Module 3. Supplements versus foods

Unit 3.1 Supplements versus foods

Supplements are often an important part of conversations about sports nutrition. Sometimes more attention is paid to supplements than to a healthily balanced diet. Many athletes are looking for the magic supplement that will give them the edge and are afraid of missing out if they do not take the supplement. A huge industry is built on this, but what supplements really do what they are claimed to do? What is the evidence? What are the risks of taking supplements and how do you minimise these risks? Most importantly, how do you go about making decisions about supplements?

Here are 5 common thoughts:

- It is believed that supplements are more effective than a healthy diet
- It is believed that supplements can provide a quick fix whereas the positive effects of a balanced healthy diet take a long time
- It is believed that the diet is already balanced and healthy and therefore the next thing to address are supplements
- It is believed that the diet is unbalanced anyway and therefore supplements need to compensate for this and help prevent deficiencies.
- It is believed that the diet may be unbalanced and therefore supplements are an insurance policy. (Jeukendrup, March 18, 2015, https://goo.gl/tWxvwb).

3.1.1 What is a supplement?

"There is no single definition, either legal or within nutritional science, of what constitutes a dietary supplement." (Maughan, Burke et al., 2018, https://goo.gl/vF6Tji). The term supplement indicates that this is something that should be used to "supplement" the diet, not replace it, nor should it be the main focus.

> The US Congress, for example, in framing the 1994 Dietary Supplement Health and Education Act (DSHEA; https://ods.od.nih.gov/About/DSHEA_Wording.aspx), described a dietary supplement as:
>
> *'...a product, other than tobacco, which is used in conjunction with a healthy diet and contains one or more of the following dietary ingredients: a vitamin, mineral, herb or other botanical, an amino acid, a dietary substance for use*

by man to supplement the diet by increasing the total daily intake, or a concentrate, metabolite, constituent, extract, or combinations of these ingredients'.[1]

This definition is unsatisfactory, as it depends on whether or not a 'healthy diet' is consumed. (Maughan, Burke et al., 2018, https://goo.gl/vF6Tji).

According to the European Parliament Directive (2002/46/EC), a food supplement is defined as:

a product intended to supplement the normal diet, consisting of a concentrated source of a nutrient or of other substances that have a nutritional or physiological effect, in a simple or combined form, commercialized in dosed formulas, capsules, tablets, pills and other similar forms, bags of powder, vials of liquid, dropper bottles and other similar forms of liquids and powders, which is taken in small, quantified amounts. (As cited in Martínez-Sanz et al., 2017, https://goo.gl/WGUEZi).

This definition is a little more complete and also describes the form in which a supplement may be delivered. In this course we will use the definition by the International Olympic Committee (IOC). In a recent consensus document by the IOC (Maughan, Burke et al., 2018), a dietary supplement was defined as: "A food, food component, nutrient, or non-food compound that is purposefully ingested in addition to the habitually consumed diet with the aim of achieving a specific health and/or performance benefit." (p. 1).

Furthermore, it is recognised that

dietary supplements come in many forms, including the following:

1. functional foods, foods enriched with additional nutrients or components outside their typical nutrient composition (eg, mineral-fortified and vitamin-fortified, as well as nutrient-enriched foods).
2. formulated foods and sports foods, products providing energy and nutrients in a more convenient form than normal foods for general nutrition support (e.g., liquid meal replacements) or for targeted use around exercise (e.g., sports drinks, gels, bars)
3. single nutrients and other components of foods or herbal products provided in isolated or concentrated forms.

[1] Amending of Section 201 (21 U.S.C. 321) of the Federal Food, Drug, and Cosmetic Act. Dietary Supplement Health and Education Act of 1994. (1994). [To amend the Federal Food, Drug, and Cosmetic Act to establish standards with respect to dietary supplements, and for other purposes.]. Public Law 103-417. Senate and House of Representatives of the United States of America. 103rd Congress. Retrieved from https://ods.od.nih.gov/About/DSHEA_Wording.aspx

4. multi-ingredient products containing various combinations of those products described above that target similar outcomes. (Maughan, Burke et al., 2018, https://goo.gl/vF6Tji).

3.1.2 Supplement risks

There is a risk associated with taking supplements which is partly the result of poor regulation. Whereas drugs and drug sales are strictly regulated, nutrition supplement are not. According to the DSHEA (Dietary Supplement Health and Education Act) passed by congress in the United States on supplements that do not claim to prevent, diagnose, or cure disease, these supplements are not subject to the Food and Drug Administration (FDA) regulation. In most other countries the situation is similar. This means that there is no requirement to provide evidence for a claim that a supplement works! Even more alarming is the fact that there is no need to demonstrate safety with acute or chronic use and there is also no quality assurance. Also, labelling requirements are liberal. The FDA regularly recalls supplements, but this usually happens after severe adverse effects have been reported.

Many supplements do not even contain the main ingredient on the label!

In an investigation into supplements sold at major retailers in the USA, only 1 out of 5 products contained what the label promised (O'Connor, 2015). "Some supplements in this investigation did not contain anything at all (other than fillers)" (Jeukendrup, April 22, 2015, https://goo.gl/vY7s63) (Figure 1).

Figure 1: Supplements may not be what you expect them to be

Source: Jeukendrup, April 22, 2015, https://goo.gl/vY7s63

An older study into DHEA (Dehydroepiandrosterone) supplements came to a similar conclusion. Fifteen DHEA supplements were purchased from various places and then analysed for DHEA content. In 20% of the products DHEA could not be detected at all. In 40% of the products the concentrations were low 70-75% of what it said on the label and in one case the product contained 50% more than it said on the label. The overall conclusion is that overall quality control is very poor (Parasrampuria, Schwartz, & Petesch, 1998).

Supplements may contain more than you bargain for

While you may not find the substance you thought you bought in the product, you may find other substances in it. Some of these substances might be on the list of banned substances, some could potentially be dangerous. The issue of contamination of supplements is real, many products are affected and quality control is not always what it should be. The contamination may be inadvertently , but there are also cases where drugs, sometimes designer drugs were added to make a product more effective and this was of course not declared on the label. (Jeukendrup, April 22, 2015, https://goo.gl/vY7s63).

Take the popular spirulina supplement as an example. "Apparently it is because of a high protein content, high vitamin B2 (riboflavin) and vitamin B12" (Jeukendrup, October 16, 2015, https://goo.gl/zxQ8yW). However, if we just focus on Vitamin B12 for a moment:

It has been shown that the high vitamin B12 contents are mainly due to contamination with insect or animal fecal matter. This is not surprising since spirulina grows in open lakes and ponds and is not thoroughly washed before it's dried. If you don't care about this as an athlete, and you just want Vitamin B12 to boost your energy levels, there is another disappointing message: There is no evidence that vitamin B12 supplementation has any effect on performance. (Jeukendrup, October 16, 2015, https://goo.gl/zxQ8yW).

But a lot of the spirulina on the market is also contaminated with lead, mercury, arsenic, insects or insect fragments, and in some cases glass. All these things cannot be found on the label of course.

Developing this skill requires appropriate training and a lot of reading (critical reading, not just reading!)

There are a number of possible adverse effects. These include:

1. Safety of the supplement
2. Composition of the supplement
3. Inappropriate use

As an example, iron supplementation for someone with iron deficiency can be very helpful. However, iron supplementation in someone with adequate iron storage may cause side effects like vomiting, diarrhea, abdominal pain, which could, in the long term, develop into haemachromatisis and liver failure.

3.1.3 Contamination of nutritional supplements

It is now well known that supplements can be contaminated with doping substances and can result in positive doping tests. Supplements may have been contaminated with small amounts of prohormones or other compounds that are on the list of banned substances, and this may have happened advertently or inadvertently.

> Since 2002, also products intentionally faked with high amounts of 'classic' anabolic steroids such as metandienone, stanozolol, boldenone, dehydrochloromethyl-testosterone, oxandrolone etc. have been detected on the nutritional supplement market. These anabolic steroids were not declared on the labels either. The sources of these anabolic steroids are probably Chinese pharmaceutical companies, which sell bulk material of anabolic steroids. In 2005 vitamin C, multivitamin and magnesium tablets were confiscated, which contained cross-contaminations of stanozolol and metandienone. (Geyer et al., 2008, p. 892).
>
> The available data indicates that between 40-70% of athletes use supplements, and that between 10-15% of supplements may contain prohibited substances. These data indicates that there is a considerable risk of accidental or inadvertent doping through using supplements (Maughan et al. 2018; Outram and Stewart 2015). Although some forms of estimation can be made, it is suggested that it is currently not possible to quantify the scale of the problem.
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> The steroid nandrolone has been especially prominent. Some competitive athletes are afraid to take supplements because of uncertainty over which supplements are contaminated and which are clean. The IOC-accredited laboratory in Cologne, Germany, reported that various steroids—including nandrolone and testosterone, as well as their precursor compounds—were found in various dietary supplements. In fact, of the 634 supplements tested, 94 of them (i.e., nearly 15%) contained enough anabolics to cause a positive result on a drug test. None of these products gave any indication on the label that they contained steroid compounds. Of the supplements made in the United States, almost 20% of the 240 tested products contained **prohormones**...

Because athletes sign a code of conduct, they are responsible for what they take, even supplements -that have insufficient quality control or labeling. Caffeine and pseudoephedrine were on this list as well, but because they have been taken off the list of banned substances and placed on a monitoring program, they will no longer cause positive doping tests.

Unfortunately, current legislation does little to protect athletes and other consumers from insufficiently labeled, mislabeled, contaminated, or even unsafe ingredients in dietary supplements. Although regulations vary widely from country to country, food supplements are never subject to the standard of manufacture and quality control that is required of foods and drugs. Also, legislation regarding product claims is less strict. Many manufacturers make claims that have never been proved scientifically.With clever marketing techniques and numerous retail outlets, supplement sellers make their products attractive and easy to obtain by athletes who do not know anything about the source or purity of the ingredients. Thus, if an athlete decides that the benefits outweigh the risks of taking a supplement, a product from a large, respectable company is probably the best choice. Reputable brands of vitamins, minerals, and other common supplements manufactured by the major food and drug companies are normally manufactured to high standards and should be safe. Contamination is especially a problem in some smaller and more exotic companies. Companies that do not sell steroids and prohormones are less likely to have their products contaminated by those substances. (Jeukendrup, & Gleeson, 2018, p. 335)

Given the overall possibility of supplement contamination, the risk of taking a mislabeled supplement is a real threat to elite athletes who have to undergo drugs tests but also the health of all consumers. Some products can be unintentionally adulterated with substances (including heavy metals, pesticides or other unwanted substances), while others may be inadvertently contaminated with sport-prohibited substances. There are even examples of cases where supplements were avertedly contaminated with doping substances. Of course many supplements that are safe and pure, but it must always be kept in mind that one batch of a particular supplement could be contaminated with a dangerous or sport-prohibited substance. This could happen when manufacturing equipment isn't cleaned to the required standards and contains remnants of ingredients from a previous product. This is similar to what can happen in a factory that manufactures nut products, as well as other products like cereals and breads. If the machines aren't cleaned correctly or if particles or dust permeate manufacturing areas, the breads or cereals can contain remnants

or traces of the nuts, which can be potentially dangerous to those with nut allergies. (United States Anti-Doping Agency, n.d., https://goo.gl/VTBYGx).

Why are supplements high risk?

Supplements can present a high risk for several reasons:

- Some supplements contain banned substances
- Some supplements can be contaminated during the manufacturing process
- Some supplements will list ingredients on the label differently to how they would appear on the Prohibited List
- Risk of counterfeit (fake) supplements, especially when purchased online. (United Kingdom Anti-Doping, n.d., https://goo.gl/wRnh62).

3.1.4 Minimising risk

As discussed

> there are significant risks associated with the use of unregulated dietary supplements. Risks include the absence of active ingredients, the presence of harmful substances (including microbiological agents and foreign objects), the presence of toxic agents, and the presence of potentially dangerous prescription-only pharmaceuticals (Maughan, 2013, p. 1843S).

When a decision is made regarding a supplement, it is highly important to make sure this is in line with the World Anti-Doping Association (WADA) code of conduct. Specifically, it should be ensured that all supplements are free from prohibited substances.

There are numerous examples of athletes who have failed doping tests because of the use of dietary supplements and of adverse serious events as a result of supplement use. It is therefore important to map out the risks and potential benefits before decisions are made.

A number of quality assurance programs for sports nutrition supplements are now available. The tests of these programs are different from the tests carried out by the FDA. The FDA is primarily concerned with consumer protection issues such as the presence of the active ingredients in the stated amounts and the absence of substances that may be harmful to health. The focus of quality assurance programs tests is on the presence of World Anti-Doping Agency prohibited substances. It is important to realise that “these sports-related programs are not complete quality assurance programs in that the presence of active ingredients is not usually verified” (Derave & Tipton, 2014, p. 445). It is

possible that a tested glutamine supplement does not contain any contaminants but does not contain any glutamine either.

Quality assurance programs

There are a number of certificates supplement companies that can get to show that they have done everything to reduce the risk for the athlete. Schemes like Informed Sport, Trusted Sport, NZVT (the Netherlands) provide labels and are used to indicate that drug tests have been performed on particular batches. You can check on their web site which batch was tested and whether a particular supplement was part of that batch. Although this may not give a 100% guarantee that there is no contamination, this is probably as much a guarantee as you can get. It is therefore highly recommended that anyone who is drug tested should only use products that have been batch tested. See Table 5 below. These programs are primarily concerned with the testing of samples provided by manufacturers or distributors for the presence of World Anti-Doping Agency-prohibited substances. "These sports-related programs are not complete quality assurance programs in that the presence of active ingredients is not usually verified." (Derave & Tipton, 2014, p. 445).

Table 5: Quality Assurance Programs

Organisation	What they do	What they don't do	Web site
NSF	Testing and certifying contents of supplements	Test for banned substances	http://www.nsf.org
Informed Sport	Test for over 160 substances that are considered prohibited in sport and substances that pose a threat in respect of product contamination. These substances include drugs of abuse, anabolic agents, stimulants, beta-2-agonists,	Test the contents	http://www.informed-sport.com

	masking agents, etc." (Ryan, July 18, 2014, https://goo.gl/sCaJbb).		
Informed Choice (sister organisation of Informed Sport)	Test for over 160 "substances that are considered prohibited in sport and substances that pose a threat in respect of product contamination. These substances include drugs of abuse, anabolic agents, stimulants, beta-2-agonists, masking agents, etc." (Ryan, July 18, 2014, https://goo.gl/sCaJbb).	Test the contents	http://informed-choice.org
Koellner liste	Test for a number of banned substances	Test the contents	
NZVT	Test for a number of banned substances	Test the contents	http://www.dopingautoriteit.nl/nzvt/database
NSF	Testing and certifying contents of supplements	Test for banned substances	http://www.nsf.org

Source: Derave & Tipton, 2014, p. 445

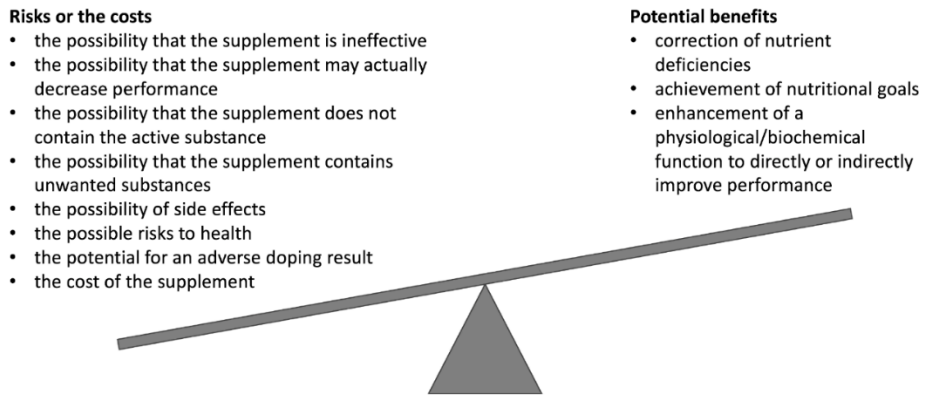
Although athletes and those who are responsible for their care often see these programs as a guarantee of the integrity of products that have been tested, it is important to recognize that a limited panel of substances is tested for and that the tests have limited sensitivity. In supplements tested through the Informed-Sport program in the United Kingdom, for example,

the level of detection is set at 10 ng/g for steroids and at 100 ng/g for stimulants. Some other schemes operate at different levels, and it is important to recognize this. For supplements that are consumed in large amounts, such as protein powders or drinks, a much more sensitive test is required than for supplements taken as small pills or capsules. If a protein powder contained 90 ng/g of a steroid such as nandrolone or one of its precursors, this would appear as a negative test if the limit of detection was set at 100 ng/g. However, a 25-g portion of this product would deliver a dose of 2.3 mg of the steroid, and there is a good chance thatthis might result in a positive test for nandrolone if a sample was collected within a few hours of ingestion of the supplement. [It is important to] recognize that although supplement quality assurance schemes do offer considerable protection, these schemes are not an absolute guarantee of quality. (Maughan, November 1, 2013, 1846S).

Unit 3.2 Decision making

Supplements should only be used after a careful cost-benefit analysis has been conducted. On one side of the balance there are the potential benefits (see Figure 2): "the most obvious of which are correction of nutrient deficiencies achievement of nutritional goals, or enhancement of one or another physiological/biochemical function to directly or indirectly improve performance" (Maughan, Burke et al., 2018, https://goo.gl/vF6Tji). On the other side there are the risks or the costs: the possibility that the supplement is ineffective or decreases performance, the active substance is absent, or that it contains unwanted substances. The supplement may have side effects: it may pose a risk to the health or may result in an adverse doping result. Of course, the financial cost of a supplement may also need to be considered in the overall analysis.

Figure 2: Potential Risks vs Benefits of supplements



Source: adapted from Maughan, Burke et al., 2018, https://goo.gl/vF6Tji

There are now quite a few good guides to help athletes make decisions on supplements. Here we will list two of these guides: one from the United States Anti Doping Agency (USADA, 2014) and one from the United Kingdom Anti Doping (UKAD, 2018) and we will discuss a decision making chart that is based on a recent publication by the IOC (Maughan, Shirreffs et al., 2018).

USADA (2014) recommends 4 steps to minimize the risk:

Step 1 - Seek Professional Advice
Consult a health professional or dietitian to make sure there is a clear nutritional benefit in using a supplement and that there are no food alternatives...

Step 2 - Third-Party Testing

Look for third-party certification, but also evaluate the limits of each program. No program is perfect, and certification is not a guarantee that the product is safe or free from prohibited substances.

If your product in question is not certified by a third-party agency, ask yourself:

1) Is there an equivalent product that is certified that you can use?

2) If there are no food alternatives, and no certified equivalents, then move on to the next step.

Step 3 - Research Specific Warnings

Look for specific warnings on your product by visiting the Supplement 411 High Risk List and the FDA Health Fraud page...

Step 4 Review the Label for Red Flags

Evaluate your product by looking for red flags, such as the ones listed below. If one or more red flags are found, it may mean the product is risky. (https://goo.gl/NcEfmv).

The UKAD used the acronym ANARAC. This stands for Assess the Need (AN), Assess the Risk (AR) and Assess the Consequences (AC):

Assess the Need (AN)

UKAD's advice is that diet, lifestyle and training should all be optimised before considering supplements. Athletes should assess the need for supplements by consulting a, registered nutritionist, or a sports and exercise medicine doctor, or even your GP before taking supplements.

Assess the Risk (AR)

If an athlete makes the decision to use supplements, they should assess the associated risks and make informed decisions about the products they opt to use. Supplements may claim to be drug-free or safe for drug-tested athletes but there are no guarantees that any supplements will be free from prohibited substances.

To minimise the risks, you MUST undertake thorough internet research of any supplement products before use – including the name of the product and the ingredients/substances listed. Information revealed as a result should be further investigated and we advise athletes to keep evidence of their research. We also advise that you only use batch tested supplement products.

Assess the Consequences (AC):

- Remember strict liability. The sanction for intentional cheating is now 4 years for the first offence
- There is less leniency for carelessness – you are more likely to receive a 2-year ban for inadvertent doping
- To get any reduction in sanction from 2 years, you must have substantial proof you have done your research and be able to demonstrate that you were not at fault or intending to cheat

Is the risk worth the gain? If it does contain banned substances how will this affect your career? It can be very difficult to prove that the presence of banned substances from supplements were through no significant fault on your part as you already know there is a risk in taking them.
Remember ANARAC (do your research) when thinking about using supplements. (UKAD, 2018, https://goo.gl/fQTWev).

It is extremely important to critically evaluate the available evidence. This requires critical reading skills, which is an essential skill for every sports nutritionist/dietitian.

3.2.1 Decision making

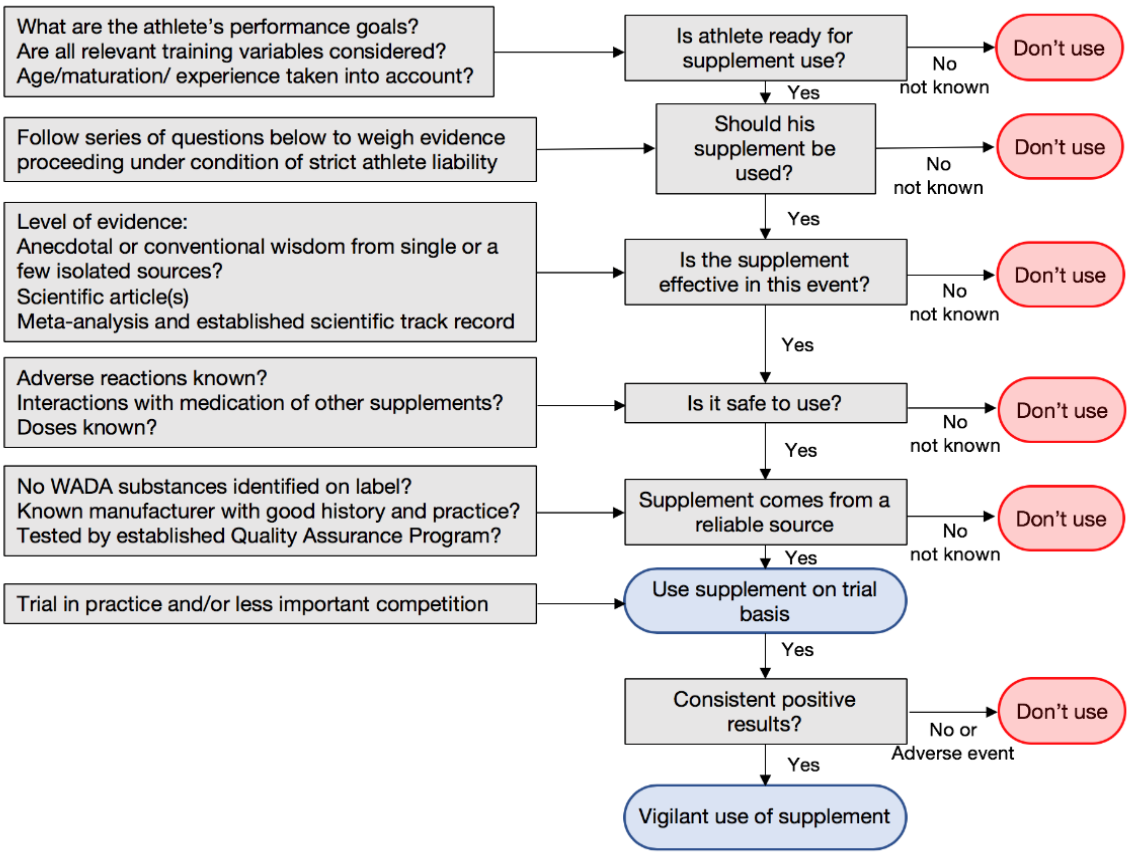
The first step in the decision making process is to consider whether and athlete is ready for supplementation. A simple example is of a beginner athlete who is new to the sport and has many things to learn. It is not the time to focus on supplements but rather on learning to train well for the sport and eating well. Also, it is generally not recommended to supplement youth athletes. But if the athlete is ready to consider supplementation, the next step is to figure out what could actually help this athlete in this sport, these disciplines, or his or her specific goals.

In deciding whether to use a supplement, athletes should consider all aspects of their maturation in, and preparation for, their event to ensure that the supplement under consideration provides an advantage that no other strategy can address. Whether the supplement is practical to use should also be assessed: is the product available, affordable, tolerated and compatible with the athlete's other goals? The input of the athlete's coaching team and medical/science support network is important. Athletes who do not have regular access to such a network should consider decisions around supplement use as an important reason to consult an

independent sports nutrition expert as well as a physician. Analysis of the evidence around the effectiveness of supplements and their safety is often difficult. A complete nutritional assessment may provide an appropriate justification for the specific use of nutritional supplements and sports foods. For a small number of sports supplements, there is good evidence of a performance effect or indirect benefit for some athletes in some specific situations with little or no risk of adverse outcomes. Professional advice is often important in ensuring that the athlete is sufficiently knowledgeable about the appropriate protocol for use of these supplements, but individual athletes may respond very differently to a given supplement, with some exhibiting a markedly beneficial effect while others experiencing no benefit or even a negative effect on performance. Furthermore, the situation in which the athlete wishes to use the supplement may differ in important ways from its substantiated use. Repeated trials may be necessary to establish whether a true effect, rather than just random variation, is seen in response to use of any novel intervention. Some trial and error may also be involved in fine-tuning the supplement protocol to suit the needs of the specific situation of use or the individual athlete.

Evidence to support the effectiveness and safety of many of the supplements targeted at athletes, however, is largely absent. There seems to be little incentive for those selling supplements to invest the substantial sums needed to undertake detailed scientific evaluation of their products. Even where some evidence does exist, it may not be relevant to the high-performance athlete because of limitations in the study design (such as the specificity of the exercise tests), the study population or the context of use. Failure to verify the composition of the supplements used may also give misleading results. It seems sensible to exercise caution when using supplements, as any compound that has the potential to enhance health or exercise performance by altering physiological function must also have the potential for adverse effects in some individuals. Athletes should see good evidence of a performance or other benefit, and should be confident that it will not be harmful to health, before accepting the financial cost and the health or performance risks associated with any supplement. Finally, the athlete should be sure, if supplements or sports foods are to be used, that they have undertaken due diligence to source products that are at low risk of containing prohibited substances. (Maughan, Burke et al., 2018, https://goo.gl/vF6Tji).

Figure 3: Flow chart to guide informed decision making and reducing risk of antidoping
rule violation during nutritional supplement use.



Source: Taken and adapted from Maughan, Burke et al., 2018, https://goo.gl/vF6Tji.

3.2.2 Evidence base

One of the hardest steps is assessing and judging the evidence base. How much evidence there is and how much evidence one needs to consider the supplement useful.

> Even if a supplement contains what it says on the label and is produced with high quality control standards, it may not actually do what it says it does. Labels sometimes contain impressive claims, but the truth is that very few of the estimated 55,000 supplements on the market actually have an evidence base. Often the claims are far-fetched extrapolations. For example, if a study in test tubes shows the effects of substance A on the production of substance B in the body and substance B is linked with muscle growth, it does not mean that giving supplement A to humans, it will have the desired effects. Humans are more than just cells. Maybe substance A cannot even be absorbed (which is the case for numerous supplements on the market) or maybe it was used in amounts that you will never find in

a supplement (true for a very large number of supplements). (Jeukendrup, April 22, 2015, https://goo.gl/vY7s63).

3.2.3 Common misunderstandings

Drug free and tested claims

If a supplement says "IOC tested" or "free of drugs" it does not mean that it is not contaminated. IOC tested is actually a meaningless claim because the IOC does not even conduct any testing. Even more recently, the use of the Informed Sport logo does not mean a supplement has been tested! Always check the web site to see if the batch has indeed been tested. Manufacturers have illegally placed the logo on their product! So, always check the web site and make sure the brand, product, and batch number is indeed tested.

If a supplemented is tested, it is doping free!

A tested supplement is more likely to be safe to use but there is no guarantee. First of all, every batch could be different. But even a batch tested supplement is not a guarantee that there is no contamination. However, the risk is significantly reduced. Although athletes often see these programs as a guarantee that the integrity of products has been tested, it is important to recognize that a limited panel of substances is tested for, and that the tests have limited sensitivity.

Small amounts cannot result in positive tests

This is wrong. Very small amounts can already result in positive tests.

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