attitude' as described by Krumer *et al*. (2011) that discounts future health for current athletic success (Camporesi and Knuckles 2014).

There is more than one ethical issue at stake in return to play considerations. One hinges on the respect of the patient's autonomy: to what degree should we let athletes exercise their autonomy and make decisions that could potentially be very harmful for their long-term health? How much risk taking is to be afforded to individuals in the context of elite sport? Are there specific reasons intrinsic to the context of elite sport for which we should limit the rights of athletes to accept risks? It should of course be stressed that decisions of return to play are often taken under a considerable pressure and, in the short-term, athletes may feel like they have no other choice but to return to play as soon as possible to avoid jeopardizing their future career. This point brings us back to the discussion of discounting future health for short-term gains. What is the role of the sport physician in a case where athletes should not return to play for their own benefit, but there is a pressure from the team or club for them to do so?

One issue that has been much discussed is when athletes may return to play safely following concussions. This is an especially serious issue because of a possible link between concussions and chronic traumatic encephalopathy or early dementia in former elite football players, hockey players and elite wrestlers. American football has been at the centre of a strident public debate in the last couple of years, owing to the recent wave of suicides among college footballers after concussion-related permanent traumatic brain injury, also known as chronic traumatic encephalopathy (CTE).[3] Concussion is defined as an event that occurs when the brain hits against the skull as a consequence of the application of force (Hecht 2002), although, as McNamee and Partridge (2013) have shown, while several global concussion statements have been issued, there is lack of universal consensus on concussion management, owing to the absence of a universal definition for concussion or mild traumatic brain injury and the presence of conflicts of interest, which have been noted above.

CTE is also referred to as 'dementia pugilistica', because elite boxers were the first known to develop the syndrome following repeated blows to the head.[4] In CTE, repetitive trauma initiates progressive degeneration of the brain tissue. The abnormal form of the protein tau, also found in Alzheimer's disease-affected individuals, is also found to accumulate in the brain of individuals with CTE. These pathological anatomical changes in the brain do not start taking place immediately after concussion but, typically, years after the last brain trauma or at the end of athletic career reference. The degeneration of the brain is associated with a plethora of symptoms – from progressive memory loss to impaired judgment, impulse control problems (often manifested as aggressive behaviour), depression and finally to dementia (McKee *et al*. 2009). In addition to these difficulties, there is no treatment and no definitive pre-mortem diagnosis, as the only definitive diagnosis is made at autopsy (Saulle and Greenwald 2012). By the end of 2012, thousands of former elite football players had been filing lawsuits against the US National Football League (NFL) accusing the League of hiding information about the long-term harms derived from concussions on the field of play.[5]

As in all diseases, genetic factors also contribute to the development of CTE. In particular, the apolipoprotein epsilon 4 allele (ApoE4) has been strongly associated with Alzheimer's disease and is now thought to have a possible role in the development of CTE (McKee *et al*. 2009) In an editorial, Gandy and DeKosky (2012) raise the question of whether screening for ApoE4 allelic variant could help to identify individuals at a higher risk of developing CTE following concussions either on the field of play (for athletes) or on the battlefield (for military personnel). They also conducted a preliminary survey among experts in the fields of Alzheimer's disease, traumatic brain injury and CTE regarding the value of introducing ApoE genotyping. The consensus resulting from the poll was clear: most of the interviewees agreed that it was premature to introduce ApoE genotyping, for several reasons. These included the lack of a systematic registry, screening or genotyping of at-risk individuals and the fact that most existing data on ApoE4 and dementia risks are healthy controls in their mid to late life, so these results could be extrapolated to athletes at risk of CTE, whose exposure may begin during adolescence (Gandy and DeKosky 2012). Savulescu and Foddy (2005: 29) have criticized the value of mandatory screening on the basis of its illiberality: 'We should educate, not involuntary test or restrict the freedom to choose what we do with our lives, including what risks we take'.

There is need for a much more substantive ethical discussion of concussion in sport, as argued by McNamee and Phillips (2011) and McNamee and Partridge (2013). The uncertainty of the safety of return-to-play decisions after a concussion needs to be recognised and disclosed to the player-patient. It is possible that only the threat of mass torts (as they are continuing in the USA from former NFL players) will drive a change in attitudes in elite sport. Policy and practice changes must be confronted by, for example, NFL rules regarding lawful head contact (e.g. in tackling) and helmet design and other prevention strategies. This will not be easy. In contact sports such as American football, ice hockey or rugby, 'hard hits and head collisions are more than simple aspects of the game; they are part of the sports' identity' as put by Saulle and Greenwald (2012: 7) and also a facet of marketing and media commodification. A successful prevention strategy requires a complex approach involving all stakeholders – from coaches, to players, to team doctors, to referees and the public (Saulle and Greenwald 2012) In addition, as noted by Goldberg (2009), 'No helmet can prevent the brain from striking the interior of the cranium upon the application of adequate force'. But, unless the 'culture' of these sports is changed from within, and athletes do not feel that they have to act as heroes and be 'patched up' for competition disregarding completely their future health, nothing is going to be changed.

Gender issues in sport: a critique of IAAF and IOC policies on hyperandrogenism[6]

Following the debacle surrounding Caster Semenya's case (Camporesi and Maugeri 2010), on 1 May 2011, the International Association for Athletics Federation (IAAF) issued its new policies on the eligibility of female athletes to compete in the female category (International Association for Athletics Federation 2011), although the Federation claimed that they were not specifically aimed at Caster Semenya. To briefly rehearse her case, in August 2009, Caster Semenya, the then 18-year-old South African runner, won the women's 800-metre race at the Berlin World Championships in Athletics with a time of 1 minute 55.45 seconds, with a margin of almost 2.5 seconds. The victory sparked rumours that she was not really a woman. On the basis of these rumours, the IAAF triggered an investigation that lasted for 11 months, while depriving Caster of her medal and banning her from competition. In July 2010, upon appeal, the IAAF cleared Semenya for competition and her Berlin victory was allowed to stand (Karkazis *et al.* 2012).

The regulations require female athletes who do not fall below the limit of 10 nmol/L of testosterone, as defined by IAAF regulations (IAAF 2011: 12) must undergo androgen-suppressive therapy for up to 2 years to reduce the level of testosterone before they may compete as females. Note that the burden of proof for demonstrating that female athletes with hyperandrogenism do not derive a competitive advantage from the excess testosterone rests with the athlete (IAAF 2011 para. 6.6). The preface to the regulations states: 'The difference in athletic performance between males and females is known to be predominantly due to higher levels of androgenic hormones in males resulting in increased strength and muscle development' (p. 1). The declared policy goal, hence, is not to determine whether someone is 'really' a woman, along the lines of the now-discontinued sex-testing policies (Heggie 2010) but to assess, instead, whether high levels of androgens (hyperandrogenism) confer any significant advantage to women displaying this condition.

The advantage or, better, the 'unfair advantage' thesis is the pervasive assumption underlying the construction of female categories in elite sports. Paragraph 6.5 of the IAAF regulations states this quite clearly:

> The Expert Medical Panel shall recommend that the athlete is eligible to compete in women's competition if:
> (i) she has androgen levels below the normal male range; or
> (ii) she has androgen levels within the normal male range but has an androgen resistance such that she derives no *competitive advantage* [emphasis added] from having androgen levels in the normal male range.
>
> *(IAAF 2011: 12)*

The idea that an extremely complex trait like athleticism can be reduced to one single biochemical component, and in a way that markedly discriminates between 'males' and females', is not uncontroversial. That is because there is no robust scientific evidence showing that successful athletes display higher levels of testosterone than less successful ones (Karzakis *et* *al.* 2012). If one assumes, for the sake of discussion, that higher levels of testosterone do indeed confer an athletic advantage, it can nevertheless be argued that the ensuing medicalization of athletes with hyperandrogenism is unwarranted.

As explained above, the rationale underlying the IAAF and International Olympic Committee (IOC) policies is that setting a limit on the levels of androgens would compensate for the 'unfair competitive advantage' of female athletes with hyperandrogenism and would achieve a 'level playing field'. But is this a plausible scenario in elite sports? As I have argued before (Camporesi and Maugeri 2010), singling out and setting a limit on hyperandrogenism from other biological variations that may confer a genetic advantage is, to say the very least, an inconsistent policy: there are plenty of other genetic variations that are not regulated by IAAF and, even though advantageous for athletic performance, are not considered unfair. One famous example is provided by Finnish athlete Eero Mäntyranta, who won two gold meals in cross-country skiing at the 1964 Winter Olympics in Innsbruck. It was later determined that Mäntyranta had primary familial and congenital polycythaemia, a rare genetic mutation characterized by an elevated absolute red blood cell mass and a consequent increase of 25–50 per cent in his blood oxygen carrying capacity (Tucker and Collins 2012). Certainly, such an increase could provide Mäntyranta with a competitive edge.

Cases like Mäntyranta's are hardly rare among elite athletes. Endurance athletes, in particular, have been shown to have mitochondrial variations that increase aerobic capacity and endurance (Ostrander *et al.* 2009). Acromegaly, a hormonal condition resulting in large hands and feet, is especially prevalent among basketball players.[7] There has also been speculation that Michael Phelps, winner of eight gold medals at the 2008 Beijing Summer Olympics, has Marfan syndrome, a rare genetic condition affecting connective tissues that results in long limbs and flexible joints, an obvious advantage for a swimmer.[8] Another example – this time not only speculated – was Flo Hyman, a world-class volleyball player, who had, post-mortem, demonstrated Marfan syndrome, which explains her tall stature and long arms, obviously also giving her an advantage in volleyball (Bostwick and Joyner 2012). In her case, it is also noteworthy that Marfan syndrome also caused aortic dissection, leading to her death during a match. All these examples (and there are many more reviewed in Ostrander *et al.* 2009) show that elite athletes derive advantages from a range of biological variations and hyperandrogenism is no different in this regard. As pointed out by Claire Sullivan:

> The fact is the playing field [in elite sports] has never been level. There will always be genetic variations that provide a competitive edge for some athletes over others. We readily accept the genetic, athletic gifts that elite athletes possess without trying to find ways to 'level the playing field'.
>
> *(Sullivan 2011)*

In addition, even if we accept the premise that hyperandrogenism were to confer a competitive advantage, this would not imply that such an advantage would be unfair. As argued by Hämäläinen (2012): 'It is often implicitly assumed that the concept of advantage is unambiguous and unproblematic; only the parameters of fairness pose a challenge. This seems to be an unwarranted assumption'. Hämäläinen distinguishes between two kinds of 'advantage' in competition: 'performance' and 'property' advantage. The former is a relationship of superiority between performance numbers possessed by different athletes (or teams) and is defined as follows: 'A has a final performance advantage over B if A has a better final performance number than B'. Examples of performance numbers are the number of seconds in which an athlete runs a sprint or the numerical score that is the result of a football match. The latter is defined as 'A has an advantage over B in property X if A has a more favourable amount of this property X than does B', where properties are 'constituent parts of competitors and competition environment' (Hämäläinen 2012). One of the examples of property advantages offered by Hämäläinen is the oxygen-carrying capacity of Finnish cross-country skier Mäntyranta already quoted above. Owing to his genetic condition, Mäntyranta had a property advantage against fellow competitors, which in at least two occasions (the two gold medals won at the Winter Olympics in Innsbruck 1964), and probably many others, contributed to his success but that not necessarily, nor always, nor alone, implies a performance advantage. Following Hämäläinen, we could also say that Caster Semenya may have (under the assumption that a higher level of androgens results in a more athletic body) a property advantage. Even though Hämäläinen does not go on to analyse the distinctions between fair and unfair advantage, it seems that merely possessing a property advantage cannot possibly be classified as 'unfair', because, as we have seen above, that does not necessarily, always or alone result in a performance advantage.

Why, then, is the IAAF policy targeting hyperandrogenism among the genetic and biological variations that confer a property advantage? What about all the other genetic and biological variations that confer an advantage and which might be thought to disrupt the level playing field by IAAF? The fact is that all exceptional biological and genetic variations are considered part of what the elite athlete *is*, and of what makes sports competitions valuable, namely achieving excellence through combination of talent: the natural endowment of the athlete, and dedication: the effort in training and preparation that the athlete puts in to maximize what her talent offers. Consequently, all the biological and genetic variations found in elite athletes are deemed ethically acceptable because we think it is part of the meaning of sports to see individuals (elite athletes) with exceptional physical characteristics push their bodies to the limit to win in competitions and achieve world records.

It seems therefore particularly problematic that the IAAF and IOC policies single out hyperandrogenism from the other biological and genetic variations, the possession of which could also be classified as property advantages (and as such, we argue, not 'unfair'), as being outside the 'ethically acceptable' limits. The current IAAF and IOC policies on hyperandrogenism raise a fundamental issue of consistency and, as Sullivan (2011) has pointed out, they can "open a floodgate for potential opposition on other types of genetic variations such as height, oxygen carrying capacity, and lactate thresholds" (Sullivan 2011, p 414). If one desires consistency to be a fundamental feature of policies impacting on the life prospects and elite careers of many people, the IAAF/IOC guidelines on hyperandrogenism need to put forward a strong rationale for regulation on a plethora of other genetic variations.

The current policies not only raise a problem of consistency but also of discrimination against female athletes with hyperandrogenism. Since the rationale underlying the policies is that they aim to achieve a level playing field by setting an upper limit for a biological molecule that provides a competitive advantage, then the rationale should be applied not exclusively to the female category. Why is a similar threshold not set for male athletes too? Indeed, as the medical historian Vanessa Heggie pointed out:

> What the sex test effectively does, therefore, is provide an upper limit for women's sporting performance; there is a point at which your masculine-style body is declared 'too masculine', and you are disqualified, regardless of your personal gender identity. For men there is no equivalent upper physiological limit – no kind of genetic, or hormonal, or physiological advantage is tested for, even if these would give a 'super masculine' athlete a distinct advantage over the merely very athletic 'normal' male.
>
> *(Heggie 2010: 158)*

Singling out hyperandrogenism from all other genetic and biological variation seems therefore to be unwarranted. For the sake of consistency, either IAAF/IOC would have to ban from competition all athletes who derive a property advantage from biological variations or let everybody who is 'out of the ordinary', compete, Caster Semenya and other athletes with hyperandrogenism included. Thus, the IAAF and IOC policies discriminate against female athletes on a feature of athletic performance that many people think is crucial to athletic competition, which, borrowing from Murray, is both a 'celebration of and a challenge posed by our embodiment' (Murray 2009: 236). By doing so, we could say that they 'dis-embody' female athletes in competition and they not only fail to achieve the ideal of 'fairness' for which they aim but they also deprive female athletes with hyperandrogenism exactly of the possibility 'to test their [bodies'] capabilities and limits, and to integrate them with our will, intellect, and character' (Murray 2009: 237).

The role of biotechnology in the Paralympics

Technology can be understood as a 'human-made means to serve human interests and goals' (Cooper 1995). Elaborating on this definition, Loland (2009) defines sports technology as a human-made means of serving human interests and goals in or related to sport. In this section, I analyse the role of prosthesis technology for Paralympic athletes, considering the case of Oscar Pistorius and its implications for the construction of categories in the Olympics and Paralympics. We all have heard of the controversy surrounding Oscar Pistorius's case but for the purposes of the discussion below it will be important to rehearse some of the early details of his case (see also Camporesi 2008).

Oscar Pistorius was born on 22 November 1986 without fibulae and had both legs amputated below the knee when he was 11 months old. Pistorius runs with the aid of carbon-fibre artificial limbs produced by Icelandic company, Ossur, called 'Cheetahs'. In 2007 (South Africa, then Rome), Pistorius took part in his first international competition for able-bodied athletes. At that time, the IAAF temporarily allowed him to compete with able-bodied athletes, while performing tests on the prosthesis. The IAAF assigned to German Professor Gert-Peter Brüggemann (Director Institute of Biomechanics and Orthopaedics, German Sport University Cologne) the task of monitoring Oscar's performances and analysing the information, which the IAAF would then use as the empirical basis for its decision. According to his study, Pistorius's limbs use 25 per cent less energy than able-bodied athletes to run at the same speed and the prosthetic limbs developed an energy loss of about 9 per cent during the stance phase, compared with 41 per cent in the human ankle joint (Brüggemann *et al*. 2008). Based on these findings, Brüggemann concludes that Oscar is actually performing a '*different kind of locomotion at lower metabolic cost*' [emphasis added]. On the strength of these findings, on 14 January 2008, the IAAF ruled Oscar ineligible for competitions conducted under its rules, including the 2008 Beijing Summer Olympics. In the same year, the IAAF amended its competition rules to ban the use of 'any technical device that incorporates springs, wheels or any other element that provides a user with an advantage over another athlete not using such a device' (rule 144.2). The Federation claimed that the amendment was not specifically aimed at Pistorius.

Pistorius appealed to the Supreme Court of Arbitration for Sport (CAS), in Lausanne (since 1984, the place where international sports dispute are resolved). He travelled to America to take part in a series of further tests carried out at Rice University in Houston by a team of scientists including Hugh Herr and Rodger Kram.[9] In their point-by-point reply to the work by Brüggemann *et al*. (2008) Kram *et al*. (2010) argue that as there are no sufficient data to support the claim that Oscar Pistorius has an advantage, the conclusion should be that he does *not* have an advantage over able-bodied athletes. 'Until recently it would have been preposterous to consider prosthetic limbs to be advantageous, thus, the *burden of proof is on those who claim that running specific prosthesis (RSP) are advantageous*' (Kram *et al.* 2010, emphasis, added).

On the basis of these findings, on 26 May 2008, the CAS in Lausanne reversed the IAAF decision and ruled that Pistorius should be able to compete against Olympic athletes, since the IAAF 'did not prove that claim [of unfair advantage] to a sufficient extent' reference. To note that the verdict is limited only to the use of the specific blades in issue in this appeal (that is, were Pistorius to change the kind of running specific prosthesis he uses, he would have to go through the same testing regimen again). It is therefore a very contextualized decision that cannot be extended to other double amputees, who would also have to undertake the relevant biomechanical tests.

After the appeal to CAS, Pistorius was allowed to compete with able-bodied athletes and he was the first amputee to compete in track events at the Olympics Games in London 2012. To note, Pistorius competed also in the Paralympics in London, as his participation in the Olympics did not exclude him from participation in the Paralympics. It is necessary to contextualise Oscar Pistorius's case within a narrative of other athletes with a 'disability' who have competed in the Olympics. Oscar Pistorius is not the first case of an athlete with an impairment or 'disability' competing in the Olympics (Edwards 2008, Jespersen and McNamee 2008). He is 'only' the first amputee competing in track events at the Games. Other athletes with impairments who have created precedents include: the American George Eyser, who won a gold medal in gymnastics while competing on a wooden leg at the 1904 Games in St. Louis; the kiwi Neroli Fairhall, paraplegic, competed in archery in the 1984 Olympics in Los Angeles; Marla Runyan, a legally blind runner from the United States, competed in the 1500 metres at the 2000 Olympics in Sydney; South African swimmer Natalie du Toit, who in 2008 became the first amputee ever to qualify for the Olympics (Beijing), where she placed 16th in the 10-km 'marathon' swim (Marcellini *et al.* 2011).

Pistorius's case has been framed by the IAAF and the CAS in Lausanne, and by many bioethics scholars, in terms of 'fair vs. unfair advantage', 'disability vs. super-ability'. It had been claimed that the blades gave Pistorius an unfair advantage over the able-bodies athletes and that, on this basis, he should not be allowed to compete with able-bodied athletes (Edwards 2008). A first way to respond to the claim that the blades give Oscar an advantage is to dispute the claim that the blades do, in fact, provide him with an advantage; that is, to question the biomechanics study by Brüggemann *et al.* (2008), as Weyand *et al.* (2009) have done. This may be done by pointing out the fact that the blades also bring some disadvantages, including a slower initial acceleration compared with natural legs and decreased stability and balance compared with a natural leg. Indeed, Oscar faces a slow start, as he needs approximately 30 metres to gain his rhythm and he suffers from an unsure grip in the rain and headwind (Edwards 2008).

Suppose, for the sake of the argument, that the blades do indeed confer Oscar an advantage. If this were the case, would that be sufficient grounds to exclude him from competition? To answer this question requires a consideration of the role and value of biotechnology in elite sports. Burkett, a biomechanist and former Paralympic swimming world champion himself, has written extensively on the value of technology in sports. He argues that technology is in many cases 'essential for performance' in Paralympic sports. (Burkett *et al.* 2011) For example, there are specialised prostheses for athletes who compete in track and field throwing events such shot-put, javelin and discus, or in jumping events. Similarly, there are specialized wheelchairs to enable athletes to compete in the equivalent of rugby, tennis and basketball. All these technologies, while being essential for performance, are also designed as being performance enhancing. The two features seem to be inextricably intertwined. The same happens also with the bikes for elite cycling, which are also designed to enhance performance. The point with performance-enhancing technologies in sport seems to be a problem of standardization of the 'essential for performance-enhancing performance' technology; that is, there needs to be an upper limit or cut-off point (arbitrarily chosen among a series of possible upper limits) for the biotechnology, above which we decide the value of athletic performance, and our admiration for it, are severely impaired by the technology itself (Murray 2009).

In addition, considerations of equity of access to technology for athletes have to be taken into account, as argued by Burkett (2010). It should be noted, though, that neither IAAF nor the World Anti-Doping Agency is concerned about providing 'equity of access' to their athletes in terms for example of access to best coaching or training facilities. Indeed, the reality is that there is a wide disparity among elite athletes in terms of access to coaching and training facilities, and both these factors do make a difference to the overall performance of the athletes. Returning to the question, 'which one of the two conceptualizations ('essential for performance' vs. 'performance enhancing') should prevail in our assessment of the role of biotechnology on our athletic performance, Burkett (2010) argues that, given that a 'grey area' remains regarding how well an athlete is able to transfer any potential mechanical advantage into a real advantage, we should err on the side of the benefit of the doubt. This implies that we should probably favour technology being essential for performance, rather than performance enhancing (Burkett *et al.* 2011) In this sense, Pistorius is an example of a technological hybrid or a 'compound athlete' (Marcellini *et al.* 2011), for which the technology essential for performance becomes part of his embodiment and may also be a way of enhancing his performance. The main problem for evaluating the role of technology, for Burkett, remains the problem of *equity of access* as highlighted above.

It is plausible to speculate that more cases similar to that of Oscar Pistorius will come to the fore at the 2016 Olympics in Rio de Janeiro (for example, Alan Oliveira, Paralympic athlete, ran faster than Oscar Pistorius at the London 2012 Paralympics in both the 100 metres and 200 metres competitions, raising Oscar's anger and talk of unfair advantage and shattering the 100-metres world record at the International Paralympic Committee Grand Prix in Berlin in 2013.[10] Bioethicists in sport need to be proactive and should start reflecting now on the role of technology in the construction of categories in sport, as I highlight in the next and final section of this chapter.

Future directions in bioethics and sport

In this last section, I outline two areas in sport medicine in which I think that ethical reflection could and should contribute in the near future: the role of biotechnology in construction of categories in sport and the shared participatory responsibility in doping.

With regard to biotechnology and the categorization of sport, I have little doubt that there will be other cases like that of Oscar Pistorius and that philosophers of sport and medicine should be proactive in these debates. I agree with Gregor Wolbring that it is necessary to reframe the discourse surrounding Oscar Pistorius's case, if 'one wants to take on the challenge linked to the advances and impacts of new and emerging science and technology on sports' (Wolbring 2008). We have seen above how Oscar Pistorius's situation has been framed as a case of 'unfair advantage' provided by the use of technology. But is there another way to frame that case?

Steven Edwards (2008) has suggested that what Oscar Pistorius does is strictly speaking not running but something closer to '*high-velocity/cadence bounding*'. In other words, he suggests that *prosthetics alter the nature of the activity*. This point is similar to one raised by Brüggemann *et al.*

(2008), who stated that Pistorius performs a "*different kind of locomotion at lower metabolic cost*" and is also similar to the conclusion of the study by Weyand *et al*. in 2009, who performed a biomechanical study on Oscar Pistorius and concluded that:

> Perhaps our most striking result … is that our amputee subject [Oscar Pistorius] could be simultaneously similar to intact-limb runners physiologically but dissimilar mechanically. Physiological similarity is most likely explained by the reliance of both transtibial amputee and intact-limb runners on the large groups of extensor muscles that act across the hip and knee joints. … However, *running with lower-limb prostheses might have substantially altered the nature of their activity*'.
>
> *(Weyand* et al. *2009, emphasis added)*

Both biomechanical studies, therefore, hint at the fact that what Oscar Pistorius does may not be running but a different kind of 'locomotion' and that the blades have fundamentally altered the nature of the activity. Indeed, Wolbring points to an alternative classification based on the establishment of a new category for double amputees running on blades (Wolbring, 2012). He notes that Olympics events should be recategorized as follows: a) those based mainly on the biological performance of the athlete (for example, high jump); b) those based or depending mainly on external tools (such as the pole vault, skiing or bobsleigh). In this sense, the role of technology is seen as a demarcation line between the two types of events. Along these lines, one could compare bionic and wheelchair racing with the pole vault and other sports where athletes use external tools to move beyond species-typical functioning while comparing biological racing with the high jump. Since both the high jump and the pole vault are included in the Olympics, the argument goes, we could envisage having both 'high-velocity bounding' and biological running in the Olympics but in two different categories. In other words, going 'beyond species-typical functioning' would not be a reason to exclude amputee athletes from competing in the Olympics. Obviously, one would not allow a person with a pole to compete in the high jump competition but a separate event could be perfectly acceptable and not seen as doping, as all athletes would perform under the same parameters. What would be the defining features of this category of 'high-velocity bounding'? The question to ask becomes: is his movement sufficiently different from running (provided that running is a 'loose' category) to warrant putting in another category? Burkett (2010), already mentioned above for his research on the role and value of technology on athletic performance, also raises the same question in a more recent paper (Burkett *et al*. 2011), where it is observed, after Edwards (2008) and McNamee (2011), that the question: 'Is what Oscar Pistorius does really running?' is not a simple empirical question to be settled by biomechanical analysis alone (although Burkett thinks that biomechanical analysis should play an important role) but is rather a conceptual question, namely, which gaits should be thought of as constituting running? I agree with Burkett *et al*. (2011) that the answer to this question cannot be informed by biomechanics alone and that ethicists need more actively to play a 'creative role' in the construction of categories in sport (Camporesi and Maugeri 2010). This construction cannot be informed by sports science or medicine alone, as questions of fairness in competition inform the categories and demand an ethical reflection.

The second area in sport medicine about which I think there is space for original ethical reflection is an interpretation of the conflict of interest dilemmas highlighted in the first section through the lens of 'unregulated clinical research', which was first applied by King and Robeson (2007) to the context of elite sport and, more recently, in King and robeson (2013) and Camporesi and McNamee (2014), where the analogies between pharmaceutical 'guinea pigs' and athlete 'guinea pigs' were discussed. King and Robeson (2007) were among the first authors to highlight the problematic position of the athlete-patient, situated in a elite sport context where the introduction of performance-enhancing technologies can be regarded, in their own words, drawing a parallel from the clinical context, as 'unregulated clinical research' (King and Robeson 2007). King and Robeson note how well-understood problems in research ethics (such as vulnerability, voluntariness, undue influence, full disclosure, equitable subject selections, conflict of interest) become particularly problematic in elite sports contexts, as opposed to the more typical health, medical and scientific contexts in and through which research is already regulated. I believe that this analogy and critical interpretation of the two contexts can be a particularly useful framework within which to understand the exacerbation of traditional norms of research ethics that are translated to the context of elite sport.

One of the ethical issues that we highlighted in relation to elite sport in (Camporesi and McNamee 2014) as unregulated terrain of experimentation and clinical research, where athletes find themselves to be guinea pigs, is the lack of transparency and accountability in the elite sport context. Following Holm (2007), it can be argued that lifting the ban on doping and putting doping 'under a medical context' would not eliminate doping from elite sport but would lead to a two-tiered system of doping, where two practices would ensue: a) the open use of well-known performance-enhancing drugs, and b) the hidden use of other performance-enhancing methods to preserve a competitive advantage over fellow athletes. In practice, doping behaviours occur under pressure and athletes often feel they have no realistic alternatives to doped participation. This happens because, to maintain a competitive advantage in a system that praises a continuous breaking of records and of improvements, athletes feel that they have to participate in the doping behaviours or they will cease to be competitive. As a consequence, choosing not to participate in doping is possible (that is, there is always the way out of doping by choosing to get out of the system) but is seriously constrained. This alternative becomes extremely costly for the athletes, as in practice it amounts to ceasing being competitive or exiting the profession. On this point, he comment by Alex Zuelle, a former Swiss professional cyclist who rode for the Festina team and who was found positive for erythropoietin in 1998 (what became later known as the 'Festina affair') is particularly insightful:

> Everybody knew that the whole peloton was taking drugs and I had a choice. Either I buckle and go with the trend or I pack it in and go back to my old job as a painter. I regret lying but I couldn't do otherwise.
>
> *(Hamilton and Coyle 2013: 100)*

In light also of the recent doping scandals in the field of elite cycling that have shown that doping is a highly organised enterprise (Hamilton and Coyle 2013), I think it is necessary to broaden the perspective of the moral responsibility in doping, beyond the athletes as the only moral agents on which blame, resentment, indignation and other reactive attitudes can be directed, to include the different stakeholders in elite sports. As Jörg Jaksche, a former professional cyclist from Germany, said in a telephone interview:

> Each new doping scandal follows the same pattern … When someone is caught, the system acts shocked and upset, declares its absolute rejection of doping and depicts the athlete as a black sheep that deserves to be slaughtered. After that, everything continues like before. But the fact is that they slaughter a scapegoat, not a black sheep, and nobody ever looks at the shepherd's responsibility. I'm talking about those in the higher levels, those who govern the sports and, most importantly, those who provide the money that fuels everything.[11]

For these reasons, an area in which I think bioethicists and sports philosophers should focus is in developing a viable concept of shared participatory responsibility for doping. Atry (2013) attempted a preliminary outline of a theoretical framework for broadening the scope of responsibility in doping behaviours (what he refers to as "participatory ethics"), drawing on Strawson's (2008) relational concept of agency, where moral agents are embedded within the social practice in which they participate. Within that particular social practice, agency is mediated through the practice of responsibility assignment, where we assign responsibility to others by making legitimate demands/claims/expectations on others. These demands/claims/expectations are mediated through "reactive attitudes" such as resentment, indignation, blame, praise and so on, which become the locus of the assignment of responsibility. As argued by Ashkan Atry, 'It seems reasonable to assert that the nature of asymmetries in power relations between individuals (e.g. coercion or manipulation) could significantly affect responsibility-seeking/assigning processes' (Atry 2013: 45–6) and therefore it is plausible to argue that responsibility should shift from athletes exclusively to the entire entourage comprising the sports doctors, the sponsors and the other team members who were the agents of the doping enterprise.

The key problem for ethical reflection is that consideration of 'social groups' or 'collectives' as moral agents are often assumed to be problematic. For this reason, much interdisciplinary work will be necessary to the future development of sport and bioethics scholarship.

Acknowledgments

I acknowledge permission to reprint in this chapter material which first appeared in section (i) of Silvia Camporesi and Michael J. McNamee, 'Is There a Role for Genetic Testing in Sports?' in *eLS*, 15 May. DOI: 10.1002/9780470015902.a0024203.

Notes

1 Atlas Sports Genetics; see www.atlasgene. com (accessed 7 October 2014).
2 Jackie MacMullan, 'Kobe Bryant pushes onward', *ESPN LA*, 7 February 2013. Available online at http://espn.go.com/los-angeles/nba/story/_/id/8924518/kobe-bryant-tries-push-los-angeles-lakers-frustration (accessed 7 October 2014).
3 Madison Park, 'College football player who committed suicide had brain injury', *CNN*, 14 September 2010. Available online at http://edition.cnn.com/2010/HEALTH/09/14/thomas.football.brain/ (accessed 7 October 2014); 'Head injuries in football', *New York Times*, 10 December 2012. Available online at http://topics.nytimes.com/top/reference/timestopics/subjects/f/football/head_injuries/index.html (accessed 7 October 2014).
4 The British Medical Association has campaigned for a ban on all forms of boxing since 1985.
5 Paolo Bandini, 'NFL concussion lawsuits explained', *Guardian*, 29 August 2013. Available online at www.theguardian.com/sport/2013/aug/29/nfl-concussions-lawsuit-explained (accessed 7 October 2014).
6 I acknowledge the intellectual contribution of Paolo Maugeri for this section.
7 Anna Katherine Clemmons, '7 Feet 7 and 360 Pounds, With Bigger Feet Than Shaq's', *New York Times*, 9 January 2008. Available online at www.nytimes.com/2008/01/09/sports/ncaabasketball/09asheville.html (accessed 7 October 2014).
8 Jessica Ryen Doyle, 'Michael Phelps unintentionally raises Marfan syndrome awareness', *Fox News*, 21 August 2008. Available online at www.foxnews.com/story/2008/08/21/michael-phelps-unintentionally-raises-marfan-syndrome-awareness (accessed 7 October 2014).
9 David Epstein, 'Fair or foul? Experts split over whether Pistorius has advantage', Sports Illustrated, 3 August 2012. Available online at www.si.com/more-sports/2012/08/03/oscar-pistorius-london-olympics (accessed 7 October 2014).
10 James Crook, 'Oliveira becomes fastest leg amputee on planet by shattering world record', *Inside the Games*, 15 June 2013. Available online at www.insidethegames.biz/sports/summer/athletics/1014683-

oliveira-becomes-fastest-leg-amputee-on-planet-by-shattering-world-record (accessed 7 October 2014).

11 Claudio Gatti, 'Looking upstream in doping cases', *New York Times*, 15 January 2013. Available online at www.nytimes.com/2013/01/16/sports/cycling/critics-take-a-look-upstream-in-doping-scandals.html?_r=0 (accessed 7 October 2014).

References

Anderson, L. (2008). Contractual obligations and the sharing of confidential health information in sport. *Journal of Medical Ethics*, 34(9): e6.

Atry, A. (2013). *Transforming the Doping Culture: Whose Responsibility, What Responsibility?* [Doctoral thesis] Uppsala: Acta Universitatis Upsaliensis. http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-206607 (accessed 7 October 2014).

Berman, Y. and North, K. N. (2010). A gene for speed: the emerging role of a-actinin-3 in muscle metabolism. *Physiology* 25(4):250–9.

Bostwick, J. M. and Joyner, M. J. (2012). The limits of acceptable biological variation in elite athletes: should sex ambiguity be treated differently from other advantageous genetic traits? *Mayo Clinic Proceedings*, 87(6): 508–13.

Brooks, M. A. and Tarini, B. A. (2011). Genetic testing and youth sport. *Journal of the American Medical Association* 305(10): 1033–4.

Brüggemann, G. P., Arampatzis, A., Emrich, F. and Potthast, W. (2008). Biomechanics of double transtibial amputee sprinting using dedicated sprinting prosthesis. *Sports Technology*, 1(4–5): 220–27.

Burkett, B. (2010). Technology in Paralympic sport: performance enhancement or essential for performance? *British Journal of Sports Medicine*, 44: 215–20.

Burkett, B., McNamee, M. J. and Potthast, W. (2011). Shifting boundaries in sports technology and disability: equal rights or unfair advantage in the case of Oscar Pistorius? *Disability and Society*, 26(5): 643–54.

Camporesi, S. (2008). Oscar Pistorius, enhancement and post-humans. *Journal of Medical Ethics*, 34: 639.

Camporesi, S. (2013). Bend it like Beckham! The ethics of genetically testing children for athletic potential. *Sport, Ethics and Philosophy*, 7(2): 175–85.

Camporesi, S. and Knuckles, J. A. (2014). Shifting the burden of proof in doping: lessons from environmental sustainability applied to high-performance sport. *Reflective Practice*, 15(1): 106–18.

Camporesi, S. and McNamee, M. J. (2014). Performance enhancement, elite athletes and anti-doping governance: comparing human guinea pigs in pharmaceutical research and professional sports. *Philosophy, Ethics, and Humanities in Medicine*, 9(1): 4. DOI: 10.1186/1747-5341-9-4.

Camporesi, S. and Maugeri, P. (2010). Caster Semenya: sport, categories and the creative role of ethics, *Journal of Medical Ethics*; 36: 378–9.

Caulfield, T. (2011). Predictive or preposterous? The marketing of DTC genetic testing. *Journal of Science Communication* 10(3): 1–6.

Cooper, D. E. (1995). Technology: Liberation or enslavement? *Royal Institute of Philosophy Supplement*, 38: 7–18.

Edwards, S. (2008). Should Oscar Pistorius be excluded from the 2008 Olympic games? *Sport, Ethics and Philosophy*, 2(2): 112–5.

European Society of Human Genetics (2010). Statement of the ESHG on direct-to-consumer genetic testing for health related purposes. *European Journal of Human Genetics* 18:1271–3.

Eynon, N., Ruiz, J. R., Oliveira, R. *et al.* (2011). Genes and elite athletes: a roadmap for future research. *Journal of Physiology* 598(13): 3063–70.

Gandy, S. and DeKosky, S. T. (2012). APOE e4 status and traumatic brain injury on the gridiron or the battlefield. *Science Translational Medicine* 4(134): 134ed4.

Goldberg, D. S. (2009). Concussions, elite sports, and conflicts of interest: why the national football league's current policies are bad for its (players') health. *HEC Forum*, 20(4): 337–55. DOI 10.1007/s10730-008-9079-0.

Hämäläinen, M. (2012). The concept of advantage in sport. *Sport, Ethics and Philosophy*, 6(3): 308–22.

Hamilton, T. and Coyle, D. (2012). *The Secret Race: Inside the Hidden World of the Tour de France*. London: Transworld.

Hecht, A. (2002). Legal and ethical aspects of sports-related concussions: the Merril Hoge story. *Seton Hall Journal of Sport Law* 12: 17–64.

Heggie, V. (2010). Testing sex and gender in sports; reinventing, reimagining and reconstructing histories. *Endeavour*, 34(4): 157–63.
Hoberman, J. M. (1992). *Mortal Engines: The science of performance and the dehumanization of sport*. New York: Free Press.
Holm, S. R. (2007). Doping under medical control: conceptually possible but impossible in the world of professional sports? *Sports, Ethics and Philosophy*, 1(2): 135–45.
Holm, S., McNamee, M. J. and Pigozzi, F. (2011). Ethical practice and sports physician protection: a proposal. *British Journal of Sports Medicine*, 45(15): 1170–3.
International Association for Athletics Federation (2011). *Regulations Governing Eligibility of Females with Hyperandrogenism to Compete in Women's Competition: In force as from 1st May 2011*. Monaco: IAAF.
Jespersen, E. and McNamee, M. (2008). Philosophy, adapted physical activity and dis/ability. *Sport, Ethics and Philosophy*, 2(2): 87–96.
Karkazis, K., Jordan-Young, R., Davis, G. and Camporesi, S. (2012). Out of bounds? A critique of the new policies on hyperandrogenism in elite female athletes. *American Journal of Bioethics*, 12(7): 3–16.
King, N. M., and Robeson, R. (2007). Athlete or guinea pig? Sports and enhancement research. *Studies in Ethics, Law, and Technology*, 1(1): 1941-6008. DOI: 10.2202/1941-6008.1006.
King, N. M., and Robeson, R. (2013). Athletes are guinea pigs. *American Journal of Bioethics*, 13(10): 13–14.
Koboldt, D. C., Steinberg, K. M., Larson, D. E., *et al.* (2013). The next-generation sequencing revolution and its impact on genomics. *Cell*, 155(1): 27–38.
Kram, R., Grabowski, A. M., McGowan, C. P., *et al.* (2010). Counterpoint: Artificial limbs do not make artificially fast running speeds possible. *Journal of Applied Physiology*, 108: 1012–14.
Krumer, A., Shavit, T. and Rosenboim, M. (2011). Why do professional athletes have different time preferences than non-athletes? *Judgment and Decision Making,* 6: 542–51.
Loland, S. (2009). Fairness in sport: an ideal and its consequences. In *Performance Enhancing Technologies in Sports: Ethical, Conceptual, and Scientific Issues*, edited by T. H. Murray, K. J. Maschke and A. A. Wasunna, 175–204. Baltimore, MD: John Hopkins University Press.
Marcellini, A., Fereza, S., Issanchoua, D., *et al.* (2011). Challenging human and sporting boundaries: the case of Oscar Pistorius. *Performance Enhancement and Health*, 1(1): 3–9.
McKee, A. C., Cantu, R. C., Nowinski, C. J., *et al.* (2009). Chronic traumatic encephalopathy in athletes: progressive tauopathy after repetitive head injury. *Journal of Neuropathology and Experimental Neurology* 68(7): 709–35.
McNamee, M. J., Mueller, A., van Hilvoorde, I., *et al.* (2009). Genetic testing and sports medicine ethics. *Sports Medicine* 39(5): 339–44.
McNamee, M. (2011). After Pistorius: Paralympic philosophy and ethics. *Sport, Ethics and Philosophy*, 5(4): 359–61.
McNamee, M. and Partridge, B. (2013). Concussion in sports medicine ethics: policy, epistemic and ethical problems. *American Journal of Bioethics*, 13(10): 15–17.
McNamee, M. and Phillips, N. (2011). Confidentiality, disclosure and doping in sports medicine. *British Journal of Sports Medicine*, 45(3): 174–7.
Murray, T. H. (2009). In search of an ethics of sport: genetic hierarchies, handicappers general, and embodied excellence. In *Performance-enhancing Technologies in Sports*, edited by T. H. Murray, K. J. Maschke and A. A. Wasunna, 225–38. Baltimore, MD: Johns Hopkins University Press.
Nixon, H. L. (1993). Accepting the risks of pain and injury in sport: mediated cultural influences on playing hurt. *Sociology of Sport Journal*, 10(2): 183–96.
Ostrander, E. A., Huson, H. J., Ostrander, G. K. (2009). Genetics of athletic performance. *Annual Review of Genomics and Human Genetics*, 10: 407–29.
Roth, S. M. (2012). Critical overview of applications of genetic testing in sport talent identification. *Recent Patents on DNA and Gene Sequences* 6(3): 247–55.
Rudnik-Schoeneborn, S. (2012). Genetic tests in sports medicine – many studies, little impact. *Genomics, Society and Policy* 8(1): 13–19.
Sandel, M. J. (2009). *The Case Against Perfection*. Harvard University Press.
Savulescu, J. and Foddy, B. (2005). Comment: genetic test available for sports performance. *British Journal of Sports Medicine* 39: 472. DOI: 10.1136/bjsm.2005.017954.
Saulle, M. and Greenwald, B. D. (2012). Chronic traumatic encephalopathy: a review. *Rehabilitation Research and Practice* 2012: 1–9. DOI: 10.1155/2012/816069.
Sherwin, S. (2007). Genetic enhancement, sports and relational autonomy. *Sport, Ethics and Philosophy*, 1(2): 171–80.

Strawson, P. F. (2008). *Freedom and Resentment and Other Essays*. Abingdon: Routledge.

Sullivan, C. (2011). Gender verification and gender policies in elite sport eligibility and 'fair play'. *Journal of Sport and Social Issues*, 35(4): 400–19.

Tucker, R., and Collins, M. (2012). What makes champions? A review of the relative contribution of genes and training to sporting success. *British Journal of Sports Medicine*, 46(8): 555–61.

Weyand, P. G., Bundle, M. W., McGowan, C. P., *et al.* (2009). The fastest runner on artificial legs: different limbs, similar function? *Journal of Applied Physiology*, 107: 903–11.

Wolbring, G. (2008). Oscar Pistorius and the future nature of Olympic, Paralympic and other sports. *SCRIPTed*, 5(1): 139–60.

Wolbring, G. (2012). Paralympians outperforming Olympians: an increasing challenge for Olympism and the Paralympic and Olympic movement. *Sport, Ethics and Philosophy*, 6(2): 251–66.

Yang, N., MacArthur, D.G., Gulbin, J.P., *et al.* (2003). ACTN3 genotype is associated with human elite athletic performance. *American Journal of Human Genetics* 73: 627–31.