



## High altitude, enhancement, and the 'spirit of sport'

Emma C. Gordon & Connie Dodds

**To cite this article:** Emma C. Gordon & Connie Dodds (2023) High altitude, enhancement, and the 'spirit of sport', *Journal of the Philosophy of Sport*, 50:1, 63-82, DOI: 10.1080/00948705.2023.2168679

**To link to this article:** <https://doi.org/10.1080/00948705.2023.2168679>



© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 24 Jan 2023.



Submit your article to this journal [↗](#)



Article views: 288



View related articles [↗](#)



View Crossmark data [↗](#)

## High altitude, enhancement, and the ‘spirit of sport’

Emma C. Gordon <sup>a</sup> and Connie Dodds<sup>b</sup>

<sup>a</sup>Department of Philosophy, University of Glasgow, Glasgow, United Kingdom of Great Britain and Northern Ireland; <sup>b</sup>Department of Medicine, University of Glasgow, United Kingdom of Great Britain and Northern Ireland, Glasgow

### ABSTRACT

The World Anti-Doping Code (2021) includes a substance on the prohibited list if it meets at least two of the following: (1) it has the potential to enhance or enhances sport performance; (2) it represents an actual or potential health risk to the athlete; (3) it violates the spirit of sport. This paper uses a case study to illustrate points of tension between this code and enhancements that are appropriate to ban; we argue that there are banned drugs (e.g., acetazolamide and dexamethasone) the use of which we have good reason to not only permit but encourage for high-altitude sports. Drawing on lessons from this case study, we propose a reformulation of the Code that requires (1–3) be met but offers preferable ways of unpacking conditions (1) and (3) – and in a way that better preserves how the spirit of sport condition should be indexed to particular sports. Our formulation is inclusive enough to rule in drugs like acetazolamide and dexamethasone as permissible in high-altitude sports while at the same time ruling out problem cases – including many drugs already on the prohibited list. The result is an attempted alignment between the conditions specified and those drugs that should be banned.

**ARTICLE HISTORY** Received 2 May 2022; Accepted 11 January 2023

**KEYWORDS** Human enhancement; high-altitude; doping; achievement; spirit of sport

### Background and overview

Under what conditions should some particular cognitive enhancement drug be banned in a given sport? Given the increasing opportunities to use the latest science and medicine to gain competitive advantages, gaining a clear answer to this question is of timely concern. Moreover, public interest and division surrounding high-profile doping scandals – in, e.g., professional cycling,<sup>1</sup> major league baseball,<sup>2</sup> and most recently, Olympic figure skating at the 2022 Winter Olympics<sup>3</sup> – have only exacerbated the need for such clarity and for a careful and principled rationale. Such scandals only serve to motivate philosophical clarity – as well as clear and principled practical

**CONTACT** Emma C. Gordon  [emma.gordon@glasgow.ac.uk](mailto:emma.gordon@glasgow.ac.uk)  Department of Philosophy, University of Glasgow, Glasgow G128LP, United Kingdom of Great Britain and Northern Ireland

© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.  
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

guidance – on questions in the neighbourhood of: when does a medical treatment, in the context of a given sport, rise to the level of problematic doping? How, specifically, should ‘doping’ charges be sensitive to considerations of fairness and ‘fair play?’.

On the matter of philosophical clarity, research led by Morgan (e.g., 2009) has led to renewed investigation of the enhancement-treatment distinction,<sup>4</sup> and of multiple dimensions of ‘fair play’.<sup>5</sup> On the question of clarity in connection with action guidance – which will be our central focus in what follows – the World Anti-Doping Code offers the most well established and widely embraced reference point. The Code has two key components: conditions under which substances should be banned, and a list of such substances. Regarding the first component, the Code offers a set of sufficiency conditions – the *enhancement potential condition*, the *health risk condition*, and the *spirit of sport condition* – any two of which are claimed to jointly suffice for a substance to be banned.

*Enhancement potential condition*: it has the potential to enhance or enhances sport performance;

*Health risk condition*: it represents an actual or potential health risk to the athlete;

*Spirit of Sport condition*: it violates the spirit of sport.

For some brief elaboration: an enhancement is commonly defined in discussions in bioethics as something that augments our capacities past the point of correcting pathology or makes us *better than well* (e.g., Juengst and Moseley 2019). It is at least *prima facie* plausible that the Anti-Doping Code has a similar notion of enhancement in mind in the enhancement potential condition (though we’ll revisit this question in §2-3).<sup>6</sup> The ‘health risk’ condition is more or less self-explanatory, though we’ll see that there are weaker and stronger ways of reading the potential risk clause. The *spirit of sport* condition is, in comparison with the other two conditions, the most contentious and philosophically interesting. To help us get a grip on what is meant by ‘violating the spirit of sport’, the Code further elaborates: by ‘the spirit of sport’, they mean ‘the ethical pursuit of human excellence through the dedicated perfection of each Athlete’s natural talents’ and add that they ‘seek to maintain the integrity of sport in terms of respect for rules, other competitors, fair competition, a level playing field, and the value of clean sport to the world’ (13).

As mentioned above, in addition to the sufficiency conditions, the Code provides an itemized ‘prohibited list’ of banned substances, dividing such substances into distinct categories: androgens, blood doping, peptide hormones, stimulants, diuretics, narcotics, and cannabinoids. The prohibited list is updated every year, most recently in 2021.<sup>7</sup>

If the Code is to be adequate, we should expect at the very least *internal alignment* between the two components of the Code, i.e., the conditions and the prohibited list:

*Internal alignment:* The Code achieves internal alignment if and only if all and only substances on the list of prohibited substances satisfy at least two of the conditions claimed to jointly suffice for a substance to be prohibited.

That said, even if the Code succeeds in achieving internal alignment, it remains an open question whether the substances banned (in internal alignment) by the code are all and only the substances that the code *should* ban. So, in addition to internal alignment, we should expect the Code also satisfies a stronger desideratum of *normative extensional adequacy*:

*Normative extensional adequacy:* The Code achieves normative extensional adequacy if and only if it achieves internal alignment *and* all and only substances that should be prohibited are prohibited by the Code.

As presently formulated after its 2021 revisions, the Code offers valuable regulatory guidance for, as of 2022, over 700 sports organisations across the world. These organizations include the International Olympic Committee, the International Paralympic Committee, International Federations (IFs), which include all IOC-recognised IFs, National Olympic and Paralympic Committees, as well as anti-doping organisations NADO and RADO.<sup>8</sup> Moreover, the Code's inclusion of dual components (a set of sufficiency conditions as well as a prohibited list) is appropriate. This is because a prohibited list in the absence of sufficiency conditions would invite objections that the list is arbitrary; it would be unclear to signatories to the Code why specific prohibited substances are on the list rather than others. Likewise, sufficiency conditions without a corresponding prohibited list could create confusion in contested cases where there might be reasonable disagreement about whether the sufficiency conditions apply.

Despite these concessions, we want to suggest that – at least at present – the Code fails not only normative extensional adequacy but also internal alignment. We will consider a case study featuring the prohibition of acetazolamide and dexamethasone in high-altitude sports to make this point. §2 explores why the Code's verdict about acetazolamide and dexamethasone in high altitude sports both reveals a way in which it fails internal alignment and normative extensional adequacy; we then extrapolate from the high-altitude sport case study to show why we can expect the Code to face structurally similar problems elsewhere. In this respect, while our case study focuses in some detail on how high-altitude sport poses challenge to the Code, we will see how the problems raised have ramifications beyond high-altitude sport. To avoid these problems, it is shown that what is needed are several important changes, which are then proposed and defended in §3. Among the key

substantive changes, we defend (i) some key changes to the enhancement potential condition; and (ii) a spirit-of-sport condition that is centred around the normative concept of *achievement*, or success-from-ability.

## High altitude sports: a case study

Our case study in high-altitude sports, which will be shown to put pressure on the current elaboration of the Code, will be organised in four parts. §2.1 reviews the impact of high altitude on body and brain; §2.2 details current interventions for enhancing performance at altitude; §2.3 discusses the World Doping Code's stance on high-altitude drug use; and §2.4 shows why the Code fails in this case to achieve both internal alignment as well as normative extensional adequacy. Taken together, the case of high-altitude sports is suggestive of how the Code might benefit from revision, which will be the aim of §3.

### *The impact of high altitude on body and brain: a brief review*

Travel to areas of high altitude – i.e., elevations above 8,200 ft. (2,400 m)<sup>9</sup> – has become increasingly popular. With a significant proportion of the world's geography lying above 10,000 ft (3,048 m) elevation, greater access to these remote regions has seen a surge in recreational, occupational, and (of particular interest in the present context) sporting pursuits.

However, such pursuits carry physical and cognitive challenges. Crucially, at high altitudes, the proportion of oxygen in the air remains constant whilst the driving pressure of oxygen in inspired air is significantly reduced. Consequently, oxygen delivery to peripheral tissues is decreased, making high-altitude a hypobaric hypoxic environment (Heath 1977). In contrast to natives who have adapted mechanisms to live at such heights (e.g., lowered alveoli to arterial oxygen gradient via genetic adaptation), individuals travelling to high altitude for short periods, such as for athletic competitions, are at increased risk of experiencing detrimental effects (e.g., Hoopeler and Vogt 2009). Specifically, these unacclimatised individuals are at risk of *high-altitude illness* (HAI) – a collective term for acute mountain sickness, high-altitude cerebral oedema, and high-altitude pulmonary oedema (e.g., Basnyat and Murdoch 2003) at as low as 4,921 ft (1,500 m). While some degree of acclimatisation occurs in those travelling to high-altitude over short periods, these changes are often inadequate, and HAI ensues, which can be fatal (Leissner and Mahmood 2009).

In addition to causing the physiological deficits mentioned above, cognitive deficits are common at high altitudes. Due to the increased oxygen demand of the brain, the central nervous system is especially vulnerable to the effects of cellular oxidative stress. An imbalance between harmful reactive

oxidant species and protective antioxidant species results in damage to proteins, lipids, and DNA, resulting in neurodegeneration (Dosek et al. 2007), which is compounded by the additional stressors present at high altitude (e.g., extreme weather, dehydration, and physical exertion).<sup>10</sup>

So, what impact does this have in practice? Clinically, altitude miners and mountaineers have presented with memory impairment, reduced psychomotor performance and reaction times, learning abilities, mood disorders, and insomnia (Hornbein et al. 1989). The effects of hypoxia can even induce auditory and visual hallucinations (Brugger et al. 1999). These deleterious effects have been reported not only to occur in both acute and chronic exposure to hypoxia but as sometimes persisting after returning to sea level (Cavaletti et al. 1990). Higher brain functions of the sort compromised at altitude are essential for everyday life and are even more critical at altitude, where environmental challenges make simple tasks troublesome. With all of this in mind, let's now consider interventions that aim to help with the physical and cognitive impacts of high-altitude environments.

### ***Current interventions for enhancing performance at altitude***

The Wilderness Medical Society presents evidence-based recommendations compiled by an expert panel on preventing and treating high-altitude illness (Luks et al. 2019). Along with a gradual ascent and the commonplace use of supplementary oxygen, they suggest acetazolamide 'should be strongly considered in travellers at moderate or high risk of [Acute Mountain Sickness] with ascent to high-altitude'. A carbonic anhydrase inhibitor, acetazolamide can combat headaches, fatigue, nausea, dizziness, and breathlessness at altitude.<sup>11</sup> Dexamethasone – a glucocorticoid medication – is suggested as a suitable alternative with similar outcomes for use when acetazolamide is unsuitable due to a history of intolerance or allergic reaction (Luks et al. 2019).

In comparison, effective medications against neuropsychological impairments at altitude are less well established. Historically, stimulants such as amphetamine were found to improve psychomotor performance – but this drug has undesirable side effects, exacerbating sleep disruption (Adler et al. 1950). And since poor sleep quality has been linked to worsening cognitive functions in hypoxia, any benefits will plausibly be outweighed by the risks it presents in the application of mountaineering medicine. Caffeine can help to improve endurance, attention, and reaction time (e.g., Adler et al. 1950), and the International Society of Sport Nutrition (ISSN) reports that the use of caffeine in conjunction with endurance exercise at altitude is now 'well supported' (for example, there have been encouraging results concerning the beneficial effects of caffeine in cases of hypoxia (Guest et al. 2021)).<sup>12</sup>

Also of value is the use of *nootropics* at high altitudes. With respect to the cognitive deficits associated with hypoxia, piracetam-like nootropics (e.g.,

stimulants like oxiracetam and Pramiracetam) appear to be of most benefit. For example, a study conducted on 60 military members ascending to 13,123 ft (4,000 m) altitude administered pre-treatment with oxiracetam to the participants. Oxiracetam significantly improved cognitive function compared to the control group post-arrival at altitude (Hu et al. 2017). This data indicates preconditioning with nootropic agents could produce cognition-protective effects in people who travel to high-altitude areas across a spectrum of objectives, including competitive objectives.

### ***The world doping code on high-altitude drug use***

Since physical activity and exercise are frequently performed for major sporting events in high-altitude environments (e.g., the Tour de France, Leadville 100, Badwater 135 Ultramarathon, etc.), such environments provide a useful case study that turns out to challenge some of the received wisdom about the nature of doping in sports, as well as how this is enshrined in the World Anti-Doping Code.

Historically, drugs used during high-altitude activities were reserved for treating emergency situations such as high-altitude cerebral oedema (HACE). Nowadays, as discussed above, it appears the use of dexamethasone and acetazolamide is generally accepted as prophylaxis against high-altitude sickness. However, there is concurrent evidence that in such contexts, these same drugs function as physical and cognitive *enhancements*, not merely protecting climbers from context-related illness but also taking them above their baseline of performance.<sup>13</sup>

With this in mind, consider now a normative question: *should* dexamethasone and acetazolamide be prohibited for use in high-altitude sporting competitions, assuming that they offer enhancement potential? We get a simple – albeit ultimately unsatisfactory answer – if we look at the World Anti-Doping Code's list of prohibited drugs; the list explicitly includes both acetazolamide and dexamethasone. We want to suggest, however, that this commitment is problematic with reference to *both* the internal alignment and normative extensional adequacy desiderata that are (as outlined in §1) applicable to the joint components of the Code (sufficiency and the list of prohibited substances).

Firstly, let's consider *internal alignment*. From the fact that acetazolamide and dexamethasone are on the prohibited substance list, we ought to be able to clearly identify (at least) two of the three conditions, which these substances satisfy. Because there is some empirical support already for *enhancement potential*, so let's grant this *ex ante*. The problem is that even granting enhancement potential, it is not clear which of the other two conditions could plausibly be met specifically for acetazolamide and dexamethasone in high-altitude sports. Let us look first at the health risk condition. As with

many drugs with therapeutic and/or enhancing potential, the possibility of unwanted side effects constitutes a health risk: an uncertain but unwanted outcome. That said, consider that if *any* non-zero probability of health risk is interpreted as implicating that fulfilment of WADA's health risk condition, then the satisfaction of the condition would become trivial. On the assumption that the WADA takes the health risk condition to be *non-trivial*, we should accordingly expect then that the health risk condition should be interpreted as being satisfied just in case the 'actual or potential health risk to the athlete' is not *merely* non-negligible but at least above some threshold (where the bare existence of side effects does not automatically imply that threshold).

One natural threshold here would be set by asking whether the *risk expectation value* (i.e., the probability of the risk event materialising multiplied by the disvalue of its materialising) of side effects from taking a given substance outweighs the (purely health-related – and controlling for any benefits to performance) benefit expectation value of taking that substance.

Regarding this kind of threshold, however, it is far from clear that using such drugs as acetazolamide and dexamethasone in high-altitude climbing context constitutes a 'health risk': after all, these drugs are recommended by the Wilderness Medical Society as both prophylactics and treatments for high-altitude illness, because of the expected health-related benefits at such altitudes and even taking into account the expected health risks at such altitudes, which include possible side effects such as the impediment of concentration and short-term memory (Wang et al. 2013).<sup>14</sup> As a second and related point, it will be useful to distinguish between risks necessary for the production of a sport's internal goods, and unnecessary risks.<sup>15</sup> A further precision of the kind of risk expectation value we're exploring above might control for the former kind of risk in its calculation – focusing on unnecessary risks (when setting the relevant threshold). However, even on such a further precision, it would still be not at all clear that any health-risks would *not* be necessary for the sport's internal goods – at least in so far as they are needed to ensure health that would be requisite to supporting the attainment such goods at altitude.

So, what about the spirit of sport condition? Here is the elaboration offered by the WADA:

The "spirit of sport" is the essence of Olympism, the pursuit of human excellence through the dedicated perfection of each person's natural talents. It is how we play true. The spirit of sport is the celebration of the human spirit, body and mind, and is reflected in values we find in and through sport, including: Ethics, fair play and honesty; Health; Excellence in performance; Character and education; Fun and joy; Teamwork; Dedication and commitment; Respect for rules and laws; Respect for self and other Participants; Courage; Community and solidarity.<sup>16</sup>



This clause has many different elements, complicating our ability to test specific cases with respect to it. Moreover, as Waddington et al. (2013, 45) notes, the phrasing in the Code, partly on account of its reliance on so many complex concepts, can be challengingly vague to pin down. We can distinguish at least the following values represented:

- Natural talent
- Ethical values (character, commitment, fairness, honesty, respect, courage, solidarity)
- Fun and joy
- Health, excellence, and commitment

As Obasa and Borry (2019) note, the wording of the above clause has stayed mostly constant over the past several decades, with one notable exception being the addition in 2015 of the phrase ‘the pursuit of human excellence through the dedicated perfection of each person’s natural talents’.<sup>17</sup>

It seems initially plausible that if drugs like acetazolamide and dexamethasone, which have enhancement potential while at the same time evidenced therapeutic benefit at high altitudes, violate the spirit of sport with reference to the values in the above passage, it will be with reference to either ‘natural talent’ or any one or more of the ethical values the passage reflects. That said, it will be difficult to see how acetazolamide and dexamethasone at high altitudes would violate the spirit of sport condition by being in tension with any of the above values based on a rationale that would not overgeneralise over to *supplemental oxygen* – which is not prohibited. As Bezruchka (2005, 14) puts it, ‘most climbers consider their supplemental oxygen as equipment – just as much a part of their experience as their Gore-Tex gear, and certainly as foundational as their extensive training’.

It is also worth noting that acetazolamide and dexamethasone use need not be at odds with an even wider interpretation of the ‘spirit of sport’ which includes other dimensions of fair play. For instance, as Morgan (2009) has argued, the ideal of ‘fair play’ against which doping should be problematized has two separate dimensions. One of those dimensions is captured by something akin to Butcher and Schneider’s (1998) notion of ‘respect for the game’, a notion that maps on very closely (even if not imperfectly) with ‘spirit of sport’ as it features in the WADA code.<sup>18</sup> However, a separate dimension of fair play noted by Morgan tracks ‘fair play as a reciprocal regard for the interests of individual participants in sport’. In principle at least, it could be an open question whether the use of a given drug fails the ‘respect for the game’ or a ‘reciprocal regard for individual interests’ criterion conditioned on its failing the other. And so, it may seem relevant then to consider whether acetazolamide and dexamethasone use in high-altitude sport fail interpretations of fair play (such as the reciprocal regard interpretation) that go *beyond*

just the core unpacking of ‘spirit of sport’ in the WADA Code. However, even brief reflection on this point suggests that there will be no interesting way in which acetazolamide and dexamethasone use come apart from supplemental oxygen use in this regard. From the point of view of fair play as reciprocal regard, for instance, there would be relational unfairness only if there were disproportionate use among competitors; but the same applies for supplemental oxygen. In sum, then, even when we widen the idea of ‘spirit of sport’ to include other interpretations of fair play, it remains difficult to see how acetazolamide and dexamethasone at high altitudes would violate the spirit of sport condition with reference to a rationale that would not overgeneralise over to supplemental oxygen.

A defender of the WADA code (which bans acetazolamide and dexamethasone but not supplemental oxygen) might attempt to press back here by drawing a disanalogy between acetazolamide and dexamethasone on the one hand, and supplemental oxygen on the other. While acetazolamide and dexamethasone have *both* therapeutic and enhancement potential, supplemental oxygen has only therapeutic potential. However, this observation does not, on closer inspection, help save the account against the overgeneralisation objection in the current dialectical context. After all, remember that we have already granted the friend of the current WADA code that acetazolamide and dexamethasone have enhancement potential and thus satisfy the first of the three conditions. What we are asking now is whether – *beyond* having such enhancement potential – these substances violate any of the other two conditions, and the spirit of sport condition in particular, in a way that supplemental oxygen would not.

Once this point is appreciated, though, it really is not clear what story the friend of the WADA code (in its present formulation) must tell for why acetazolamide and dexamethasone would violate the spirit of sport (while supplemental oxygen would not). Both interface in the same way with the ‘natural talent’ dimension of the spirit of sport condition; none of these is natural. And as for ethical values: of course, *if* we hold fixed that acetazolamide and dexamethasone are banned, and supplemental oxygen is not, then it follows trivially that using acetazolamide and dexamethasone is cheating with reference to established rules, and such cheating has a bearing on such things as fairness, character, honesty, respect, etc. However, the friend of the current WADA code’s formulation isn’t in a position to respond to the overgeneralization objection in this way without begging the question against one who doubts that acetazolamide and dexamethasone *should* be banned.

### ***Problems with internal alignment and normative extensional adequacy***

The foregoing discussion in §2.3 suggests that the current formulation of the WADA code features *internal misalignment*: acetazolamide and

dexamethasone are on the prohibited list, but (in the absence of further clear argument) it looks as though they meet only one of the three conditions in a plausible way. Interestingly, what goes for acetazolamide and dexamethasone might also plausibly go at high altitudes for nootropics such as oxiracetam. Whereas acetazolamide and dexamethasone plausibly have both therapeutic and enhancement potential at high altitudes (and so satisfy *enhancement potential*), so does oxiracetam, which is so even if one's use of oxiracetam would be an enhancement but not therapeutic for otherwise healthy individuals who are not at high altitude.

The wider situation for the present WADA code is more vexed: not only do we have internal misalignment but we plausibly also fail to satisfy *normative extensional adequacy*; because the WADA code currently prohibits substances it should prohibit only if it should prohibit supplemental oxygen at high altitudes (which it should not), it is not the case that the code prohibits all and only substances it should prohibit.

### **A proposed revision**

It is worth, at this point, briefly taking a step back and thinking about the import of the case study from a wider perspective. Even by just focusing on substances such as acetazolamide and dexamethasone, for use specifically in high-altitude competition, we see how two kinds of problems surface for the WADA code, problems concerning both *internal misalignment* as well as *normative extensional adequacy*. The problems raised concerning *internal misalignment* as well as *normative extensional adequacy* – however, it is worth registering – owed in our case study to the fact that both substances have enhancement potential while at the same time evidenced therapeutic benefit at high altitudes. We have reason to expect, then, that revisions suggested to the Code on the basis of this case study will have wider import in other cases where substances have both enhancement potential while at the same time evidenced therapeutic benefit when used in the specific conditions were performance (in a given sport) as assessed. We will continue in our proposed revision to the Code to use the high-altitude example as our reference point, but the reader should keep in mind this broader context in which such revisions to the Code are plausibly relevant.

Against the background, how, then, should the Code be revised in light of the problems for both internal alignment and normative extensional adequacy outlined? Let us begin with a few desiderata that will guide our proposed revisions.

First, and drawing from our discussion of how a substance's meeting the 'enhancement potential' condition should not entail that it violates the spirit of sport condition (or else the spirit of sport clause would be redundant), we should insist on the following 'irredundancy' desiderata:

*Irredundancy desideratum:* Any proposed prohibition condition should be irredundant within the set of conditions any subset of which are jointly sufficient for prohibition; that is, its satisfaction should not be entailed by the satisfaction of any of the other conditions.

Additionally, and drawing from the complexity of the current spirit of sport clause (with its wide range of values), we should insist on a desideratum we can call *action-guidance*:

*Action-guidance desideratum:* No proposed prohibition condition should be too complex to apply in a principled way in practice.

With the above desiderata in mind, we want to suggest at least an initial way that the code might be beneficially revised so as to get the following concrete results: it should not prohibit, by its conditions, acetazolamide, dexamethasone, and oxiracetam for use at high altitudes, and getting this result will require amending the sufficiency conditions so that they can leave these drugs off the prohibited list (for high altitude sports) without the cost of internal misalignment. However (keeping in mind normative extensional adequacy), we want to attain the above result while at the same time leaving the Code's conditions strong enough that paradigmatic cases of doping (e.g., anabolic steroids in baseball, etc.) will meet the conditions for prohibition. And finally, to reiterate, we want to get all of these results while simultaneously meeting the irredundancy and action-guidance desiderata on the conditions offered.

A first idea we want to advance in the course of meeting the above objectives is what we'll call *therapeutic exemption*, which will be useful for navigating cases where there is overlap between enhancement potential and therapeutic potential.<sup>19</sup> The key idea here is as follows: for a given substance, X, and competitive activity A, *even if* X has enhancement potential in A, if it also has (i) significant *therapeutic* potential in A, *and* (ii) the environment in which one is competing in A is such that that therapeutic potential is likely to be *realised* on account of A's taking one below normal levels of functioning, then X does fail to meet the 'enhancement potential' condition. The reasoning here is as follows: 'natural abilities' are *environment relative* in the sense that abilities just are abilities to perform reliably when one is in the right kind of shape and situation for performing that ability type.<sup>20</sup> When one is deprived of oxygen and cognitively impaired (as is expected at high altitudes) one's natural abilities are best understood as dispositions that are *masked* by this impairment; one is, so impaired, not in a position to exercise natural abilities.<sup>21</sup>

Accordingly, then, once we accept therapeutic exclusion, we get an amended formulation of the enhancement potential condition: call this *Enhancement potential+*:

*Enhancement potential+*: (i) it has the potential to enhance or enhances sport performance; and (ii) the conditions for *therapeutic exemption* are not met.

As far as we are concerned, the 'health risk' condition can be left more or less intact, with just one caveat: the relevant health risk, as this term features in the condition, should be understood *non-trivial* in the manner described in §2. Thus:

*Health risk+*: it represents a *non-trivial* health risk to the athlete;

*Enhancement potential+* and *Health risk+* are logically independent conditions, and so satisfy irredundancy. Moreover, *enhancement potential+* nicely gets us the result that acetazolamide, dexamethasone, and oxiracetam would not be prohibited in high-altitude climbing (with reference to the revised *enhancement potential+* condition), given therapeutic exclusion.

However, what is still needed is a spirit of sport condition the satisfaction of which would not be entailed by the *enhancement potential+* condition. After all, without such an additional (irredundant) condition, we would lack a way of explaining why we should *not* prohibit substances that *do* have enhancement potential in *non-therapeutic* environments but which (keeping normative extensional adequacy in mind) we should *not* plausibly prohibit. This includes, e.g., Nike VaporFly running shoes in track competition (which allow for faster running than most other shoes)<sup>22</sup> and rosin for pitching in baseball; rosin is a sticky powder made from pine tree sap that pitchers rub on their hands to better grip the baseball before throwing a pitch.<sup>23</sup> Furthermore, the kind of spirit of sport condition that is needed should (from action-guidance) not be too complicated to apply in a principled way by organisations adopting the Code.

We submit, drawing from recent work in axiology, that the core normative concept at the heart of a plausible spirit of sport condition should be that of *achievement*: where the structure of an achievement is a *success primarily explained by ability* (Greco 2010) rather than by luck or by something external to one's own ability. The core idea we will elaborate upon further is as follows:

*Spirit of Sport+*: it violates the spirit of sport by undermining the performer's achievement.

This suggestion to capture the spirit of sport condition principally through the normative concept of achievement is for several reasons.

First, notice that from the simple fact that a substance satisfies *enhancement potential+*, it will remain (as it should) an open question whether one's performance that depends on that substance would be an achievement. There would be no entailment here; a success can both depend (to some extent) on an enhancing substance and be such that the success is primarily explained by ability. For a non-competitive example of such compatibility: if

a brilliant mathematician solves a complicated proof partly via non-therapeutic Adderall to stay awake during the last stage of the proof, the Adderall in this context meets *enhancement potential+* even though the mathematician's success remains primarily explained by ability and not by the drug. (After all, consider the boost in wakefulness in the absence of the mathematical ability would give one no chance whatsoever of solving the proof). Given that from the fact that a substance satisfies the prohibition condition *enhancement potential+* it remains an open question whether the substance fails to qualify as an achievement (success primarily explained by ability), an achievement-theoretic spirit of sport condition will accordingly be *irredundant*, which meets a core desideratum outlined above.

Second, consider that the value of achievement, understood as success from ability, is a value that lines up nicely with a wide range of the values already noted and is a proper object of reactive attitudes such as respect<sup>24</sup>; in this way, as a value, it is harmonious with values already specified in the WADA characterisation of the spirit of sport and its value. Third, the normative concept of achievement offers a more concrete touchstone for action guidance than what is presently a complex concatenation of disjoint normative concepts (e.g., ethics, character, commitment, fairness, honesty, respect, courage); qua singular normative concept, it is *ceteris paribus*, a better candidate for *action-guidance*. Fourthly, and relatedly: a 'test' for whether a substance meets (or does not meet) an achievement-theoretic spirit of sport condition can be structured with reference to the familiar notion of *causal explanation*, and it is a notion that is sensitive to context in a way that offers desired flexibility.

This point is worth elaborating on. Consider that when asking whether a success is *primarily explained* by ability (as opposed to substance), we are asking a question about comparative causal explanations. As Greco has argued, causal explanations are sensitive to interests and purposes in one's practical reasoning environment (Greco 2008). For example, the most salient cause in an explanation for a traffic accident, when the cause of the accident is assessed in a practical reasoning environment consisting in the drivers and the officers at the scene, might be a driver's failure to yield. In contrast, when the practical reasoning environment is a city hall planning meeting, the more salient explanation of the accident might be a poorly designed intersection as opposed to the driver's failure to yield. The fact that our judgments of causal-explanatory salience are sensitive to the interests and purposes of the practical reasoning environment in which such judgments are made is a benefit of the proposal. This 'contextualist' feature of the proposal leaves it flexible enough to allow that judgments of causal explanatory salience that are pertinent to whether an achievement-theoretic spirit of sport prohibition condition is met (or not) will be indexed to the interests and purposes that govern salience for the *specific kind of competition* in which the condition is

being applied. Fifth, the achievement-theoretic spirit of sport does well by the lights of normative extensional adequacy. Anabolic steroids in baseball will come out as violating the spirit of sport prohibition condition, given that the influence of steroids in explaining a success (e.g., a home run) will, given the interests and purposes of baseball competition and the level of gain achieved by such steroids over the baseline, trump whatever default salience the player's natural abilities will have in explaining that success. The same does not hold in the case of acetazolamide and dexamethasone in high altitude sports. That said – crucially – even if acetazolamide and dexamethasone do not meet the *Spirit of sport+* prohibition condition in the context of *high-altitude* sports, it remains open that acetazolamide and dexamethasone might meet the *Spirit of sport+* prohibition condition in the context of other (non-high altitude) sports.<sup>25</sup>

The above observation brings us to a wider point about our proposed revised code that is relevant for internal alignment. From what we've suggested, *normative extensional adequacy* will require that drugs such as acetazolamide and dexamethasone might violate the spirit of sport *in non-high-altitude* contexts even if they do not at high-altitude. This suggests an inescapable conclusion: our revised code will fail internal alignment *if* there is a single prohibited list of substances that is meant to cover all competitions equally. Prohibited lists should be competition-relative; and the substances prohibited on a given (competition-relative) list will just be those substances that are prohibited by the *three* conditions: *enhancement potential+*, *health risk+*, and *spirit of sport+*, where (as we've seen) *spirit of sport+* is a contextualist condition that will generate different results in different competitions, as we should expect. (In our example, we've suggested acetazolamide and dexamethasone, even if they meet the *spirit of sport+* prohibition condition (by undermining achievement) at normal altitude, they will not likewise undermine achievement (and thus violate spirit of sport+ at high altitude). This is just the result we should want.

With the above benefits of the achievement proposal in view, it will be useful to briefly distinguish this proposal from a related proposal to which we are sympathetic, but which differs in its substantive details. On this point, consider, for instance Heather Reid's (2020) recent emphasis on 'athlete agency' in characterising the kind of values that line up with the spirit of Olympic sport. As she puts it: 'Olympism celebrates humanity, specifically human agency, so we need to preserve the degree to which athletes are personally and morally responsible for their performances' (2020, 22). Our characterisation of the spirit of sport is clearly in line with this idea. Where we diverge from Reid, however, is on the place of *causation* in her account. For Reid, athlete agency (as it features in her characterisation of the spirit of sport) is 'the idea that the athlete herself is the primary cause of her performance (2020, 28)'. Our proposal, following a tradition due to Davidson (e.g., 1992)

distinguishes between *causal relations* and *causal explanations*, focusing only the latter in our account of achievement in characterising the spirit of sport. The difference here is subtle but has material implications. Causal relations (e.g., of the form 'A caused B') asymmetrically entail causal explanations 'B because of A'. Causal explanations, for one thing, are less restrictive about what kinds of things can feature in their relata (see, e.g., Beebe 2004). The athlete's *refraining* from attempting an unwise shot can be an admirable achievement in a certain circumstance, even if strictly speaking, absences of events (e.g., the absence of the event of the athlete taking the shot) don't ordinarily feature in standard views of causes (e.g., Collins et al. 2004),<sup>26</sup> which include only events as causal relata. Secondly, the social context of a performance inextricably determines what counts as salient of causal explanations (e.g., we blame the goalie – due to the normative expectations assigned to that role – rather than a striker for not defending against a shot, even if both equally played no causal role in stopping it). Our achievement-theoretic gloss of the spirit of sport condition, by relying on causal-explanatory salience rather than agent causation, accordingly can accommodate a wider class of activity that we intuitively take agents to be responsible for.

In sum, then, the overarching picture – which offers some key revisions to the present formulation of the Code – meets the desiderata outlined and does so in a way we've seen the current formulation does not. The picture we've suggested, to reiterate, is one that features three jointly necessary and sufficient conditions for a substance's prohibition, conditions that target (as the present formulation does) enhancement potential, health risk, and the spirit of sport. Our preferred formulation of the third (spirit of sport) condition is distinctly *contextualist*. As such, the results we get in applying the third condition will be sensitive to specific sports, and the interests and purposes and success norms internal to those sports: in a bit more detail, such interests and purposes and norms (internal to a given sport) will determine what does (and does not) count as salient in a causal explanation for actual and hypothetical success in that particular sport – and by extension, whether the spirit of sport prohibition condition is met for a given substance (in that sport). Accordingly, then, when the conditions are applied to substances within a particular type of competition, we get *internal alignment* only by articulating a prohibited list that includes all and only substances that meet the three necessary and sufficient conditions as applied *within the context of that particular competition-type*. Different prohibited lists will differ across different competition types. *Normative extensional adequacy* is attained just when the internal alignment (relative to a competition type) maps onto a prohibition list that includes all and only those substances we ought to prohibit for that competition type. We've suggested here why our proposed revisions do well (and better than the former proposal) by the lights of



normative extensional adequacy: among other things, it offers the flexibility to handle our high-altitude case study, and it does so while also getting the right result in prohibiting paradigmatic cases of prohibited substances (as well as substances that would violate the spirit of sport at high altitude) while at the same time failing to prohibit substances that are clear-cut enhancers (and where there is no therapeutic exclusion) but which do not plausibly violate the spirit of sport. These are just the results we should hope a successful formulation of the Code would secure.

## Concluding remarks

We have used the case of high-altitude sports as an extended case study in order to motivate several revisions to the World Anti-Doping Association Code. A careful look at high-altitude sports reveals why the current formulation of the Code – consisting in a list of sufficiency conditions alongside a list of prohibited substances – fails two important desiderata we should expect a Code to meet. These desiderata are what we call *internal alignment* (between the sufficiency conditions and the prohibited list) and *normative extensional adequacy* (viz., the desideratum that the code will prohibit all and only those substances it ought to). After seeing why high-altitude cases pose an intractable problem for the current formulation of the Code (*vis-à-vis* both internal alignment and extensional adequacy), we've articulated several key substantive revisions, the incorporation of which would allow the Code to do better by both of these important metrics of evaluation.

What we've proposed, specifically, are revisions to all three core conditions that feature in the present formulation of the Code: the enhancement potential condition, the health risk condition, and crucially, the spirit of sport condition. The critical normative concept at the centre of our revised spirit of sport condition is that of *achievement*, or success primarily explained by ability; we've argued that suitably understood, an achievement-theoretic articulation of the spirit of sport condition has a number of advantages over the present formulation of this condition, which is a concatenation of disjoint normative concepts. Furthermore, we've also traced out an important implication of the contextualist character of our favoured substantive gloss of our achievement-theoretic spirit of sport condition, which is that different prohibited lists will inevitably – and rightly – applicable for different competition types; this is necessary, we've shown, for both internal alignment and normative extensional adequacy.

Applying our conditions in practice will sometimes require complex interpretation, particularly when it comes to assessing the spirit of sport condition concerning achievement (and making causal-explanatory judgments that require assessment of whether a given substance undermines achievement in the context of a particular sport). This, we see, is unavoidable; what we've

offered here, however, are conditions that require comparatively less interpretive confusion than the present conditions while at the same time generating more plausible and internally consistent results.

## Notes

1. See McNamee (2012); McNees (2015); Moore (2017).
2. In particular, the 2002 BALCO scandal in major league baseball (e.g., McGrath 2011).
3. The recent case of particular interest has been Russian Olympic figure skater Kamila Valieva, who tested positive for trimetazidine during the 2022 Winter Olympics.
4. As Morgan characterises the landscape, we find ‘pharmacological libertarians’ on one end of the spectrum of permissiveness, and ‘essentialists of varying stripes’ (2009, 162) on the other end. Morgan’s own position on the distinction is meant to represent a kind of alternative that understands the distinction in light of its historical situatedness. For critical discussion, see, e.g., Schneider (2018).
5. For example, one aspect of fair play is relational and concerns principally advantages over competitors and the sources of those advantages; another dimension of fair play concerns comportment with something like a ‘sporting spirit’ – which is a dimension that is, in principle, separate from the relational aspect of fair play.
6. Note that the characterisation given above is minimally committal, and so is meant to offer a largely uncontentious way of capturing the core idea of an enhancement. By relying on this general idea only, for the purposes of discussion here, we are not meaning to rule out the plausibility of more robust and substantive characterisations of enhancement and how it differs from mere therapy, and how (e.g., as per Morgan 2009) such differences might be importantly influenced in specific domains of attribution by historical contingencies. Rather, we are simply not *assuming* anything beyond the core idea in what follows.
7. <https://www.wada-ama.org/en/prohibited-list>
8. See ‘Code Compliance’ <https://www.wada-ama.org/en/what-we-do/world-anti-doping-code>
9. See e.g., Paralikar and Paralikar (2010).
10. See e.g., Huey and Eguskitza (2001).
11. See e.g., Leaf and Goldfarb (2007).
12. Thanks to an anonymous reviewer for noting that this substance has been recognized as violating the WADA criteria but is accepted because of its social use.
13. For example, dexamethasone injections have the potential to significantly raise the level of glucocorticoids in the blood.
14. Note that another potential side effect is steroid toxicity (Subedi et al. 2010).
15. Thanks to an anonymous referee for suggesting this distinction.
16. WADA 2015. spirit of sport. [https://www.wada-ama.org/sites/default/files/resources/files/wada\\_ethicspanel\\_setofnorms\\_oct2017\\_en.pdf](https://www.wada-ama.org/sites/default/files/resources/files/wada_ethicspanel_setofnorms_oct2017_en.pdf)
17. (Obasa and Borry 2019, 444).

18. For instance, there is overlap between values itemised under the spirit of sport description in the WADA code and the Butcher and Schneider characterisation of 'respect for the game'.
19. Note that we are using this term in a technical sense, which is different from the entirely separate policy of the WADA in which individuals (on a case by case basis) may apply for a therapeutic use exemption on the basis of personal-specific needs. <https://www.wada-ama.org/en/athletes-support-personnel/therapeutic-use-exemptions-tues>.
20. See Sosa (2010).
21. For a discussion of masking in the philosophy of dispositions, see Fara (2008).
22. (Guinness et al. 2020; Dyer 2020).
23. See, e.g., Yamaguchi et al. (2020).
24. See, e.g., Bradford (2015).
25. A point we will bracket for the present purposes is whether there might, in some contexts, be independent justifications for banning a substance, where this independent justification is different from what is captured by the set of conditions (e.g., enhancement potential, health risk, spirit of sport). The kind of justification we have here is the following: some drugs have the capacity to mask whether one has taken *other* drugs where these other drugs may be rightly prohibited. There might be a plausible justification for banning such drugs; however, the justification will need to be made independent of the standard set of conditions given.
26. See, e.g., Ch. 1 and Ch. 10.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## ORCID

Emma C. Gordon  <http://orcid.org/0000-0002-0117-2811>

## References

- Adler, H, W Burkhardt, A Ivy, and A Atkinson. 1950. "Effect of Various Drugs on Psychomotor Performance at Ground Level and at Simulated Altitudes of 18,000 Feet in a Low Pressure Chamber." *The Journal of Aviation Medicine* 21 (July): 221–236.
- Basnyat, Buddha, and David R. Murdoch. 2003. "High-Altitude Illness." *Lancet (London, England)* 361 (9373): 1967–1974. doi:10.1016/S0140-6736(03)13591-X.
- Beebee, H. 2004. "Causing and Nothingness." In *Causation and Counterfactuals*, edited by L. A. Paul, E. J. Hall, and J. Collins, 291–308. Cambridge, MA, USA: MIT Press.
- Bezruchka, Stephen. 2005. *Altitude Illness: Prevention & Treatment*. Seattle: Mountaineers Books.
- Bradford, Gwen. 2015. *Achievement*. USA: Oxford University Press.
- Brugger, P., M. Regard, T. Landis, and O. Oelz. 1999. "Hallucinatory Experiences in Extreme-Altitude Climbers." *Neuropsychiatry, Neuropsychology, and Behavioral Neurology* 12 (1): 67–71.

- Butcher, R. B., and A. J. Schneider. 1998. "Fair Play as Respect for the Game." *Journal of the Philosophy of Sport* 25: 1–22.
- Cavaletti, G., P. Garavaglia, G. Arrigoni, and G. Tredici. 1990. "Persistent Memory Impairment after High Altitude Climbing." *International Journal of Sports Medicine* 11 (3): 176–178. doi:10.1055/s-2007-1024787.
- Collins, J., N. Hall, and L. A. Paul, ed. 2004. *Causation and Counterfactuals*. Cambridge: MIT Press.
- Davidson, D. 1992. "Thinking Causes." In *Mental Causation*, edited by John Heil and Alfred R. Mele. Oxford: Oxford University Press.
- Dosek, Agoston, Hideko Ohno, Zoltan Acs, Albert W. Taylor, and Zsolt Radak. 2007. "High Altitude and Oxidative Stress." *Respiratory Physiology & Neurobiology* 158 (2–3): 128–131. doi:10.1016/j.resp.2007.03.013.
- Dyer, Bryce. 2020. "A Pragmatic Approach to Resolving Technological Unfairness: The Case of Nike's Vaporfly and Alphafly Running Footwear." *Sports Medicine-Open* 6 (1): 1–10. doi:10.1186/s40798-020-00250-1.
- Fara, Michael. 2008. "Masked Abilities and Compatibilism." *Mind* 117 (468): 843–865. doi:10.1093/mind/fzn078.
- Greco, John. 2008. "Whats Wrong with Contextualism." *Philosophical Quarterly* 58 (232): 416436. doi:10.1111/j.1467-9213.2008.535.x.
- Greco, John. 2010. *Achieving Knowledge: A Virtue-Theoretic Account of Epistemic Normativity*. Cambridge: Cambridge University Press.
- Guest, N. S., T. A. VanDusseldorp, M. T. Nelson, J. Grgic, B. J. Schoenfeld, N. D. M. Jenkins, S. M. Arent et al, 2021. "International Society of Sports Nutrition Position Stand: Caffeine and Exercise Performance." *Journal of the International Society of Sports Nutrition* 18 (1).
- Guinness, Joseph, Debasmita Bhattacharya, Jenny Chen, Max Chen, and Angela Loh. 2020. "An Observational Study of the Effect of Nike Vaporfly Shoes on Marathon Performance." *ArXiv Preprint ArXiv:2002.06105*.
- Heath, Donald. 1977. *Man at High Altitude: The Pathophysiology of Acclimatization and Adaptation*. Edinburgh (etc.): Churchill Livingstone.
- Hornbein, T. F., B. D. Townes, R. B. Schoene, J. R. Sutton, and C. S. Houston. 1989. "The Cost to the Central Nervous System of Climbing to Extremely High Altitude." *The New England Journal of Medicine* 321: 1714–1719.
- Huey, R. B., and X. Eguskitza. 2001. "Limits to Human Performance: Elevated Risks on High Mountains." *The Journal of Experimental Biology* 204 (Pt 18): 3115–3119. doi:10.1242/jeb.204.18.3115.
- Hu, ShengLi, JianTao Shi, Wei Xiong, Li WeiNa, LiChao Fang, and Hua Feng. 2017. "Oxiracetam or Fastigial Nucleus Stimulation Reduces Cognitive Injury at High Altitude." *Brain and Behavior* 7 (10): e00762. doi:10.1002/brb3.762.
- Juengst, Eric, and Daniel Moseley. 2019. "Human Enhancement." In *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta, Summer 2019 Metaphysics Research Lab, Stanford University. <https://plato.stanford.edu/archives/sum2019/entries/enhancement/>
- Leaf, David E., and David S. Goldfarb. 2007. "Mechanisms of Action of Acetazolamide in the Prophylaxis and Treatment of Acute Mountain Sickness." *Journal of Applied Physiology (Bethesda, Md.: 1985)* 102 (4): 1313–1322. doi:10.1152/jappphysiol.01572.2005.
- Leer, Kay B., and Feroze U. Mahmood. 2009. "Physiology and Pathophysiology at High Altitude: Considerations for the Anesthesiologist." *Journal of Anesthesia* 23 (4): 543–553. doi:10.1007/s00540-009-0787-7.

- Luks, AM., PS. Auerbach, L. Freer, CK. Grissom, LE. Keyes, SE. McIntosh, GW. Rodway, RB. Schoene, K. Zafren, and PH. Hackett. 2019. "Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Acute Altitude Illness: 2019 Update." *Wilderness & Environmental Medicine* 30 (4S): S3–S18.
- McGrath, Ben. 2011. *King of Walks: Barry Bonds and the Doping Scandal*, 52–58. New York, N.Y.: NewYorker.
- McNamee, Mike. 2012. "Lance Armstrong, Anti Doping Policy, and the Need for Ethical Commentary by Philosophers of Sport." *Sport, Ethics and Philosophy* 6 (3): 305–307. doi:10.1080/17511321.2012.708252.
- McNees, Matthew James. 2015. *Sport Philosophy Now: The Culture of Sports after the Lance Armstrong Scandal*. Lanham, MD: Rowman & Littlefield Publishers.
- Moore, Eric. 2017. "Did Armstrong Cheat?" *Sport, Ethics and Philosophy* 11 (4): 413–427. doi:10.1080/17511321.2017.1292306.
- Morgan, William J. 2009. "Athletic Perfection, Performance-Enhancing Drugs, and the Treatment-Enhancement Distinction." *Journal of the Philosophy of Sport* 36 (2): 162–181. doi:10.1080/00948705.2009.9714755.
- Obasa, Mojisola, and Pascal Borry. 2019. "The Landscape of the "Spirit of Sport": A Systematic Review." *Journal of Bioethical Inquiry* 16 (3): 443–453. doi:10.1007/s11673-019-09934-0.
- Paralikar, Swapnil J., and Jagdish H. Paralikar. 2010. "High-Altitude Medicine." *Indian Journal of Occupational and Environmental Medicine* 14 (1): 6–12. doi:10.4103/0019-5278.64608.
- Reid, H. L. 2020. "Athlete Agency and the Spirit of Olympic Sport." *Journal of Olympic Studies* 1 (1): 22–36. doi:10.5406/jofolympstud.1.1.0022.
- Schneider, A. J. 2018. "William J. Morgan on Fair Play, Treatment versus Enhancement and the Doping Debates in Sport." *Sport, Ethics and Philosophy* 12 (4):386–400.
- Sosa, E. 2010. "How Competence Matters in Epistemology." *Philosophical Perspectives* 24: 267–475.
- Subedi, BH., J. Pokharel, TL. Goodman, S. Amatya, L. Freer, N. Banskota, E. Johnson, and B. Basnyat. 2010. "Complications of Steroid Use on Mt. Everest." *Wilderness & Environmental Medicine* 21 (4): 345–348.
- Vogt, M., and H. Hoppeler. 2009. "Eccentric exercise in Alpine skiing." In *Science and Skiing IV*, edited by E. Muller, S. Lindinger, and T. Stoegg. Aachen, Germany: Meyer and Meyer.
- Waddington, Ivan, A.V. Christiansen, J. Gleaves, J. Hoberman, and V. Møller. 2013. "Recreational Drug Use and Sport: Time for a WADA Rethink?." *Performance Enhancement & Health* 2 (2): 41–47. doi:10.1016/j.peh.2013.04.003.
- Wang, J., T. Ke, X. Zhang, Y. Chen, M. Liu, J. Chen, and W. Luo. 2013. "Effects of Acetazolamide on Cognitive Performance During High-Altitude Exposure." *Neurotoxicology and Teratology* 35: 28–33.
- Yamaguchi, Takeshi, Naoto Yamakura, Shinnosuke Murata, Takehiro Fukuda, and Daiki Nasu. 2020. "Effects of Rosin Powder Application on the Frictional Behavior between a Finger Pad and Baseball." *Frontiers in Sports and Active Living* 2: 30. doi:10.3389/fspor.2020.00030.