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Doping and athlete's nutrition

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Educational and methodical manual is made up on the basis of the working curriculum and the program on «Physical rehabilitation and sports medicine» for medical students of the medical educational institutions of the III-IV accreditation levels for direction of education "Medicine" 1101, for branches of study 7.110101 and 7.110104, according to the educational-qualifying characteristic and the educational-professional program authorized by orders of Ministry of Health of Ukraine as of 16.04.03 No. 239 and of 28.07.03 No. 504, and the experimental curriculum of Ministry of Health of Ukraine developed on principles of the European credit-transfer system and authorized by order of Ministry of Health of Ukraine as of 31.01.2005, No. 52.

The educational and methodical manual is intended for independent work of students of medical faculties at preparation for practical employment on «Physical rehabilitation and sports medicine» subject.

Discussed and approved at a meeting of the Cyclic Methodical Committee from Therapeutic Disciplines of Zaporozhye State Medical University (the record No 5 as of 16.02.2017).

CONTENTS

Foreword

Pierre de Coubertin, founder of the modern Olympic games, was one of the first to point out the necessity of protecting sport from the dangers threatening it as an institution. In 1923, in a speech delivered in Rome, he denounced "the intrusion of politics into sports, the increasingly venal attitude towards championship, the excessive worshipping of sport, which leads to a belief in the wrong values, chauvinism, brutality, overworking, overtraining, and doping".

Human's ability to resist extreme factors appreciably depends on individual features of physiological reactivity of an organism, the speed of involving and urgent efficiency adaptation mechanisms. Mechanisms of adaptation to various environmental influences and physical loads have common and individual features. Hereditary features of reactivity to a humoral stimulus and the character of metabolisms which are under genetic control and are interconnected to the development, structure and actions of skeletal muscles are a probable basis of individual differences arising in adaptation. The specific metabolic capacities usually are related to aerobic potential realization during loads of different power and specific of athletes' aerobic-anaerobic energy potential utilization for sports event.

Eating disorders are devastating psychiatric conditions. They have an unacceptably high mortality rate and invoke considerable morbidity among those affected. Athletes are at greater risk for eating disorders given the pressure to achieve a body composition that optimizes performance.

This corresponds to the academic program for the 4th- year English-speaking students of the Medical department upon studying “

I. The aims.

In order to enhance their performance, sportsmen use specific "methods" which optimize the qualities needed for their sport, on the basis of various physiological, biological, and psychological factors. According to a widespread opinion, "upstream" doping, used for the above-mentioned aim, is "bad" and should be distinguished from "downstream", or "good" doping, meant to help athletes recover their physiological and biological balance. In fact, both types of doping are complementary, since they artificially boost the body's abilities, the second type of doping aiming to make up for the negative effects of the former.

Aerobic potential can be increased by increasing the blood's oxygen transfer capacity. This is very important in sports requiring staying power, rely on the body's energy metabolism, or require intense effort and varying sources of energy. After long-lasting or intense effort, glycogen reserves must be restored. A specially adapted nutritional strategy and drugs are then needed to modify the metabolic process. Methods include altitude training, self-transfusion, more recently, recombinant EPO, and of course glucocorticoids, etc. When the aim is to increase **strength and muscular power** and improve technique, protein, natural or synthetic anabolic agents are frequently used, in combination with hyperprotein diets and muscle-building exercises. The balance between the increase in muscle mass and the loss of fat mass can be maintained thanks to growth hormones associated with aminoacids or other drugs with anabolic properties (but whose initial medical purpose is other), or with nutritional supplements. To postpone fatigue and enable the body to reach its utmost limits, one can use antalgics, cardio-respiratory analeptics, central nervous system stimulants, several of which are strong anti-depressants and stimulants.

In sports where body features or size, tall or short, are important, such as body-building, the shape of the body can be modified through hormonal manipulations. Various drugs are used to fight stress, facilitate sleep, remain in good physical

shape, such as benzodiazepine derivatives and amphetamines, cannabinoids, alcohol, beta-blockers. For disciplines where it is important to stay alert, the sleeping-waking rhythm can be controlled thanks to amphetamines or more recent drugs. Last, cultural and invidual factors also play a role in drug-taking behaviour. On the one hand, as concerns men, value is placed on the mesomorphic body type and muscular strength; physical stereotypes are spread by the media and the athletic subculture. On the other hand, one must take into account factors such as low self-esteem, or other psychological problems linked to for example to one's body image and which existed prior to drug-taking. Illicit drugs are of course taken on the sly. Several ways of hiding the fact exist: diluting urine, hemodilution, reducing kidney tubular secretions or the testosterone/epitestosterone ratio.

2017 Prohibited List

WORLD ANTI-DOPING AGENCY
play true

SUBSTANCES AND METHODS PROHIBITED AT ALL TIMES (IN AND OUT-OF-COMPETITION)

S0. NON-APPROVED SUBSTANCES.

Any pharmacological substance which is not addressed by any of the subsequent sections of the List and with no current approval by any governmental regulatory health authority for human therapeutic use (e.g. drugs under pre-clinical or clinical development or discontinued, designer drugs, substances approved only for veterinary use) is prohibited at all times.

S1. ANABOLIC AGENTS.

Anabolic agents are prohibited.

1.Anabolic Androgenic Steroids (AAS):

a. Exogenous* AAS, including: 1-androstenediol (5a-androst-1-ene-3ß, 17ß-diol); 1-androstenedione (5a-androst- 1-ene-3,17-dione); bolandiol (estr-4-ene- 3ß,17ß-diol); bolasterone; boldenone; boldione (androsta-1,4-diene-3,17-dione); calusterone; clostebol; danazol ([1,2] oxazolo[4',5':2,3]pregna-4-en-20-yn-17aol); dehydrochlormethyltestosterone (4-chloro-17ß-hydroxy-17amethylandrosta-1,4-dien-3-one); desoxymethyltestosterone (17a-methyl- 5a-androst-2-en-17ß-ol); drostanolone; ethylestrenol (19-norpregna-4-en-17aol); fluoxymesterone; formebolone; furazabol ((17a-methyl[1,2,5] oxadiazolo[3',4':2,3]-5a-androstan-17ß-ol); gestrinone; 4-hydroxytestosterone (4,17ß-dihydroxyandrost-4-en-3- one); mestanolone; mesterolone; metandienone (17ß-hydroxy-17amethylandrosta-1,4-dien-3-one); metenolone; methandriol; methasterone (17ß-hydroxy-2a,17a-dimethyl-5aandrostan-3-one); methyldienolone (17ß-hydroxy-17a-methylestra-4,9-dien-3-one); methyl-1-testosterone (17ß-hydroxy-17a-methyl-5a-androst- 1-en-3-one); methylnortestosterone (17ß-hydroxy-17a-methylestr-4-en-3-one); methyltestosterone; metribolone (methyltrienolone, 17ß-hydroxy-17amethylestra-4,9,11-trien-3-one); mibolerone; nandrolone; 19-norandrostenedione (estr-4-ene-3,17-dione); norboletone; norclostebol; norethandrolone; oxabolone; oxandrolone; oxymesterone; oxymetholone; prostanozol (17ß-[(tetrahydropyran-2-yl)oxy]-1'Hpyrazolo[3,4:2,3]-5a-androstane); quinbolone; stanozolol; stenbolone; 1-testosterone (17ß-hydroxy-5a-androst- 1-en-3-one); tetrahydrogestrinone (17-hydroxy-18a-homo-19-nor-17apregna-4,9,11-trien-3-one).and other substances with a similar chemical structure or similar biological effect(s).

b. Endogenous*** AAS when administered exogenously: Androstenediol (androst-5-ene-3ß,17ß- diol); androstenedione (androst-4- ene-3,17-dione); dihydrotestosterone (17ß-hydroxy-5a-androstan-3-one); prasterone (dehydroepiandrosterone, DHEA, 3ß-hydroxyandrost-5-en-17-one); testosterone;

and their metabolites and isomers, including but not limited to: 5a-androstane-3a,17a-diol; 5aandrostane-3a,17ß-diol; 5a-androstane- 3ß,17a-diol; 5a-androstane-3ß,17ß-diol; 5ß-androstane-3a,17ß-diol; androst- 4-ene-3a,17a-diol; androst-4-ene-3a,17ß-diol; androst-4-ene-3ß,17a-diol; androst-5-ene-3a,17a-diol; androst-5- ene-3a,17ß-diol; androst-5-ene-3ß,17adiol; 4-androstenediol (androst-4- ene-3ß,17ß-diol); 5-androstenedione (androst-5-ene-3,17-dione); androsterone; 3ß-hydroxy-5a-androstan-17-one; epi-dihydrotestosterone; epitestosterone; etiocholanolone; 7a-hydroxy-DHEA; 7ß-hydroxy-DHEA; 7-keto-DHEA; 19-norandrosterone; 19-noretiocholanolone.

2. Other Anabolic Agents, including but not limited to: Clenbuterol, selective androgen receptor modulators (SARMs, e.g. andarine and ostarine), tibolone, zeranol, and zilpaterol.

For purposes of this section:

* "exogenous" refers to a substance which is not ordinarily produced by the body naturally. ** "endogenous" refers to a substance which is ordinarily produced by the body naturally.

S2. PEPTIDE HORMONES, GROWTH FACTORS, RELATED SUBSTANCES AND MIMETICS.

The following substances, and other substances with similar chemical structure or similar biological effect(s), are prohibited:

1. Erythropoietin-Receptor agonists: 1.1. Erythropoiesis-Stimulating Agents (ESAs) including e.g. darbepoietin (dEPO); erythropoietins (EPO); EPO-Fc; EPO-mimetic peptides (EMP), e.g. CNTO 530 and peginesatide; methoxy polyethylene glycol-epoetin beta (CERA);

1.2. Non-erythropoietic EPO-Receptor agonists, e.g. ARA-290; asialo EPO; carbamylated EPO.

2. Hypoxia-inducible factor (HIF) stabilizers, e.g. cobalt and FG-4592; and HIF activators, e.g. argon, xenon;

3. Chorionic Gonadotrophin (CG) and Luteinizing Hormone (LH) and their releasing factors, e.g buserelin, gonadorelin and leuprorelin, in males;

4. Corticotrophins and their releasing factors, e.g. corticorelin;

5. Growth Hormone (GH) and its releasing factors including: Growth Hormone Releasing Hormone (GHRH) and its analogues, e.g. CJC-1295, sermorelin and tesamorelin; Growth Hormone Secretagogues (GHS), e.g. ghrelin and ghrelin mimetics, e.g. anamorelin and ipamorelin; GH-Releasing Peptides (GHRPs), e.g. alexamorelin, GHRP-6, hexarelin and pralmorelin (GHRP-2).

Additional prohibited growth factors: Fibroblast Growth Factors (FGFs); Hepatocyte Growth Factor (HGF); Insulin-like Growth Factor-1 (IGF-1) and its analogues; Mechano Growth Factors (MGFs), Platelet-Derived Growth Factor (PDGF); Vascular-Endothelial Growth Factor (VEGF) and any other growth factor affecting muscle, tendon or ligament protein synthesis/ degradation, vascularisation, energy utilization, regenerative capacity or fibre type switching.

S3. BETA-2 AGONISTS.

All beta-2 agonists, including all optical isomers, e.g. d- and l- where relevant, are prohibited.

Except:

- Inhaled salbutamol (maximum 1600 micrograms over 24 hours);
- Inhaled formoterol (maximum delivered dose 54 micrograms over 24 hours);
- Inhaled salmeterol in accordance with the manufacturers' recommended therapeutic regimen.

The presence in urine of salbutamol in excess of 1000 ng/mL or formoterol in excess of 40 ng/mL is presumed not to be an intended therapeutic use of the substance and will be considered as an Adverse Analytical Finding (AAF) unless the Athlete proves, through a controlled pharmacokinetic study, that the abnormal result was the consequence of the use of the therapeutic inhaled dose up to the maximum dose indicated above.

S4. HORMONE AND METABOLIC MODULATORS.

The following hormones and metabolic modulators are prohibited:

1. Aromatase inhibitors including, but not limited to: aminoglutethimide; anastrozole; androsta-1,4,6-triene- 3,17-dione (androstatrienedione); 4-androstene-3,6,17 trione (6-oxo); exemestane; formestane; letrozole and testolactone.

2. Selective estrogen receptor modulators (SERMs) including, but not limited to: raloxifene; tamoxifen and toremifene.

3. Other anti-estrogenic substances including, but not limited to: clomiphene; cyclofenil and fulvestrant.

4. Agents modifying myostatin function(s) including, but not limited, to: myostatin inhibitors.

5. Metabolic modulators:

5.1. Activators of the AMP-activated protein kinase (AMPK), e.g. AICAR; and Peroxisome Proliferator Activated Receptorδ (PPARδ) agonists, e.g. GW 1516;

5.2. Insulins and insulin-mimetics;

5.3. Meldonium;

5.4. Trimetazidine.

S5. DIURETICS AND MASKING AGENTS.

The following diuretics and masking agents are prohibited, as are other substances with a similar chemical structure or similar biological effect(s).

Including, but not limited to:

- Desmopressin; probenecid; plasma expanders, e.g. glycerol and intravenous administration of albumin, dextran, hydroxyethylstarch and mannitol.

- Acetazolamide; amiloride; bumetanide; canrenone; chlortalidone; etacrynic acid; furosemide; indapamide; metolazone; spironolactone; thiazides, e.g.

bendroflumethiazide, chlorothiazide and hydrochlorothiazide; triamterene and vaptans, e.g. tolvaptan.

Except: - Drospirenone; pamabrom; and ophthalmic use of carbonic anhydrase inhibitors (e.g. dorzolamide, brinzolamide).

- Local administration of felypressin in dental anaesthesia.

The detection in an Athlete's Sample at all times or In-Competition, as applicable, of any quantity of the following substances subject to threshold limits: formoterol, salbutamol, cathine, ephedrine, methylephedrine and pseudoephedrine, in conjunction with a diuretic or masking agent, will be considered as an Adverse Analytical Finding unless the Athlete has an approved TUE for that substance in addition to the one granted for the diuretic or masking agent.

PROHIBITED METHODS.

M1. MANIPULATION OF BLOOD AND BLOOD COMPONENTS.

The following are prohibited:

1. The Administration or reintroduction of any quantity of autologous, allogenic (homologous) or heterologous blood, or red blood cell products of any origin into the circulatory system.
2. Artificially enhancing the uptake, transport or delivery of oxygen. Including, but not limited to: Perfluorochemicals; efaproxiral (RSR13) and modified haemoglobin products, e.g. haemoglobin-based blood substitutes and microencapsulated haemoglobin products, excluding supplemental oxygen.
3. Any form of intravascular manipulation of the blood or blood components by physical or chemical means.

M2. CHEMICAL AND PHYSICAL MANIPULATION.

The following are prohibited:

1. Tampering, or Attempting to Tamper, to alter the integrity and validity of Samples collected during Doping Control. Including, but not limited to: Urine substitution and/or adulteration e.g. proteases.
2. Intravenous infusions and/or injections of more than 50 mL per 6 hour period except for those legitimately received in the course of hospital admissions, surgical procedures or clinical investigations.

M3. GENE DOPING.

The following, with the potential to enhance sport performance, are prohibited:

1. The transfer of polymers of nucleic acids or nucleic acid analogues;
2. The use of normal or genetically modified cells.

SUBSTANCES AND METHODS PROHIBITED IN-COMPETITION

In addition to the categories S0 to S5 and M1 to M3 defined to the left, the following categories are prohibited In-Competition:

PROHIBITED SUBSTANCES

S6. STIMULANTS.

All stimulants, including all optical isomers, e.g. d- and l- where relevant, are prohibited. Stimulants include:

a: Non-Specified Stimulants: Adrafinil; amfepramone; amfetamine; amfetaminil; amiphenazole; benfluorex; benzylpiperazine; bromantan; clobenzorex; cocaine; cropropamide; crotetamide; fencamine; fenetylline; fenfluramine; fenproporex; fonturacetam [4- phenylpiracetam (carphedon)]; furfenorex; mefenorex; mephentermine; mesocarb; metamfetamine(d-); p-

methylamphetamine; modafinil; norfenfluramine; phendimetrazine; phentermine; prenylamine and prolintane. A stimulant not expressly listed in this section is a Specified Substance.

b: Specified Stimulants: Including, but not limited to: Benzfetamine; cathine**; cathinone and its analogues, e.g. mephedrone, methedrone, and a-pyrrolidinovalerophenone; dimethylamphetamine; ephedrine***; epinephrine**** (adrenaline); etamivan; etilamfetamine; etilefrine; famprofazone; fenbutrazate; fencamfamin; heptaminol; hydroxyamfetamine (parahydroxyamphetamine); isometheptene; levmetamfetamine; meclofenoxate; methylenedioxymethamphetamine; methylephedrine***; methylhexaneamine (dimethylpentylamine); methylphenidate; nikethamide; norfenefrine; octopamine; oxilofrine (methylsynephrine); pemoline; pentetrazol; phenthylamine and its derivatives; phenmetrazine; phenpromethamine; propylhexedrine; pseudoephedrine*****; selegiline; sibutramine; strychnine; tenamfetamine (methylenedioxyamphetamine), tuaminoheptane; and other substances with a similar chemical structure or similar biological effect(s).

Except:

- Clonidine
- Imidazole derivatives for topical/ ophthalmic use and those stimulants included in the 2017 Monitoring Progam*.

* Bupropion, caffeine, nicotine, phenylephrine, phenylpropanolamine, pipradrol, and synephrine: These substances are included in the 2017 Monitoring Program, and are not considered Prohibited Substances.

** Cathine: Prohibited when its concentration in urine is greater than 5 micrograms per milliliter.

*** Ephedrine and methylephedrine: Prohibited when the concentration of either in urine is greater than 10 micrograms per milliliter.

**** Epinephrine (adrenaline): Not prohibited in local administration, e.g. nasal, ophthalmologic, or co-administration with local anaesthetic agents.

***** Pseudoephedrine: Prohibited when its concentration in urine is greater than 150 micrograms per milliliter.

S7. NARCOTICS.

Prohibited: Buprenorphine; dextromoramide; diamorphine (heroin); fentanyl and its derivatives; hydromorphone; methadone; morphine; oxycodone; oxymorphone; pentazocine; and pethidine.

S8. CANNABINOIDS.

Prohibited: Natural, e.g. cannabis, hashish and marijuana, or synthetic Δ 9-tetrahydrocannabinol (THC). Cannabimimetics, e.g. "Spice", JWH-018, JWH-073, HU-210.

S9. GLUCOCORTICOIDS.

All glucocorticoids are prohibited when administered by oral, intravenous, intramuscular or rectal routes.

SUBSTANCES PROHIBITED IN PARTICULAR SPORTS

P1: ALCOHOL:

Alcohol (ethanol) is prohibited In-Competition only, in the following sports. Detection will be conducted by analysis of breath and/or blood. The doping violation threshold is equivalent to a blood alcohol concentration of 0.10 g/L.

- Air Sports (FAI)
- Automobile (FIA)
- Archery (WA)
- Powerboating (UIM)
-

P2: BETA-BLOCKERS:

Beta-blockers are prohibited In-Competition only, in the following sports, and also prohibited Out-of-Competition where indicated.

- Archery (WA)* ;
- Automobile (FIA);
- Billiards (all disciplines) (WCBS);
- Darts (WDF);
- Golf (IGF);
- Shooting (ISSF, IPC)*;
- Skiing/Snowboarding (FIS) in ski jumping, freestyle aerials/halfpipe and snowboard halfpipe/big air;
- Underwater sports (CMAS) in constant-weight apnoea with or without

Including, but not limited to: Acebutolol; Labetalol; Alprenolol; Levobunolol; Atenolol; Metipranolol; Betaxolol; Metoprolol; Bisoprolol; Nadolol; Bunolol; Oxprenolol; Carteolol; Pindolol; Carvedilol; Propranolol; Celiprolol; Sotalol; Esmolol; Timolol.

The growng competition between technical and biological research and detection methods.

1. The rules enforced by the medical commission of the IOC.

The definition of doping established by the medical commission of the "International Olympic Committee" is based on the prohibition of certain types of pharmaceuticals. This definition also bans new substances which may have been developed by laboratories specifically for doping purposes.

2. Drugs which are detectable thanks to present testing methods.

All natural or synthetic doping drugs have a common physical and chemical characteristic, which is low molecular weight (under 500) (see table II). They can thus be detected by the usual analytical methods, such as gas chromatography, together with mass spectrometry.

The only problem with the detection of xenobiotics is the fact that analysts have to work with small samples, which are not always best suited to this type of testing. However, as concerns endogenous substances, their detection does not constitute sufficient proof of doping for the institutions in charge of enforcing the law.

Table II: example of the molecular weight of several molecules

Type of active substance	Example of substance	Molecular Mass (Mw)
a. Stimulants	Amphetamine Cocaine	135 303
b. Natural or synthetic anabolic agents	Nandrolone Testosterone	274 288
c. Narcotics and analgesics	Dextromoramide Propoxyphene Morphine	392 339 285
d. Beta-blockers	Pindolol Acebutol Propanolol	248 336 259
e. Diuretics and masking drugs	Ethacrinic acid Furosemide Canrerone	303 330 340
f. Peptide hormones	HGH LH EPO	22,400 30,000 30,400

More recently, recent research in organic synthesis and genetic engineering has produced new substances which are similar to natural peptide hormones (f) — a combination of aminoacids which can stimulate the endogenous secretion of substances such as androgenous steroids (hCG, LH, etc.) or corticoids (ACTH). These molecules have a much heavier molecular weight than the others (see table

II). They are present in the body at very low levels of concentration, with considerable variations from one person to the next, and are influenced by environmental parameters such as effort, stress and/or fatigue. It is thus very difficult to distinguish between natural and artificial variations.

3. The problem of natural or semi-synthetic or synthetic substances.

A certain number of substances normally used in specific medical circumstances are now being used in top level sports because of their positive effect on several physiological functions which play a role in sports. Erythropoietin (EPO) was thus developed to treat anemia by stimulating the synthesis of red blood cells. Since it increases corpuscular mass and oxygen transfer capacity, this drug has been used for the past ten years in aerobic sports and as a rule all intense aero-anaerobic disciplines, whether practised continuously or alternately. In healthy subjects, it raises hemoglobin and hematocrite levels and improves staying and maximum aerobic power. Its use — through injections, as in standard medical practice — is simpler than transfusions which can cause problems and accidents. For the time being, anti-doping tests cannot detect EPO. It is commercialized under various denominations and sold in France at the *Pharmacie Centrale des Hôpitaux.*

Other drugs, either hardly commercialized or still awaiting market authorization, are known for their ability to increase oxygen transfer capacity, such as **reticular haemoglobin**, developed from a human molecule mainly used in hemorrhagic emergencies, in order to avoid having to determine the blood type for selective corpuscle transfusions. This is also the case of **fluoro-carbons** which are even more convenient since they keep well. They can also be used as a recovery activator after intensive effort. So far, no control procedure, in terms both of prevention and testing, exists for this type of drug. A solution to this problem should be found before it is commercialized, if possible.

The possibility of increasing muscular mass and acting on the anabolic or catabolic properties of the metabolism is extremely interesting for top-level sports.

The use of androgens and anabolic agents has become increasingly widespread over the past 20 years, especially with the development of synthetic anabolic agents whose anabolic power is 30 to 50 times higher than that of natural androgens. The **growth hormone (hGH)** developed by genetic engineering has made it possible to avoid testing positive on synthetic anabolic agents. The recombinant growth hormone is available on the market. It is used in all sports where performance is linked to muscular mass, as well as in aero-anaerobic sports, including team sports. The production of **IGF1** (Insulin-like growth factor), which completes the physiological action of the growth hormone, by genetic engineering complicates the issue. IGF1 used together with the growth hormone provides optimal results with smaller doses of both drugs and fewer side-effects. This may explain the standardization of a certain body shape and the disappearance of indirect signs of use of the single growth hormone. The availability of a second IGF2 opens new prospects in the field of energy metabolism.
To a lesser degree, **interleukin 3** can be used singly or with another drug to enhance growth and stimulate corpuscle production. G-CSF is a growth enhancer which acts mainly on white corpuscles. Although it does not have any known effect on performance, it may help resist infections.
Analyzing peptide hormone levels in blood, especially the chorionic gonadotropin hormone (hCG), the growth hormone and EPO is thus of utmost importance. Synthetic peptide hormones presently in use have a chemical structure which is identical, or at least very similar to that of natural hormones, and it is impossible to distinguish their physical or chemical characteristics. Their dosage is at present determined by immunology techniques, but quantitative standards would be necessary to determine the exogenous presence of such substances.

4. Organizing the tests

Sports officials organize sports events, but the task of detecting illegal drugs is devolved to others. If an athlete tests positive, s/he is punished by sanctions. Three possible cases can occur:

- In the first case, tests show the presence of a banned substance which enhances performance more than would simple training. In this case, there is no question that this person must be sanctioned.

- In the second case, the tests show the presence of an illegal drug which does not necessarily enhance performance. Sanctioning the athlete for this would be unfair, since it would create an unequal situation between athletes and non-athletes, the latter not being tested.

- In the last case, the test does not reveal any illegal doping substance because it is "masked", new, or (temporarily) undetectable as an exogenous substance. In this case, testing is impossible, though justified.

The world of sport is understandably quite ill-at-ease regarding this complex issue. Indeed, sportsmen are used to dealing with extremely strict rules, in the sense that all that is not explicitly forbidden is allowable. This principle is actually what motivates technical progress, which in turn leads to a modification of the rules.

Another important problem concerns the tests' underlying principle: indeed, sports, as an institution, focuses on performance, not on the actors, whereas anti-doping tests focus on the actors, in other words on the athletes as individuals. Considered necessary, though imperfect, these tests are at the same time perceived as imposed by external authorities; they are usually criticized and condemned on principle, and when it comes to the actual testing procedure, attitudes are often unclear: upon arrival of the physician in charge of carrying out the tests, athletes and organizers often join forces. If an athlete is tested positive, the entire "family" falls necessarily under suspicion, which leads to a tightening of group bonds. When a case of doping is announced, the athlete and his entourage usually protest loudly. Sports officials thus finds themselves in a contradictory situation: they ban doping and base their authority on this prohibition, but at the same time, when doping cases occur and persons are sanctioned, they express surprise, doubt, and

minimize the issue. The attitude of sporting authorities is thus far from clear, especially if we consider that a century ago, doping was a poor man's resource to earn some profit from sports, and that today, doping has become extremely expensive. "Scientific" doping, with the accompanying "masking" procedures, is affordable only to the rich. Improving the efficiency of antidoping tests does not mean increasing the frequency of testing but carrying them out more efficiently, for example by monitoring the athlete during the training period, and especially by improving detection methods and reducing the margin of error on the tested samples.

The task of laboratories specializing in drug detection is quite complex. To search for the possible presence of one of 300 illegal drugs and/or their metabolites, at any possible level of concentration in a selective and small urine sample, without any chemical diagnosis to help direct the search in any specific direction, requires extremely precise procedures in terms of sample preparation, methodology and interpretation of results. Every year, the list of banned substances gets longer and longer, which means that laboratory researchers must constantly revise and improve their detection methods. Such a task is almost impossible when results must be ready within 24 hours.

5. Present detection techniques.

Detection techniques are practically the same in all laboratories with international accreditation. The first analytical stage, called the "fast" stage, is based on immunological or radioimmunological methods, separative methods such as gas chromatography and liquid chromatography (GC and HPLC) and methods associating two techniques, such as chromatography/mass spectrometry (GS-MS, HPLC-MS), chromatography/atomic emission detection (GC-AED).

Obviously, it is important to attain a maximum degree of sensitivity at this level, in order to avoid falsely negative tests.

At this initial level of analysis, the samples can be sorted out so as to determine those containing illegal substances, or, more generally speaking, those which do not look quite normal.

The second stage of analysis consists in formally identifying the substances (illegal or not) detected during the first stage and searching for various possible metabolites, determining their level of concentration and identifying the drug as precisely as possible by looking for other characteristic active ingredients or vehicles.

The impact of doping on health.

1. Potentially fatal risks.

In 1886, Arthur Linton died during the Bordeaux-Paris race. In 1904, the marathon runner Thomas Hicks collapsed after winning the Saint-Louis Olympics: he had taken strychnine. Dorando Pietri died in London in 1908 for the same reason. In 1960, the cyclist K. Jensen died during the 100 km road run in the Rome Olympics. The drug Ronicol was blamed. In 1967, Tom Simpson, a professional world cycling champion, collapsed and died while climbing the Mont Ventoux after having taken amphetamines. In 1975, anabolics killed Kangasniesmi, a weight lifter. His muscles gave in under the weight and the iron bar fell down, breaking his spine.

These grave accidents, and there are many more, are well-known. It would be difficult to ignore them, since they happened during competitions, in view of the public and TV cameras. This, however, is only the visible part of the damage done by doping: indeed, little is known about its effects once the athlete has left the sports arena or given up his/her career. We do know for a fact that several great champions suffered from serious health problems after leaving sport. And we also know that there is a direct relationship between certain drugs and certain health problems, such as heart disease or cancer: the existence of a causal relationship

between doping and disease thus appears increasingly probable. However, an additional difficulty resides in the fact that some substances are very often used together with another, main, drug, that some substances of the same nature (but bearing different names) are used together, and that these cocktails undeniably have a positive effect on performance.

1.1. Potentially dangerous drug cocktails.

No single drug can satisfy the numerous demands made on athletes to improve performance, stimulate staying power, sustain effort during training, eliminate stress. For this reason, s/he can be tempted to use drug cocktails, either as "scientific doping" and/or as "easy" doping, the latter being used by athletes with limited financial means. These "cocktails" can be made up of different drugs whose combined effect increases their power, or of similar drugs with different names, which, when taken together, bring the dosage to toxic levels. Among these combinations: amphetamines combined with corticoids, cardio-respiratory analeptics or cocaine, caffeine or ephedrin; EPO with aspirin and/or an anticoagulant, or natural or synthetic glucocorticoids; to recover strength, a combination of glucose-enriched serum added to insulin, IGF1, and as a supplement, androgens, GH, beta 2-agonists. The list of possible combinations is much longer, since cocktails are elaborated and adapted according to need. ***Pharmacodependency***.

Several doping substances used by athletes are considered by psychiatrists as addictive, leading to drug abuse and dependence, and their psychological effects and impact on behaviour have been described in the context of the study of dysfunctions linked to drug use (cf. DSM-IV, American Psychiatric Association, 1994). Caffeine intoxication can lead to nervousness, overexcitement, insomnia, or attacks of anxiety in certain persons. Cocaine or amphetamine intoxication can cause hyperactivity, anxiety, stereotyped and repetitive behaviour, anger and violent behaviour, altered judgement. Their chronic use can cause dulled

emotions, fatigue, sadness, social withdrawal, or, as concerns cocaine, persecution mania and aggressiveness. According to De Mondenard (1991), marijuana, which is used by some athletes either for its disputed stimulating effect or for the feeling of calm it provides before an event, can sometimes cause anxiety, dysphoria and social withdrawal.

2. Clinical and biological signs indicating an iatrogenic disease.

Drug abuse can lead to the development of iatrogenic diseases which must be diagnosed early and with precision. The drugs used — generally in combination and at high dosages — provoke changes in the person taking them, modifies in his/her homeostasis, behaviour, and morphology. As a result, a clinical and biological semiology of doping with a diagnostic tree should urgently be drawn up as a diagnostic tool for physicians. Such a medicalized approach to doping could lead to further investigation of the problem by specialists and to the establishment of certificates of inaptitude to sport. This approach is only possible in the framework of a system centered on the long-term monitoring of athletes, conducted in specialized centers, by teams of clinical specialists in sports medecine and thanks to sophisticated equipment for the evaluation of the athletes' functional ability to sustain effort. This medical/athletic monitoring would be computerized and carried out in close collaboration with the athlete's personal physician.

3. Psychopathological problems.

Knowledge about the possible psychological and behavioral effects of drugs on athletes stems exclusively from publications describing isolated cases of pathological reactions to the use of anabolic steroids, and from experimental research carried out on animals, voluntary human subjects, either healthy or taking

these drugs for therapeutic reasons, or still, from more or less systematic comparisons conducted within small groups of athletes, both taking and not taking drugs.

For example, problems linked to body image occur more frequently than average in body-builders taking anabolic steroids. These subjects often suffer from "reverse anorexia", feelings of dissatisfaction regarding their body, and bulimia. Amateur weight-lifters of the male sex taking high doses of anablic steroids are more aggressive towards objects and verbally aggressive during training. Their periods of waking are longer and they are more irritable, anxious, suspicious and negative. Mood changes are more frequent and personal relationships more difficult when they are "on" drugs than when they are "off", or than in non-users.

4. Numerous determining factors.

Due to rising financial stakes and the toughening of the competition for recognition and fame, athletes and their entourage tend to search for additional ways of improving performances, even if it means disobeying the rules established by the sports federations. Today, science has developed very effective drugs to enhance performance and hasten the recovery of athletes facing increasing constraints (schedule, competitions, events, etc.). Many athletes use drugs. The wealthier athletes use them under the supervision of competent professionals, while the others, in order to "stay in the race", resort to self-medication on the basis of advice or information gathered in stadiums ("poor man" doping), unaware of the risk they run. The analysis of determining factors shows that both sociological and personal factors must be taken into account.

Calling into question sports institutions: the sociological point of view.

A sociological study of the doping issue must be based on the analysis of relationships between sports actors holding various positions and whose interests differ. With the development of sports as a business, the interaction between two

different rationales, that of athletic performance and that of profit, has become increasingly complex, leading us to raise the question of the power of sports.

Competition sports are dominated by a complex system of interdependent actors:

- the federations, whose aim, among others, is to ensure that rules and traditions are respected,
- the athletes, who compete mainly for glory; however, through their unions and associations, they demand recognition as professional players, as well as better working conditions,
- the educators and coaches who wish to protect their interests, as opposed to those of their employers (the clubs),
- the referees, employed by federations or professional leagues, who wish to improve their working environment (professionalization, protection against violence and pressure, etc.),
- the professional clubs (Unions of professional football clubs, basketball clubs, etc.) who aim to some profit from their investment in sports, either in financial terms or in terms of public image, etc.),
- the consultants, sometimes grouped together in multinational firms (International Management Group, News Corporation, etc.), who manage the athletes' business. Some of them own TV channels, shares in broadcasting rights for the more popular sporting events,
- showbusiness companies, which try to reconcile the interests of the public with those of their clients (sponsors, sports announcers) and those of the actors (the athletes).
- companies selling sports and leisure equipment (equipment makers, distributors, service companies, etc.) and sponsors,
- the specialized medical (sports physicians), paramedical, pharmaceutical professions;
- journalists hunting for pictures, declarations, revelations which could be of interest to news editors wishing to satisfy their readers'/viewers' demands,

- academics and researchers who publish articles and speak out on the subject and thus wield some influence on public opinion and on the various actors involved,
- persons practising sports or sports fans, who, as consumers (of lessons, images, clothing, equipment, etc.), support the entire system. Due to their numbers (evaluated in terms of audience, number of copies sold, etc.), they play a very important role (events postponed to ensure better attendance, scandals stifled so as not to shock, etc.). Thanks to them, sponsors, businessmen and professional athletes are able to earn a living.

When high level sports are governed by federations or olympic bodies, thanks to state support or because of these institutions' monopoly over the award system (their titles being the only "noble" titles), the rules of the game remain stable and more or less protected against attacks of businessmen wishing to adapt the rules of sport to public demand. However, when federations have little authority, sport can turn into show business, opening the way for corruption, cheating and rule changes.

1. Playing with the rules: a risky game.

As the stakes involved in competition sports grow higher, the rule is to get around the rules. Not to take risks with the rules, or not being able to ensure one's protection if suspected of cheating can mean being left out of the race. Those who have nothing or not much to lose are the first to resort to cheating to attain their goal. Those on the higher rungs of the social ladder are in a much better position than others to play that dangerous game without getting caught. Persons who have access to information, to more or less legal ways of getting round the rules (waivers, corruption, or getting those in charge of enforcing the rules to close their eyes), and resort to all kinds of loopholes to get around the law, move ahead faster and remain in dominant positions longer than those who have no way of doing so. (A "wealthy" club or athlete, in terms of both money and information, has easier access to the services of physicians, or of laboratories specialized in doping and masking drugs than "poor" clubs or athletes). To explain why certain athletes,

federations, physicians, referees, resort to cheating, it is necessary to question the entire international sports system, nowadays entirely focused on the tough competition for medals and money. Not to take drugs when others are taking them would mean to lose. In this context, a special study on the side effects of the drugs most used by athletes ought to be commissioned and results publicized among regularly competing athletes. Players' and athletes' unions or associations would be in the best position to carry out these information campaigns, since they can protect athletes who are already locked in the system — forced to take drugs, or addicted. Of course, athletes are under very high pressure, if only because only the "best" are selected for competition; the pressure is exerted by actors who have an interest in seeing "their" athletes win — federations, TV channels, consulting firms, directors of professional clubs, coaches, event organizers, sponsors, etc. There is a direct link between doping and the question of power relationships between these various actors. Internationally recognized associations and unions (such as in golf or tennis) would thus be the best source of information and protection for athletes.

2. ***The declining authority of the federations***.

Two processes are responsible for the decline of the power of federations. In the first place, sports are now practised by all, whereas before World War II, the working classes, women, and adults over 50 did not practise sports. The growing TV audience for sports events has generated new sources of profit, leading to the professionalization of the most popular sports. The sponsors of "show-business sport" represent a counter-authority for federations, whose power stems from two main sources: the monopoly on "noble sports" titles, which are a hundred years old for the more traditional disciplines, and a network of clubs and volunteer educators who coach millions of athletes and organize their activities. These two elements are essential to the development of a sports elite, for the benefit of showbusiness managers, independent professional leagues, sponsors, etc. The recruitment by private companies of an elite trained in state subsidized clubs (professional clubs

or teams) is reminiscent of the transfer to the private sector of graduates of the French state subsidized *grandes écoles* system. The second reason for the decline of the power of federations is the development of other types of sports ("leisure" sports, "street" sports) which, according to national surveys, draws as large a public as there are licensed athletes, in other words about 12 million people. Along with the emergence of these "new" sports, there has been a change of attitude towards federations, which tend to be considered as service providers rather than authorities. Athletic excellence is viewed differently from one generation to the next; nowadays, the winner (according to the rules) is not necessarily the "best" player. "Excellence" is less a question of measurable, objective performance than one of self-expression and style, mirroring the aspirations of a generation. "Fun" sports remain competitive, of course, but creativity and artistic expression are nevertheless central. These "new" sports include skateboarding, rollerblading, acrobatic biking, break-dancing, border-crossing, jumping contests, etc. Demographic and social transformations may explain why the principles which dominated 19th and 20th-century sports no longer correspond to the expectations of most members of today's new generations. Though institutional sports have managed so far to preserve the illusion that their principles were universal, it now appears that they are not eternal; they only hold true in a world where the values, beliefs and ideals they represent are shared by all.

Individual factors and the critical age question.

1. Varying degrees of susceptibility.

In addition to sociological factors, individual factors also play a significant role. Group pressure and financial interests can drive most, if not all, athletes to

dope themselves. Nevertheless, doping behaviour — the age at which an athlete will begin to use drugs and the development of addiction — is also determined by individual factors. In this respect, it should be noted that there are many former top athletes among chronic drug users. Heroin or any other drug thus acts a replacement for sport, which for them was practically a drug in itself. Several reasons have been suggested to explain this phenomenon. On the one hand, the daily and mechanical practise of sports blocks unpleasant thoughts and anesthetizes the mind, in the same way as heroin. Furthermore, when a person attempts to exceed his/her physical limits, the body secretes endorphin which acts as an endogenous drug. Although no specific study has been carried out on the relationship between sports, doping and drug addiction, enough scientific data exists to show that there is a great deal of inequality among athletes in this respect.

1.1. Temperamental factors.

Personal temperament also determine the choice of behaviour in a given situation. It is a known fact that differences in behaviour are determined for a large part by biological factors, in particular as concerns reactivity towards the environment and need for stimulation. Thus, it has been shown that highly reactive persons tend to prefer situations which have low stimulating power, and conversely for persons with low reactivity. The need for strong sensations and new and intense experiences is governed by the need to reach a high level of sensorial activation. However, the forms of behaviour aimed at reaching this level of activation may vary a great deal: drugs and alcohol, danger, adventure (dangerous sports, mountain-climbing, hang gliding, etc...). In the understanding that each individual has his/her own personal optimal level of activation and his/her own way of reaching it, one can see how persons who enjoy taking risks may be liable to use psychostimulants or drugs.

1.2. Motor activity as a source of gratification.

Physical exercise requires the participation of the body's physiological systems and modifies its homeostasis. In particular, it modifies the activity of several cerebral neurotransmitter systems. In animals, heavy exercise, prolonged exercise and overexercising have opposite effects. For most neurotransmitters, the release increases, then decreases (with slowing down of activity) if the exercising lasts a long time. Furthermore, it is a known fact that exercising can lead to hormonal changes, by increasing the secretion of prolactin, of the growth hormone and corticosteroids. Some of these hormones have a powerful effect on most neurotransmitter systems. These neurotransmitter systems are both the target of doping substances and the providers of gratification. As a result, it is easily conceivable that proneness to addiction should entail doping behaviour, with doping substances taken together with other drugs. This is all the more true for persons with a need for strong sensations.

2. Adolescence: a period of major risk.

2.1. Taking doping substances together with drugs: the risk for teenagers and top athletes.

The subject of doping is usually exclusively related to sports, since doping drugs are used to enhance performance, as opposed to other forms of addictive behaviour. In fact, in recent years, the parallel between doping and drug addiction has become increasingly obvious, and some authors, such as P. Laure (1995), have been considering whether one should not "regard doping not only as a way of enhancing performance but also, and most importantly, as a new form of drug addiction". Indeed, it has long been known that the use of "doping" substances such as amphetamines, and more recently, anabolic steroids, can lead to drug abuse and physical and psychological dependence. Between 1980 and 1990, several epidemiological surveys were conducted in United States high schools. Their aim was to evaluate teenagers' consumption of anabolic steroids, possibly in combination with other drugs. This represents a new phenomenon among teenagers, whether or not they practice sports, and the reason they gave for

taking drugs was the wish to improve physical appearance and muscular strength. According to the surveys, 2 to 4% of teenagers of both sexes, but mostly boys, had used anabolic steroids. The average age at which they begin is 14 (ranging from 8 to 17), and the proportion of users is slightly higher among those practising sports. Recent surveys conducted in American and Canadian high schools show that teenagers practising sports admitted to having taken anabolic steroids in order to improve their performance, but that they also drank, smoked and used other drugs, in the same way as those who did not practise sports.

The first surveys conducted on the drug habits of **young American athletes** date back to the early 1980s. These surveys showed that athletes took psychoactive drugs just as did their non-athletic peers. Subsequent studies carried out in the early 90s do not confirm the generally accepted idea that sports students use more drugs and drink more alcohol than others. Neither do they confirm the existence of an anabolic doping "epidemic" in American colleges. Recent studies carried out in Canada among athletes of both sexes underscore the importance of alcohol and caffeine consumption. In conclusion, the various epidemiological surveys conducted in the United States and Canada, in various environments, with students practising competition sports, or not practising sports, show that there are not many differences in the choice of drugs in general, whether these are legal, such as alcohol, illicit, or "doping" substances. The distinction between use and abuse is not clearly marked.

2.2. Psychopathological disorders underlying the abuse of psychoactive drugs

Certain psychiatric disorders are more frequently observed among young drug addicts, a fact which raises the question of whether these disorders play a role in determining a subject's proneness to drug-taking. Depending on the survey, emphasis is laid on some substances rather than others, but globally, all are involved (tobacco, alcohol, marijuana, hard drugs such as cocaine). The vast majority of users are male. However, "externalized" disorders are not the only explanations for drug addiction among these teenagers. "Internalized" or

"emotional" disorders — mood changes, anxiety — are also frequently observed. It is important to determine whether these observations apply to doping substances as well.

Important semiological similarities have been observed between the behavioural and biological characteristics of athletes and those of persons suffering from eating disorders. Thus, amenorrhea, which often happens in cases of mental anorexia, is a frequent problem among long-distance runners. These connections show that the intensive practise of sports is often in itself a form of addiction. In the same line of thought, one may note that eating disorders are extremely frequent among young female gymnasts. Another disorder, hyperactivity with ***attention deficiency*** may be an underlying problem in cases of drug abuse. Given its frequency among children, as well as among teenagers and adults, it would be particularly interesting to study its incidence in a large sample of young athletes and correlate this disorder with drug and/or doping substance abuse. This disorder affects 2 to 3% of the adult population. Drug abuse usually begins during adolescence or in early adulthood, and affects 10 to 20% of adults.

Energy drinks.

Health hazard data on energy drinks were found to be limited and therefore the hazard assessment was based on individual ingredients. Caffeine was identified as the ingredient with the greatest potential for intakes of possible health concern. On this basis, excess consumption of energy drinks would be expected to result in health consequences similar to those from excess exposure to caffeine. The more mild and transient health conseq uences could include anxiety, headache and insomnia and these health consequences can become chronic conditions.

More severe health consequences may include irregular heartbeat, heart attack and, very rarely, death. Currently, the potential for taurine and glucuronolactone to interact with caffeine is unknown and therefore they

may or may not exacerbate the effects of caffeine. In addition, the health effects of excessive intake of taurine and glucuronolactone are also unknown.

Using exposure modelling, the potential health risk posed by energy drink consumption was examined. However, no Canadian intake data for energy Drinks were available. Therefore, for the purpose of modelling intake, it was assumed that energy drinks are consumed in a manner similar to that of caffeinated carbonated soft drinks. In the worst case modelling exposure scenario, energy drinks were substituted for caffeinated carbonated soft drinks on a volume basis. The energy drink caffeine concentration was set to 320 ppm (80 mg of caffeine/250 ml serving) for modelling purposes. In the most conservative scenario, all caffeinated carbonated s oft drinks were replaced by a typical energy drink for consumers who drink these beverages. The results of this conservative estimate showed that slightly less than 30% of male and female adults, about 15% of pregnant woman an d more than 50% of the children and adolescents, amongst consumers who drank caffeinated carbonated soft drinks, were above Health Canada's recommended maximum daily caffeine intake.

This extreme scenario only applies to that subset of the population that consumes caffeinated carbonated soft drinks, which does not exceed 8% of young children (1-8 years old), 22% of older children (9-14 years old), 32% of ado lescents, 20% of the adult population and 13% of pregnant females.

In critically reviewing the outcomes of this exposure modelling, it appeared that the corresponding health concerns for children and adults would be limited to remote, based on this scenario, in view of the parental control that should exist and would limit access of these products to to children, as well as the ability of adults and pregnant women to monitor their own caffeine intake.

This hypothetical scenario and its outcomes could not be as easily excluded for adolescents, given that energy rinks tend to be marketed to this subset of the

population, which is less likely to adhere to consumption recommendations than adults. The existence of larger volume containers (e.g., 710 ml) increases the likelihood of exceeding caffeine recommended intakes in one consumption setting. Specific risk management measures to address potentially high caffeine levels in larger volume energy drink products would therefore be desirable.

It is acknowledged that various data gaps would need to be addressed to improve the exposure assessment and the overall risk characterization. In particular, data related to the evolving consumption patterns of these products by the various subsets of the population, in Canada, needs to be gat hered. Health Canada's proposed risk management approach for energy drinks, announced in October 2011 and updated in 2012, limits the concentration and total amount of caffeine in these products and requires that caffeine and nutrition information be displayed on product labels.

These measures support the mitigation of risks related to overconsumption of caffeine from this type of product that are within the possible areas of intervention available to a federal food regulator. A more concerted approach (e.g., education, awareness and regulation) and more research would be needed to ascertain the effectiveness of the various measures taken by regulators and other stakeholders.

Defining a typical energy drink.

Defining products known as energy drinks For the purpose of thi s document, a typical energy drink is characterised by the ingredients and ingredient levels shown in Table 1. Ingredients include caffeine, taurine, glucuronolactone, inositol and a variety of B vitamins. The basis for this characterisation is the formulation of the most commonly sold products of this category of beverages, such as the product known as Red Bull.

Although Health Canada does not have a definition or standard for products known as energy drinks, other food regulators have reached a decision on this aspect of these products. For

example, Australia and New Zealand categorizes energy drinks as 'formulated caffeinated beverages' which are defined under the Australia New Zealand Food Standards Code as "a non-alcoholic water-based flavoured beverage which contains caffeine and may contain carbohydrates, amino acids, vitamins and other substances, including other foods, for the purpose of enhancing mental performance".

In Europe, the Ireland Food Safety Promotion Board (FSPB) established a committee consisting of external experts to research the health effects of 'stimulant drinks' (energy drinks). The committee noted in its final report that there is no agreed definition in the regulatory framework for products referred to as energy drinks or 'stimulant drinks'. For the purposes of the report, the term 'stimulant drinks' was adopted. The committee defined stimulant drinks as "beverages, which typically contain caffeine, taurine and vitamin(s), and may contain an energy source (e.g. carbohydrate), and/or other substance(s), marketed for the specific purpose of providing real or perceived enhanced physiological and/or performance effects" (FSPB, 2003).

Major components of energy drink products During the preparation of this manuscript, energy drinks were marketed in Canada under the Natural Health Products (NHP) Regulations. At the time, it was estimated that over 300 energy drink product submissions were before Health Canada for consideration as NHPs. Only twelve were assessed and received a license. Approximately half of the 300 product submissions

were either refused a license or withdrawn by the petitioner.

either refused a license or withdrawn by the petitioner.

A number of products were also on the Canadian market under the provisions of the Unprocessed Product Licensing Regulations. Table below lists the major ingredients and levels typically found in the products that were in the queue for consideration to be licensed as an NHP.

Substance Formulation of products known as Energy Drinks (mg. per 250 ml

serving)

Caffeine 50 – 200 80

Taurine 10 – 2000 1000

Glucuronolactone 600 – 1200 600

niacin 10 – 40 18a

vitamin B6 5 – 10 2

vitamin B12 0.002 - 0.2 0.001

pantothenic acid 5 – 10 6

thiamine 0.5 - 5 2

riboflavin 0.5 - 5 1.65

Inositol 50-200 50

Serving size is typically 250-473 ml.

Health Effects of Energy Drinks.

The research on energy drinks is largely limited to a small number of clinical studies (about 12 studies) and case reports.

The clinical studies tended to have small numbers of participants (less than 100 su bjects) and focused on very specific health effects. These studies mostly examined the effect of energy drink consumption on behaviour and physical activity; therefore, the parameters examined were limited and not necessarily significant from a health and safety perspective. Other studies assessed the consequences of consuming the combination of energy drinks and alcohol.

Calories.

Except for sugar-free versions, energy drinks, like many beverages, contain sugars in the form of sucrose, glucose, and/or high-fructose corn syrup. The sugar content varies among energy drinks but ranges from 21 to 34 grams per 237 ml. can (Clauson et al. 2008). This sugar content is similar to that of carbonated caffeinated soft drinks.

During each heartbeat, blood pressure varies between a maximum (systolic) and a minimum (diastolic) pressure. constitutes the vast maj ority of calories in these products. A 250 ml. serving of a typical energy drink contans 110 calories, which is similar to the 86-130 calories in the same volume of a carbonated caffeinated soft drink (USDA Nutrient Database, 2011).

Health Effects of Energy Drinks and Sports Activity Energy drinks are frequently marketed to individuals interested in athletics and an active lifestyle.

The ain ingredients in energy drinks purported to enhance sport performance are caffeine and carbohydrates. The term "energy drink" itself implies that its consumption might enhance physical activity.

Energy drinks should not be confused with 'sports drinks'. Sports drinks are typically a mixture of carbohydrates and electrolytes formulated to enhance athletic performance and prevent dehydration, and, unlike energy drinks, they do not contain caffeine. Conversely, energy drinks contain caffeine which is a stimulant and therefore they are not considered suitable to re-establish normal body function after exercise (e.g. normal heart rate).

Studies investigating the use of energy drinks have generally found an improvement in endurance performance.

The consumption of 500 ml of a Red Bull energy drink 40 minutes before a s imulated cycling time trial in 12 trained cyclists significantly improved endurance performance compared to a non-caffeinated, sugar-free placebo. Significantly increased upper body muscle endurance but had no effect on anaerobic peak or average power during repeated Wingate cycling tests in healthy young adults, when compared to a non-caffeinated, isoenergetic, control beverage. Pre-workout energy drink consumption, significantly improved some physiological adaptations to combined aerobic and resistance training, when compared to a non-caffeinated, sugar-free control drink. Lastly, a study investigating the use of a sugar-free energy drink (Red Bull) found that there was no difference in run time-to-

exhaustion or perceived exertion in young adults when compared to non-caffeinated sugar-free placebo. Overall the studies' result suggest that the consumption of energy drinks may enhance physical ability but it is not clear whether the effect is due to the presence of caffeine, sugar or both of these co nstituents in the energy drink.

Energy drinks, like other beverages containing added sugars, are often associated with a high caloric intake. These drinks are not to be considered "sports drinks" as they contain at least one ingredient that is a stimulant (caffeine). Despite some study results suggesting that energy drink consumption prior to exercise may have some performance benefits, there are concerns, as caffeine may delay the return to a resting heart rate. Limited study res ults have shown increases in systolic blood pressure and heart rate associated with moderate intakes of energy drinks (2 servings). However, across the various studies, transitory changes in blood pressure did not reach hypersensitive levels with consumption of energy drinks. These effects were deemed to be similar to the effects on blood pressure demonstrated in conjunction with caffeine intake.

There were insufficient toxicological data to characterize the health hazard associated with energy drinks as a single product.

As a consequence, the major individual ingredients were assessed for hazard identification and hazard characterization, and this was considered a means to gain insight into the hazard characterization of energy drinks.

Energy drinks can be generally characterised as containing the following ingredients: caffeine, taurine, glucuronolactone, inositol and a variety of B vitamins, including thiamine, niacin, vitamin B6, vitamin B12, pantothenic acid and riboflavin.

The dietary sources, nutritional aspects and toxicity of these ingredients are reviewed below.

Caffeine.

Caffeine is consumed as a natural constituent of coffee, tea, chocolate and other natural sources, such as guarana and yerba mate. It is also used as a food additive and is present in certain carbonated soft drinks. It is also present in some therapeutic products, such as cold remedies and allergy medicines. In Canada, it is estimated that male and female adults have a respective mean intake of 281 and 230 mg. of caffeine per day. These amounts are about three times the 80 mg of caffeine present in a single 250 ml. serving of a typical energy drink.

When a single serving of a caffeinated beverage containing 40-120 mg of caffeine is consumed the main biological effect of caffeine is that it acts as a stimulant and promotes alertness,
stimulant enhances cognitive performance, relieves fatigue and promotes physical endurance. A single serving can also cause transient adverse effects, such as insomnia, headaches and nervousness in caffeine-sensitive individuals.

It was concluded that a healthy adult could tolerate a maximum intake of 400 mg of caffeine per day (equivalent to 6 mg/kg bw/day for a 65 kg adult). Th is amount of caffeine was not associated with adverse effects such as general toxicity, cardiovascular effects, effects on bone status, changes in behaviour, effects on male fertility or increased incidence of cancer.

Further, the assessment concluded that reproductive-aged women could tolerate a maximum intake of up to 300 mg.
caffeine per day (equivalent to 4.6 mg/kg bw/day for a 65 kg. adult), based on reproductive considerations (spontaneous abortion, retarded fetal growth). Finally children, aged 4 to 12 years, were considered to tolerate a maximum of 45 to 85 mg. of caffeine per day (equivalent to 2.5 mg/kg bw/day for a child weighing 18 to 34 kg.), based on transient mild behaviour changes.

There were insufficient data to recommend a daily maximum intake of caffeine for adolescents, aged 13 to 18 years.

However, the adult recommendation could be considered inappropriate since many adolescents may have a lighter body weight may have a lighter body weight More importantly, adolescents are less developed than adults and their growing bodies may be more susceptible to adverse effects of caffeine.

One author has suggested that caffeine may adversely affect the growing adolescent brain.

Alternatively, adolescents may be less habituated to consuming caffeine and therefore may be more susceptible. In any case, there is substantial uncertainty as to whether the adult recommendation should be applied. As a precaution, it would be prudent to recom mend that an adolescent have a daily intake of caffeine no greater than the amount calculated from the dose used to determine the recommended maximal intake for children (2.5 mg/kg bw/day) and the individual adolescent body weight (estimated range of adolescent body weights: 40-70 kg.). This dose would suggest that adolescents could consume 100 to 175 mg. of caffeine daily, depending on the individual body weight of the adolescent.
It should be noted that all of these recommended maximum intakes of caffeine are considered a daily amount that would be the result of cumulative consumption throughout the day. The ingestion of the daily maximum intake in a brief period of time, that is 1-2 hours, may cause adverse reactions, such as insomnia, headache, stomach ache, nervousness, nausea or more serious reactions. For example, studies have shown that a single ingestion of more than 250 mg. of caffeine by a healthy adult can also cause an increase in blood pressure while more than 450 mg. of caffeine may result in tachycardia.

Taurine.

Taurine is an amino acid that is naturally present in the diet. Specifically, it is found in meat and seafood. Estimates of human daily intake of taurine range from 40 mg. to 400 mg. These dietary levels of

taurine are relatively low compared with the 1000 mg. of taurine present in a single serving of a typical energy drink.

Taurine is also synthesized in the liver from the amino acid cysteine, as well as from other sulphur compounds. It has a role in several biological processes, including the formation of bile salt, cell membrane stability, the modulation of calcium flow and neuronal excitability (FSPB 2002). Taurine is considered essential for the normal development of infants and consequently it is a standard ingredient in infant formula, such that newborns ingest about 280 mg daily (equivalent to a dose of 17 mg/kg bw/day). Taurine is one of the most abundant amino acids in the human body.

Human studies suggest that taurine is readily absorbed from consumed food and that plasma level of taurine peak within an hour after ingestion (SCF 2003). This observation is consistent with the findings of a study where rats received taurine as a single oral dose of 300 mg/kg bw. It was observed that the exogenous taurine is quickly absorbed into the body, equilibrates with endogenous pools of taurine and that excess amounts are rapidly eliminated by the kidneys. The study also showed that a 14-day repeat treatment with taurine did not change the fate of the last single oral dose, which suggests that the body can metabolically handle relatively large amounts of taurine daily. The acute oral toxicity of taurine is considered relatively low, such that no adverse effects have been observed following a single administration in rats up to 7000 mg/kg bw or in humans up to 150 mg/kg bw (equal to 10,500 mg for a 70 kg. adult). In short-term studies with human subjects, the ingestion of up to 6000 mg per day for 42 days and 1500 mg per day for 90 days showed no evidence of adverse effects (SCF 2003). In a 90-day study in rats, taurine was administered by gavage to groups of animals (20animals/sex/dose) at doses of 0, 300, 600 or 1000 mg/kg bw/day. No taurine-related changes of standard toxicological

parameters were observed. The exception was a dose-related behavioural change (increased activity, self-injury) that was observed in all three treated groups and in both sexes of the test animal (SCF 2003).

A developmental toxicity study in mice showed that when orally administered at a dose of 4000 mg/kg bw/day on days 7 to 14 of gestation, taurine was not a teratogen, that is, it did not cause birth defects.

In the additional studies conducted, taurine has not shown any mutagenic or genotoxic potential in bacterial or mammalian cell in vitro assay systems.

There are no long-term toxicity or carcinogenicity studies conducted to assess the carcinogenic potential of taurine; however, there is no indication that taurine is a carcinogen based on short-term toxicity studies.

In over thirty studies with adult, child and infant subjects, the use of taurine has not demonstrated any safety concerns. Most of these studies involved the ingestion of taurine on a daily basis with doses in the range of 3000 to 6000 mg for periods of up to one month or longer without any apparent adverse health effects (EFSA 2009).

One double-blind study in human volunteers (14 subjects) showed that a combination of caffeine and taurine, at levels present in a typical energy drink, had no effect on short-term memory, as indicated by an abbreviated version of a standard test for short-term memory. However, this combination did induce a decrease in heart rate and an increase in mean arterial blood pressure.

This finding is unexpected since caffeine generally stimulates heart rate. Furt her investigation into the combination of these two substances is warranted.

D-Glucurono-γ-lactone.

D-Glucurono-γ-lactone (glucuronolactone) is the γ-lactone of glucuronic acid. It is a normal human metabolite and formed from glucose and glucuronic acid. It seems to be found naturally in only a small number of foods such as wine and pl ant gums (e.g. guar gum, gum Arabic). An estimate of the mean daily intake

is 1.2 mg/day and a high daily intake is suggested to be 2.3 mg/day (SCF 1999). These intake values are very small when compared to the intake of glucuronolactone of 600 mg from the consumption of a single serving of a typical energy drink. It is claimed that glucuronolactone is a quick energy source and may assist in the detoxification of xenobiotics (SCF 1999).

Human and rat studies show that when ingested, glucuronolactone is rapidly absorbed, metabolised and excreted as glucaric acid, xylitol and L-xylulose. These compounds are not considered to be toxicologically significant (ANZFA 2001). In contrast to humans, mice and rats have an additional metabolic pathway that allows them to use glucuronic acid to synthesize vitamin C. Rodents can also use exogenous glucuronolactone to yield glucuronic acid and then generate vitamin C. This additional pathway in the rodent created some uncertainty with respect to the appropriateness of rodents as a model for humans.

However, further examination of the issue has determined that the rodent metabolic pathway is relatively minor in the animal's handling of glucuronolactone, which suggests that toxicological results from rodents are relevant to the human situation.

The acute oral toxicity of glucuronolactone is very low, such that in mice the oral LD50 is greater than 20000 mg/kg bw. The short-term oral toxicity of glucuronolactone was assessed in a study where groups of rats (20 animals/sex/dose) were administered a single daily gavage dose of 0, 300, 600 or 1000 mg/kg bw, for up to 90 days (SCF 2003). The results showed no treatment-related deaths, no significant difference in body weights, food consumption, hematological or clinical chemistry parameters. Urinalysis showed that males treated

with 1000 mg/kg bw group had urine with a lower pH than the control group, and males in the 600 and 1000 mg/kg groups had a lower specific gravity than the control group. Results from histopathological examination showed vacuolisation and inflammatory changes localised to the papilla of the kidney in females such that at doses of 0, 300, 600 and 1000 mg/kg bw/day, the incidences were respectively 11/20, 9/20, 11/20 and 11/20.

In a second 90-day study in rats, the toxicity of glucuronolactone was assessed with specific focus on the kidneys (SCF 2009). The previous gavage study was repeated with an additional four sets of animals (20 animals/sex/dose) that received glucuronolactone in drinking water; with both routes of administration animals received nominal dos es of 0, 300, 600 or 1000 mg/kg bw for 90 days. There were no treatment-related deaths, no effects on clinical observations, food or water consumption, body weights, clinical parameters, organ weights or clinical chemistry parameters related to renal function. Lastly there were no test m aterial-related gross or microscopic findings. This included the kidneys which showed typical amounts of background lesions for this strain of rat. There was no test material-related vacuolisation of the cells lining the collecting tubules of the kidney. This suggests that the kidney lesions observed in the first study were not significant, since the drinking water administered in the second study was more relevant to the human situation. Reproductive and developmental toxicity studies for glucuronolactone were not available but were not considered necessary to conduct, as part of the safety evaluation since glucuronolactone in the body hydrolyses to glucuronic acid, which is an endogenous metabolite in humans and present in normal human diets. Glucuronolactone was shown not to be mutagenic in a bacterial reverse mutation system.

Inositol.

Myoinositol (inositol) is a constituent of phosphatidylinositol, a phospholipid, which plays an essential role in growth, metabolism regulation and signal transduction. Inositol is a normal component of human tissue and can be synthesized in some tissues. It is a normal part of food der ived from plants in the form of phytate and from animals in the form of free and phosphorylated inositol and as inositol phospholipid. It is estimated that adults ingest about 500 to 1000 mg of inositol daily. This amount is relatively large compared to the 50 mg of inositol present in a single serving of a typical energy drink.

The toxicity associated with inositol is very low. In mice the oral LD50 is reported to be 10000 mg/kg bw. There are no reproductive or developmental toxicity studies or genotoxicity studies that assessed inositol. Although inositol was not tested as a carcinogen, several studies assessed its ability to prevent cancer development in mouse models. The results showed that a 3% level in the diet (equivalent to a do se of 6000 mg/kg bw/day) did not increase cancer formation.

In humans, inositol has been used as an experimental therapy for depression, panic disorder, and obsessive compulsive disorder. There is a report of people consuming up to 20,000 mg of inositol daily for 2 weeks. Another report cites the administration of 18g. of inositol daily for 6 weeks. In these reports and several others, no adverse effects were observed.

B Vitamins.

Most energy drinks contain added B vitamins including thiamine, riboflavin, niacin, vitamin B6, vitamin B12, and pantothenic acid.

Thiamine (Vitamin B1).

Thiamine is widely found in foods, including meat, legumes, and whole or enriched grain products. The Recommended Dietary Allowance (RDA)8 for thiamine for adult males is 1.2 mg/day and for adult females, 1.1 mg/day (IOM 1998). Based on data from the Canadian Community Health Survey (CCHS)

(2004), the 95th percentile of dietary intake indicates that adults consume up to 4 mg of thiamine per day. The formulation of a typical energy drink product as described in Table 1 does not contain thiamine; however, other energy drinks may contain up to 5 mg. of thiamine per serving.

The US Institute of Medicine (IOM) was not able to set a tolerable upper intake level (UL) for thiamine due to the lack of data on adverse effects (IOM 1998). In addition, the European Commission concluded that while it is not possible to derive a UL for thiamine, current levels of intake from all sources do not represent a health risk for the general population (European Commission 2001). However, the Australia New Zealand Food Authority (ANZFA) set a maximum limit for thiamine of 20 mg/250 ml. in formulated caffeinated beverages as a conservative limit that was based on a maximum one-day quantity of 40 mg thiamine (ANZFA 2001). Orally ingested thiamine has a long history of use as a supplement without reported adverse effects. There are no reports of adverse effects of oral thiamine, even at dosages of several hundred milligrams per day (European Commission 2001). A Canadian evaluation of micronutrient safety classified thiamine as a nutrient with no known adverse effects (Program on Food Safety 1996).

Riboflavin (Vitamin B2).

Riboflavin is found in a wide variety of foods but milk and milk products are thought to contribute the majority of dietary riboflavin. Eggs, meat, and legumes also provide riboflavin in significant quantities.

The RDA for riboflavin for adult males is 1.3 mg/day and for adult females, 1.1 mg/day. Based on data from CCHS (2004), the 95th percentile of dietary intake indicates that adults consume up to 4.5 mg of riboflavin per

day. The typical energy drink product formulation, as described in Table 1, contains 1.65 mg. of riboflavin per 25 0 ml serving while other energy drinks may contain up to 5 mg of riboflavin per se rving.

ANZFA set a maximum limit for riboflavin of 20 mg/day in formulated caffeinated beverages based on the composition of Red Bull and knowledge of regular consumption of 500 ml per day of this product (ANZFA 2001).

The toxicity of riboflavin is considered to be extremely low due in part to ready excretion of excess amounts. Available sub-chronic data from human studies and pharmacokinetic studies do not show reported effects on oral toxicity of riboflavin. Apart from a few minor gastrointestinal disorders, which are not clearly related to riboflavin intake, it is free from serious side effects.

Niacin (Vitamin B3).

Niacin is the term used to describe vitamin B3; nicotinic acid and nicotinami de are two different forms of niacin. The best dietary sources of niacin include tuna, beef, other meats, and cereal grains. The RDA for niacin for adult males is 16 mg/day and for adult females, 14 mg/day (IOM 1998). Based on data from CCHS (2004), the 95th percentile of dietary intake indicates that adults consume up to 76.7 mg. of niacin per day. The typical energy drink, as defined in Table 1, contains 18 mg of niacin per 250 ml serving while other energy drinks may contain up to 40 mg of niacin per serving. The niacin in these products is generally present in the form of nicotin amide and is most likely added due to its role in energy metabolism.

The Institute of Medicine (IOM) in the United States (1998) set a UL of 35 mg/day for niacin based on the adverse effect of flushing. Flushing is first observed after excess niacin intake and is generally observed at lower doses than are other effects. Flushing that results in patients deciding

to change the pattern of niacin intake (i.e., reduce the amount taken at a time or withdraw from treatment) was sel ected as the most appropriate endpoint on which to base a UL. Although nicotinamide appears not to be associated with flushing effects, a UL for nicotinic acid that is based on flushing is considered protective against potential adverse effects of nicotinamide (IOM 1998).

The Expert Group on Vitamins and Minerals (Food Standards Agency 2003) set a guidance level of 560 mg/day for nicotinamide as the limited data on the occurrence of nicotinamide toxicity indicates that it is quite low.

There is no evidence of adverse effects from the consumption of normal levels of niacin in foods. Adverse effects have been obs erved with intakes of nicotinamide greater than 3000 mg/day compared with intakes of nicotinic acid of 1500 mg/day (ANZFA 2001). Adverse effects can be observed following high intakes of nicotinic acid, which may be achieved through consumption of pharmacological preparations or dietary supplemental products. Adverse effects associated with the use of nicotinic acid as a drug, especially in doses of 1 g or more per day include:

Pyridoxine (Vitamin B6).

Excellent sources of vitamin B6 in commonly consumed foods are bananas, navy beans, and walnuts. The RDA for vitamin B6 for adult males is 1.3-1.7 mg/day and for adult females, 1.3-1.5 mg/day (IOM 1998).

The typical energy drink, as described in Table 1, contains 2 mg of vitamin B6 per 250 ml serving while other energy drinks may contain up to 10 mg of vitamin B6 per serving.

Health Canada's Category Specific Guidance for Temporary Marketing Authorization: Caffeinated Energy Drinks (March 2012) set a daily maximum level of 450 mg/day for the addition of nicotina mide to energy drinks.

ANZFA set a maximum limit for vitamin B6 of 10 mg/day in formulated caffeinated beverages based on history of use, rather than the U.S. UL (ANZFA 2001).

There are no safety concerns in relation to vitamin B6 intake from food sources. However, adverse neurological effects have been detected in humans after very high doses (>500 mg/day, equivalent to approximately 8 mg/kg/day)13. Minor neurological symptoms may be apparent at doses of 100 mg/day or more if consumed for long periods. There are n o subgroups that are known to be unusually susceptible to the adverse effects of vit amin B6 (European Commission 2000).

Cobalamin (Vitamin B12).

The only dietary sources of vitamin B12 for humans are from animal products, which have derived their cobalamins from microorganisms. The best sources of cobalamins are meat and meat products, poultry and eggs. The RDA for vitamin B12 for adult males and females is 2.4 mcg/day (micrograms/day) (IOM 1998). Based on data from CCHS (2004), the 95th percentile of dietary intake indicates that adults consume up to 6 mcg of vitamin B12 per day. The typical amount used for energy drinks, as described in Table 1, contains 1 mcg of vitamin B12 per 250 ml serving while other energy drinks may contain up to 20 mcg of vitamin B12 per serving. IOM was not able to set a UL for vitamin B12 due to the lack of data on adverse effects (IOM 1998). Similarly, the European Commission concluded that it is not possible to derive a UL for vita min B12 as there are no clearly defined adverse effects produced from this vitamin (European Commission 2000). ANZFA set a maximum limit for vitamin B12 of 10 mcg/day in formulated caffeinated beverages based on history of use. No adverse effects have been associated with excess vitamin B12 intake from food or supplements in healthy individuals (European Commission 2000). 14 4.6.6 Pantothenic acid (Vi tamin B5) Meats (especially liver), egg yolk, legumes, and whole grain

cereals are good sources of pantothenic acid. The adequate intake (AI) for pantothenic acid for adult males and females is 5 mg/ day (IOM 1998). CCHS (2004) did not have any dietary intake data on pantothenic acid; however, another source indicates that average intakes of adults range between 3-12 mg/d (European Commission 2002).

The typical energy drink, contains 6 mg of pantothenic acid per 250 ml. acid per 250 ml. contains 6 mg of pantothenic acid per 250 ml. serving while other energy drinks may contain up to 10 mg. of pantothenic acid per serving.

IOM was not able to set a UL for pantothenic acid due to the lack of data on adver se effects (IOM 1998). In addition, the European Commission concluded that while it is not possible to derive a UL for pantothenic acid, current levels of intake from all sources do not represent a health risk for the general population ANZFA set a maximum limit of 10 mg/day for pantothenic acid in formulated caffeinated beverages based on the composition of the reference product known as Red Bull™ and knowledge of regular consumption of 500 mL per day of this product (ANZFA 2001).

There are no reports of pantothenic acid or panthenol toxicity in humans. Minor gastrointestinal effects such as occasional diar rhea and water retention occurred only at very high intakes (10-20 g/day) Health hazard data on energy drinks are extremely limited and therefore the hazard assessment was based on individual ingredients. Caffeine was identified as the ingredient in energy drinks having the greatest potential for intakes of health concern. Assuming no additional caffeine from the diet, it was determined that no more than 5 servings per day of a typical energy drink should be consumed by the general adult population. At this level of consumption, the lev els of taurine and glucuronolactone in a typical energy drink are not expected to pose a health hazard in the short term. Although there are limited

hazard data on energy drinks as formulated in the published literature, actual use of energy drinks has been associated with some adverse reactions. However, due to the absence of long-term safety data on high levels of consumption of taurine and glucuronolactone, the potential interaction of these substances with caffeine, and for most consumers, the known addition of caffeine from other dietary sources, it was concluded that the long-term consumption of 5 servings of energy drinks per day could not be considered to represent no health concern for the general adult population.
Also, the evidence examined suggests that most of the B vitamins and other constituents of a typical energy drink would not pose a health hazard in the short term, but long-term safety data were not available for this level of consumption.

The health hazard assessment concluded that the general adult population could consume 2 servings of a typical energy drink per day with no expected negative health consequences. This conclusion was based on the safety of the non-caffeine ingredients of energy drinks (i.e. taurine, glucuronolactone, inositol and B vitamins) at this level of consumption, and the fact that caffeine from other dietary sources in addition to that in 2 servings of energy drinks would not pose a health risk to the general adult population.
More specifically, the respective mean daily intakes of caffeine from all dietary sources for adult Canadian males and females are 281 and 230 mg. With body weights of 80 and 65 kg., theses intakes are equivalent to a daily dose of 3.5 and 3.1 mg/kg bw, respectively (Statistics Canada, Canadian Community Health Survey, 2004). The consumption of two servings of a typical energy drink containing 80 mg of caffeine per serving would result in the addition of 160 mg caffeine to the diet. In males, this would result in a daily dose of 5.5 mg/kg bw and in females, a daily dose of 6.0 mg/kg bw.16 Health Canada's recommended maximum

daily intake of caffeine for adults is 6.5 mg/kg bw or about 400 mg for an adult weighing 65 kg.

Given that the addition of two servings of a typical energy drink to the diet would not exceed the recommended maximum daily intake of caffeine, it can be concluded that this level of consumption would not pose an additional hea lth hazard based on the caffeine content of these products. The consumption of energy drinks by subpopulations, such as children and pregnant and breastfeeding women, is not generally recommended. Based on caffeine conte nt, consumption of such drinks by any group should be limited to their recommended maximum daily intake of caffeine.

Excess consumption of energy drinks would be expected to result in health conseq uences similar to those from excess exposure to caffeine.

Eating disorders.

In the USA, it is estimated that 10 million women, and 1 million men will suffer from a clinically significant eating disorder in their lifetime. Given the secretive nature and denial surrounding eating disorders, these numbers likely grossly underrepresent the total disease burden in the US population. In a Finnish community study, approximately half of all individuals with anorexia nervosa had not yet been identified by the healthcare system. Worldwide, rates of eating disorders in Western societies parallel those in the USA, whereas in developing countries, the likelihood of disease is considerably less.16–11 Among athletes, estimating the prevalence of eating disorders remains somewhat elusive. Disordered eating is more prevalent among athletes than non-athletes, Illustrating the relative importance of this problem in the athletic community. The majority of studies investigate the prevalence of eating disorders in female athletes. In a study of 522 elite female athletes and 448 nonathlete controls completing a disordered eating questionnaire, clinical examination and interview,13 18% of athletes were diagnosed with an eating disorder compared to only 5% of non-athlete controls. In

addition, athletes tended to under-report disordered eating symptoms on questionnaires compared to the control group. A similar but larger study including 1620 athletes and 1696 controls found similar results—20% of female athletes met criteria for an eating disorder, compared to 9% of female controls.12 Even among female athletes the rates of eating disorder vary by sport and have generally been higher in sports with weight classes (such as rowing), aesthetic sports (such as gymnastics or figure skating) and sports where having a low body mass is seen as advantageous (such as cross-country or cycling). These conclusions were supported by Sundgot-Borgen's study that found rates of eating disorders in aesthetic sports and weight-dependent sports were 25%, compared to 12% in other sports. In the 2004 study the prevalence of eating disorders in aesthetic sports was 42%, in endurance sports it was 24%, in technical sports it was 17% and in ballgame sports it was 16%. Similarly, in a 2015 study of 108 elite German athletes who were age-matched with 108 non-athlete controls, rates of eating disorders were 17% in aesthetic sports, 2% in ball sports and 2% in non-athletes.14 Additional studies suggest that the prevalence of disordered eating behaviours (such as binging, using saunas, taking laxatives or diuretics, self-inducing vomiting, etc) is higher in the college-aged population, even in the absence of a formal eating disorder diagnosis.15 Similar to the trend in eating disorder prevalence, athletes in lean sports exhibited more disordered eating behaviours than non-lean sport athletes. Glazer found that disordered eating scores on standardised questionnaires were higher in athletes than non-athletes, and highest in athletes within physique salient sports. An Australian study also found that disordered eating behaviours and body dissatisfaction were higher in lean sports, regardless of level of competition.

In some studies as much as 70% of athletes in weight class sports were dieting or exhibiting abnormal eating behaviours to reduce their weight before competition.

Eating disorders in male athletes.

An increasingly large body of research also indicates that eating disorders and disordered eating are significant problems among male athletes. In general, male athletes have a lower prevalence of eating disorders than female athletes, but a higher prevalence than male non-athletes. In one study, 20% of female athletes and 8% of male athletes met criteria for an eating disorder, compared to 9% of female controls and 0.5% of male controls. Another study of male and female rowers supported this trend by showing that male athletes had higher rates of pathological eating behaviours than the general male population–12% of men had reported at least two binge eating episodes per week, 3% of men had self-induced vomiting and rates of rapid weight fluctuation and fasting were even higher in male athletes than female athletes (57% vs 25%). Similar to the trend seen in elite female athletes, male athletes in lean sports are more likely to suffer from an eating disorder than those in other sports. In a 2004 study rates of eating disorders in male athletes in antigravitation sports were 22%, as compared to 9% in endurance sports and 5% in ball game sports. In a study by Rosendahl, et al, the prevalence of eating disorders among male athletes was 10% in endurance sports, 17% in weight class sports and 42% in antigravitation sports. As was observed in the female athlete population, numerous studies focusing specifically on male athletes in lean sports have found similarly high rates of disordered eating in this population, even in the absence of a formal eating disorder diagnosis. In a survey of 732 male collegiate athletes in the USA, Chatterton and Petrie found that male athletes who participated in weight class sports were more likely to engage in pathological eating and weight control behaviours and be symptomatic compared to male athletes in endurance sports or ball game athletes.

The importance of eating disorders in athletes is further emphasised by concerns that rates of eating disorders are increasing in the general population among individuals age 15–19 years old. While this may be partially explained by changes to DSM-V criteria and greater awareness surrounding the Female Athlete Triad, it may also reflect broader cultural changes including public health efforts to reduce the burden of obesity.

DIAGNOSTIC CRITERIA.

The majority of the studies mentioned above were conducted using definitions of eating disorders from the Diagnostic and Statistical Manual of Mental Disorders (DSM). The release of the DSM has provided several important updates to the diagnostic criteria (**tables 1–3**).

One study found that according to DSM IV criteria, 81% of adolescents and 75% of adults who presented for treatment of eating disorders were classified as ***'eating disorder not otherwise specified'*** (EDNOS) because they did not meet all of the criteria for one type of eating disorder. The changes in the DSM are intended to reduce the number of diagnoses which fall into the EDNOS category (or its renamed counterpart), which should facilitate more accurate descriptions of patient symptoms and also further research on eating disorders. Several studies have shown reductions in EDNOS diagnosis rates using the DSMV criteria. The criteria for anorexia nervosa have undergone the greatest number of revisions. Previously, individuals were required to have a weight less than 85% of normal. This has been updated to state that significantly low weight is 'less than minimally normal weight in adults or less than expected weight in children and adolescents.' Additionally patients no longer need to explicitly endorse a fear of weight gain; this can now be inferred from patient behaviours. This change is likely to be particularly beneficial in the athlete population, because athletes may deny symptoms in an effort to continue competing. Lastly, amenorrhoea has been discarded as a diagnostic criterion for anorexia. Studies found that women who otherwise met criteria for anorexia but still had regular (or irregular) menses did not differ clinically from women with similar symptoms plus amenorrhoea.6

Removing amenorrhoea as a diagnostic requirement also facilitates the diagnosis of anorexia in men, postmenopausal women and adolescents with delayed menarche.

The new definition for bulimia nervosa in the DSMV reduced the required frequency of binge episodes and compensatory behaviours from twice per week to an average of once per week over a period of 3 months. This change was made because the frequency of binge episodes did not significantly impact prognosis or treatment, and it caused more EDNOS diagnoses. The DSM V also created a new diagnosis that had previously fallen under EDNOS—binge eating disorder. Lastly, the miscellaneous category previously called EDNOS has been changed to two categories—'other specified feeding or eating disorder,' and 'unspecified feeding or eating disorder.' The first of these categories is used for individuals who have a specific reason why they do not meet criteria for one of the types of eating disorder. For example, it would include a patient who had lost significant weight but was still within the normal weight range despite meeting all other criteria for anorexia. The second category is used in situations where the clinician cannot or does not clarify the reasons why the patient fails to meet full criteria for an eating disorder.

COMMON COMORBIDITIES.

Individuals affected by eating disorders commonly suffer from other mental health conditions, including depression, anxiety, obsessive-compulsive disorder and substance use disorder. In a Canadian study almost half of all patients with eating problems were also found to have mood or anxiety disorders. Similarly, in a Swedish study half of patients with eating disorders had depression and one-quarter endorsed substance abuse. Lifetime prevalence of substance abuse in patients with bulimia nervosa is at least 30%.

Furthermore, among patients with bulimia nervosa, those with comorbid psychiatric conditions were more likely to report suicidal ideation and history of suicide attempts. Binge eating disorder has been found to significantly co-occur with depression, bipolar disorder, anxiety, bulimia nervosa, kleptomania and body dysmorphic disorder. Limited data exists regarding the relationship between eating

disorders and comorbid mental health conditions in female and male athletes. A study in British athletes found a positive and significant relationship between eating psychopathology and risk of subsequent depressive symptoms 6 months later.35 Importantly, clinicians caring for an athlete with an eating disorder should consider and evaluate for other mental health conditions.

In addition to the aforementioned mental health conditions, premorbid medical conditions can increase the likelihood of subsequent eating disorders and contribute significantly to the morbidity of eating disorders. For example, individuals with type 1 diabetes mellitus are at higher risk for eating disorders later in life—in a German study, one in three females with type 1 diabetes and one in six males with type 1 diabetes had disordered eating and insulin restriction. Data on athletes with type 1 diabetes and eating disorders is unknown. Gastrointestinal conditions such as chronic constipation, ***gastroesophageal reflux disease*** (GERD), coeliac disease, lactose intolerance, delayed gastric emptying, gastroparesis and superior mesenteric artery syndrome may all occur as a result of eating disordered behaviour,and in some cases may predate the eating disorder, thereby contributing to its onset.

CONSEQUENCES OF EATING DISORDERS.

There are both health and performance consequences of eating disorders.

Health consequences Eating disorders have wide-ranging health consequences, including one of the highest mortality rates of any mental health condition.

Risk of premature death is 6–12 times higher in women with anorexia nervosa.41 Crude mortality rate is approximately 5% per decade.In 1994 the death of US gymnast Christy Henrich from anorexia nervosa was a devastating example of the extent to which athletes will manipulate their dietary intake and exercise to achieve what is perceived as an ideal body image. Death is most often caused by suicide or cardiac arrhythmia—suicide accounts for 20% of deaths among patients with anorexia nervosa, and 23% of deaths among patients with bulimia

nervosa.42 43 Particularly worrisome is the finding that among individuals with an eating disorder, overexercise (common among competitive athletes) is the disordered eating behaviour which is most strongly associated with suicidal behaviour.

Death from cardiac arrhythmia may result from electrolyte disturbances associated with self-induced vomiting, laxative abuse and diuretic use, especially among those with extremely low body weight. While cardiac consequences of eating disorders—especially anorexia nervosa—are considered a significant contributor to morbidity and mortality, a recent meta-analysis of mortality rates in anorexia nervosa was unable to elucidate exact cause of death, aside from medical causes versus suicide.

Disordered eating behaviours such as restricted dietary intake, excessive exercise, binge eating, self-induced vomiting, laxative abuse, diuretic use, regurgitation and eat and spit, can affect nearly every system of the human body. While some individuals practice a single behaviour such as restriction, studies suggest that up to a third of individuals engage in two or more pathogenic behaviours.Furthermore, individuals who report using multiple compensatory behaviours have more severe presentations of eating disorders, lower levels of functioning and increased rates of general psychopathology.

As athletes may approach the medical care team for evaluation of an 'eating disorder consequence' rather than seeking care directly for an eating disorder, sports medicine clinicians should be aware of the signs and symptoms of restricting and purging behaviours (**table 1**).

Table 1

№

System

Signs

Symptoms

1

General

Marked or sudden weight loss, gain or fluctuation;

Failure to gain expected weight in child/adolescent who is still growing and developing;

Hypothermia, cold intolerance

Fatigue

2

Oral/dental

and throat

Oral trauma/lacerations;

Dental erosion or caries;

Perimolysis;

Parotid enlargement;

Recurrent sore throats;

3

Gastro-intestinal

Epigastric discomfort and/or abdominal pain;

Early satiety and delayed gastric emptying;

Gastroesophageal reflux;

Hematemesis;

Haemorrhoids, rectal fissures and rectal prolapsed;

Constipation;

Diarrhoea;

4

Endocrine

Irregular or missed menses;

Loss of libido;

Infertility

5

Neuro-psychiatric

Memory loss/poor concentration;

Insomnia;

Depression, anxiety;

Obsessive compulsive behavior;

Self-harm;

Suicidal ideation attempt;

Seizures;

6

Cardio-respiratory

Chest pain;

Palpitations;

Hypotension;

Bradycardia;

Other cardiac arrhythmias;

Shortness of breath; Oedema;

7

Musculo-skeletal

Low bone mineral density;

Stress fractures;

Fragility fractures

8

Dermato-logical

Lanugo hair;

Hair loss;

Yellowish skin discolouration;

Calluses or scars on the dorsum of the hand (Russell's sign);

Poor skin healing;

Evidence of self-harm (superficial

lacerations in various stages of healing)

People at normal weight may also have an eating disorder. Do not rely on weight or BMI alone to diagnose or rule-out an eating disorder. Awareness of the broad array of signs and symptoms that may be present can facilitate early identification of patients struggling with an eating disorder.

Among female athletes with eating disorders, especially those with restricted dietary intake, a commonly recognized consequence is the Female Athlete Triad. The Triad describes three distinct but inter-related conditions including low energy availability, menstrual dysfunction and low bone mineral density. Low energy availability (whether inadvertent, intentional or psychopathological), can result

from low energy intake relative to high energy expenditure during training and is the underlying factor contributing to negative effects on reproductive and skeletal health.

While not as extensively studied, there is increasing research on the health consequences of disordered eating in the male athlete. In a subset of male athletes, especially those participating in sports emphasizing leanness, parallels to the Triad have been described that include low energy availability - with or without disordered eating, hypogonadotropic hypogonadism or other gonadal steroid effects and low bone mineral density. Similar to the female athlete, male athletes with low energy availability (with or without disordered eating) may be predisposed to stress fractures and bone stress injuries. However, our current understanding of the mechanisms of nutrition and low energy availability on neuroendocrine function and bone health in males is limited compared to that for female athletes and further research is needed.

Performance consequences

Athletic performance suffers as a result of eating disorders. Female athletes with anorexia nervosa and a body mass index (BMI) <16.5, and those with bulimia nervosa purging four or more times per day should be categorically restricted from participation in sport. Additionally, low energy availability leading to the loss of fat and lean body mass, electrolyte abnormalities and dehydration all contribute to poor sport performance. A study of junior elite female swimmers, found that those with energy restriction and ovarian suppression had poor sport performance compared to cyclic swimmers.68 Even among high school athletes, those with disordered eating behaviours were more than twice as likely to sustain a musculoskeletal injury during their competitive season.

SCREENING FOR EATING DISORDERS IN ATHLETES

the Preparticipation Physical Examination (PPE)

The PPE includes several questions aimed at identification of disordered eating behaviours:

1. Do you worry about your weight?

2. Are you trying to, or has anyone recommended that you gain or lose weight?

3. Are you on a special diet or do you avoid certain types of food?

4. Have you ever had an eating disorder?

5. Have you ever taken any supplements to help you gain or lose weight or improve your performance?

Additional questions on the PPE questionnaire screen for downstream consequences of eating disorders including menstrual dysfunction (in female athletes), and stress fractures, mood disturbance and substance use (in female and male athletes).70 Clinicians should maintain a high index of suspicion for disordered eating since some studies show that athletes tend to under-report disordered eating behaviours on questionnaires.

The Female Athlete Triad Coalition has published an 11-question screening tool that aims to identify disordered eating, menstrual dysfunction and low bone mineral density. It is recommended that these questions be administered to athletes during the preparticipation examination.

Recommended screening questions for the female athlete triad.

Recommended questions:

1. Have you ever had a menstrual period?

2. How old were you when you had your first menstrual period?

3. When was your most recent menstrual period?

4. How many periods have you had in the past 12 months?

5. Are you presently taking any female hormones (oestrogen, progesterone, birth control pills)?

6. Do you worry about your weight?

7. Are you trying to or has anyone recommended that you gain or lose weight?

8. Are you on a special diet or do you avoid certain types of foods or food groups?

9. Have you ever had an eating disorder?

10. Have you ever had a stress fracture?

11. Have you ever been told you have low bone density (osteopenia or osteoporosis)?

These questions should be included as a part of the preparticipation physical examination (PPE).

DIAGNOSIS AND EVALUATION OF ATHLETES WITH EATING DISORDERS.

Sports medicine providers serve an important role in evaluating disordered eating and diagnosing eating disorders. Physicians, athletic trainers, sport psychologists, sport dietitians and physical therapists interact with athletes and active persons, and may have an opportunity to identify eating disordered behaviours.

Early identification and early intervention are associated with better outcomes. Referral of an athlete suspected of engaging in unhealthy eating behaviours to a physician with expertise in the evaluation and management of eating disorders, and especially with additional knowledge regarding the interaction with competitive sport, is a key step. As is often the case in medicine, 'the mystery is in the history,' and given the secretive nature of eating disorders, this adage is particularly applicable when caring for athletes with eating disorders. Questions such as, 'what percentage of your waking hours do you spend thinking about food, weight and body image?' and 'in what ways does your weight affect the way you think about yourself?' are but a few questions that often open up a dialogue about feelings, eating behaviours and health consequences. A more complete list of questions to consider integrating into the medical history when evaluating an athlete suspected of having disodered eating or an eating disorder can be found in **table 2.**

A review of systems and a comprehensive physical examination (table 1) can further aid in the identification of disordered eating behaviours and health consequences, leading to diagnosis as well as subsequent treatment. Laboratory evaluation and additional diagnostic testing are often required to better assess health consequences. Both historical and physical examination findings should guide the laboratory and additional diagnostic evaluation (**table 3).** Female athletes who develop menstrual dysfunction and/or evidence of low bone mineral density—the Female Athlete Triad—should undergo testing of their reproductive

hormones and evaluation of their bone mineral density as defined in the 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to Play of the Female Athlete Triad.

Table 2. Eating behaviour questions.

№	*Topic*	*Questions*
1	Questions to start the conversation	- How have you been feeling in general? How do you feel about yourself? - Do you mind if we talk about your eating habits?
2	Initial critical questions	- Are there foods or food groups that you avoid eating? - How do you feel about dieting in general? –How do you feel about your body size? – In what ways does your weight affect the way you think about yourself? – What percentage of your waking hours do you spend thinking about weight, food and body image?
3	Diet and dieting	- Do you worry that you have lost control of how much you eat? – Are you happy with your eating behaviour? – Do you eat in secret? – What did you have for breakfast today/yesterday? Lunch? Dinner? Snacks? – Do you count your calories? Watch fat grams? Avoid certain foods?

		– Do you ever eat a lot in one sitting—enough that you feel sick afterward? – Are you worried because sometimes you can't stop eating?
4	Vomiting/purging	- Do you make yourself throw-up because you feel Uncomfortably full? Do you use diuretics, laxatives or diet pills?
5	Weight and self-perception	- When you look in the mirror, what do you see? – What do you think you should weigh? What are you doing to reach or maintain that weight? – Have you recently lost or gained a lot of weight in a short period of time? – What was your lowest weight in the last year? Your highest weight?
6	Exercise and training	- Do you exercise above and beyond what is required for your sport? – Do you feel anxious if you miss a workout?
7	Family and support	- Does your family have any history of obesity, eating disorders, depression, mental illness or substance abuse (parents or other family members)? – Who are your primary sources of emotional support? How do they support you?
8	Health female patients	- When did you have your first period? Are your periods regular? When was your last period? – Do you have constipation? Diarrhoea? – Are you ever dizzy? Weak? Tired? Have you ever fainted? – Do you get cold easily? – Have you lost any hair? Grown new hair? Do you have dry skin? – Do you ever feel bloated? Have abdominal pain? – Do you have muscle cramps, bone pain?

Consider these questions for engaging patients and their family members in meaningful discussion that can help to identify the eating disorder.

Table 3 Eating disorder laboratory evaluation and diagnostic testing.

№	*Lab/test*	*When to use*
1	Basic blood chemistry: serum electrolytes; renal function (BUN, Cr); calcium; liver function tests; thyroid stimulating hormone (TSH); complete blood count (CBC), differential and platelets; urinalysis.	All patients with suspected eating disorder.
2	Additional blood chemistry: iron studies; vitamin D; vitamin B12; magnesium; phosphorous.	Malnourished and severely symptomatic patients.
3	Additional blood chemistry: serum luteinizing hormone; follicle stimulating hormone; prolactin; estradiol; thyroid stimulating hormone (TSH)—if not previously obtained; urine pregnancy test.	Patients with delayed menarche—no menses by age 15. Absence/delay of secondary sexual characteristics by age 13. Secondary amenorrhea (no menses for three consecutive months).
4	Toxicology screen.	Patients with suspected substance use.
5	Radiological imaging: dual energy X-ray absorptiometry (DXA), radiographs, advanced imaging.	DXA for patients with amenorrhoea for 6 months or more of prolonged oligomenorrhoea (<6 periods in 24 months); Radiographs to evaluate for stress fractures, or more advanced imaging if needed ECG.
6	ECG	Patients with syncope, recurrent near syncope, palpitations, resting supine

heart rate <50 bpm.

Rapid weight loss; weight <80% of ideal body weight.

Hypophophatemia.

TREATMENT OF DISORDERED EATING AND EATING DISORDERS IN ATHLETES.

Once a diagnosis of disordered eating or an eating disorder has been made, a knowledgeable and experienced multidisciplinary team of healthcare professionals should care for the athlete, with a goal of personalised patient-centered care (figure 1).

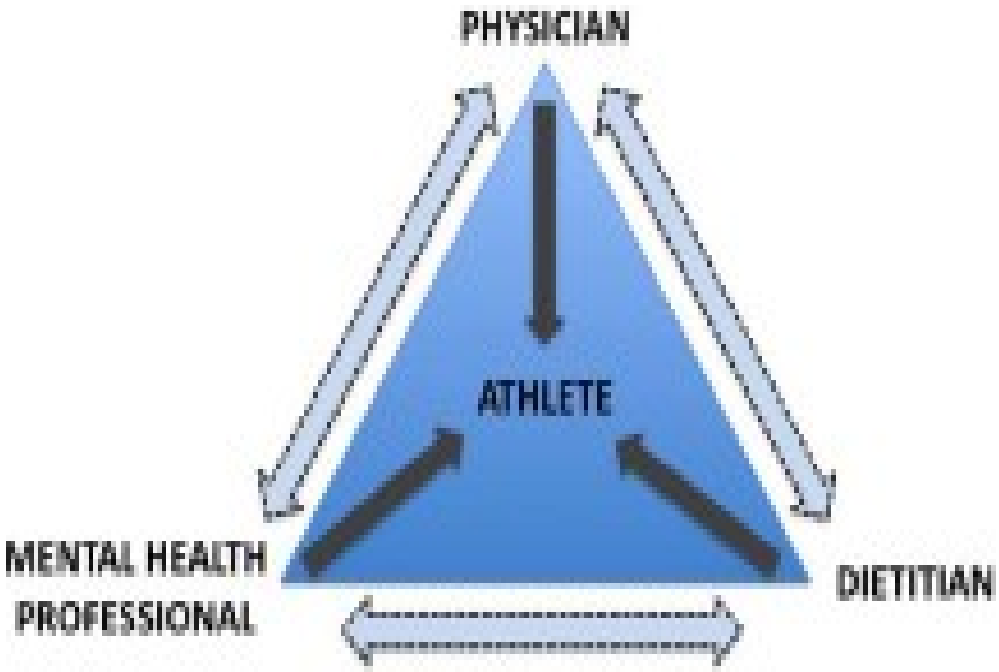

Figure 1 Multidisciplinary care. Multidisciplinary care of patients affected by eating disorders should include a physician, dietitian and mental health professional. Regular communication between team members facilitates clinically relevant information exchange, and cohesive, comprehensive, patient-centered care.

The first step in treatment is determining the level of care. Can the athlete be treated in an outpatient setting, or does he or she require a higher level of care in

the hospital or in a residential treatment setting? Deteriorating physical and/or mental health are the primary reasons prompting a higher level of care—examples include rapid uncontrolled weight loss, severe electrolyte abnormalities, syncope, suicidal intent and inability to function in one's environment. The majority of individuals can be treated in an outpatient setting using the multidisciplinary team care model. In the athletic setting the team often consists of a physician, a sports dietitian, a mental health professional and the athletic trainer.

Communication among team members is critically important. The individual affected by the eating disorder must feel like he or she is receiving a cohesive and consistent message from the treatment team. While each member of the team plays a unique role in supporting the athlete's recovery from the eating disorder, there is considerable crossover in the care that team members provide—with the physician talking about nutrition, or the dietitian discussing feelings and function alongside calories and carbohydrates. Setting aside time for the team to 'round' and share important information about the athlete can help to facilitate care.

Additional health professionals may have a consulting role in the care of the athlete affected by an eating disorder (such as psychiatry, or gastroenterology).

For younger athletes still living at home, engagement and alignment with parents or guardians is critically important.

Knowing that chaotic or disruptive family situations (such as divorcing parents) can contribute to the development of an eating disorder, it is imperative that the multidisciplinary treatment team understands the environment in which the athlete lives, and takes that into account when developing and implementing treatment plans.

The primary role of the physician is to address the eating disordered behaviours and their health consequences, and to support and reinforce the treatment plans of the dietitian, mental health professional and others involved in the athlete's care. Healthcare visits are typically monthly, although may be more or less frequent

depending on the athlete's stage of recovery. Medical care should focus on the following areas:

▸ Function—Assessing day-to-day functioning

– How have you been doing since your last visit?

– Is there a time of day that your behaviours are better or worse?

– What helps you succeed (with changing behaviours, with treatment, etc)?

– Are you taking your medications as prescribed?

– Additional questions to develop rapport and further assess patient functioning (eg, 'How is school? Practice? Work? Family/Friends?').

▸ Physical health discussion—Discussing health-related topics, such as:

– A targeted symptom review: sleep, bowel habits, energy,urination, palpitations, syncope/near-syncope, menstruation, other issues or concerns – Eating behaviours —restriction, binging, purging, etc

– Exercise and training behaviours—healthy and unhealthy; issues related to clearance and return to play

▸ Mental status—Assessing the patient's mental health with a standard mental status examination (MSE) and discussion of various topics, such as body image, stressors, and mental health issues.

▸ Physical health examination—Checking and recording the following:

– Vital signs—blinded weight, height, BMI, blood pressure, heart rate, temperature

▸ Change in weight since last visit

– Physical examination if necessary—throat, heart, lungs, extremities, etc

– Repeated tests/examination items from diagnosis as necessary

▸ Medications—Prescribing and managing medications as needed.

► Other health needs as necessary—Reviewing menstrual function, digestive issues, bone health, endocrinology manifestations, etc.

Medication use

Medications are often prescribed to patients with eating disorders to treat comorbid conditions such as depression and anxiety, or to manage physical complications. Target symptoms should be established with the patient and regularly monitored. Sports medicine physicians should be aware of the unique interaction between medications and sport participation. For example, medications that induce orthostatic hypotension should not be prescribed to a gymnast who experiences many changes in posture and position. Likewise, sedating medications may not be tolerated by student athletes attending school, practice or trying to complete evening homework tasks.

CLEARANCE AND RETURN TO PLAY CONSIDERATIONS

One of the most important areas of concern for the team physician involves the decision-making process regarding clearance and return to play. For female athletes with disordered eating behaviours and health consequences related to those behaviours, the Female Athlete Triad: Cumulative Risk Assessment in the 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to Play of the Female Athlete Triad can serve as a guide to physicians making clearance and return to play decisions. The risk assessment tool takes into account: dietary restriction, BMI, menstrual history (delayed menarche, oligomenorrhoea, amenorrhoea), bone mineral density and history of stress reaction or fracture. Each risk factor carries a point value, and the numeric score suggests whether an athlete should receive full clearance, provisional/limited clearance or restriction from participation. While this risk assessment tool can help to guide clearance and return to play decisions for athletes with disordered eating and eating disorders, physicians should combine these recommendations with their own clinical

decision-making skills, and need not use the tool in isolation. Of note, athletes diagnosed with anorexia nervosa who have a BMI <16 kg/m² or athletes with moderate-to-severe bulimia nervosa (purging >4 times/week) should be categorically restricted from training and competition. Female athletes who fall into moderate and high- risk categories should have a written contract completed and signed by the athlete and each member of the multidisciplinary team. While a similar evidence-based scoring system with concomitant clearance recommendations has not yet been developed for male athletes, the IOC has proposed a return to play model based on a red light (high risk), yellow light (moderate risk), green light (low risk) system.

PREVENTION

Efforts to prevent disordered eating behaviour among athletes should be aimed at athletes, coaches, athletic administrators and parents. Primary prevention efforts work to expand athlete knowledge about healthy eating, pathological eating behaviours and their consequences, and what to do if you or a teammate are thought to have an eating disorder. Athletes should be educated that dietary restriction and/or purging behaviour in pursuit of optimal weight and body composition will negatively impact sport performance and result in adverse health consequences. In one study, a peer-led educational programme for athletes resulted in improved bulimic pathology even 1 year after the intervention, and researchers noted an increase in the number of athletes who sought medical care because they had become concerned that they might have symptoms of the Female Athlete Triad. Likewise, athletes, coaches and parents should be informed that the loss of menstruation is not a positive adaptation to high-intensity training and sport participation, and represents a state of low energy availability stemming from either intentional or unintentional dietary restriction. Studies have shown that educational programmes directed at coaches are successful in increasing their knowledge about eating disorders in athletes, including recognition and management. However, it is not yet clear whether this increased awareness

translates to improved outcomes among athletes. The National Collegiate Athletic Association (NCAA) has developed educational materials for coaches, athletic administrators and athletes in an effort to prevent eating disorders. They identify 10 strategies for coaches and administrators, which aim to reduce the likelihood of disordered eating and eating disorders among their athletes:

1. Be aware of the symptoms of disordered eating.
2. Consult a registered dietitian who specialises in sport, particularly a Board Certified Specialist in Sports Dietetics (CSSD) to prescribe appropriate nutrition for optimal sport performance.
3. De-emphasise weight: Be aware of how you are communicating to athletes about weight and performance. Focus on ways for athletes to enhance their performance that do not involve weight.
4. Keep an open dialogue with athletes about the importance of nutrition and staying injury-free for optimal athletic performance.
5. Recognise that the body composition and training required for optimal health and performance are not identical for all athletes.
6. Screen student-athletes before the start of the season for risk factors of disordered eating using a validated screening instrument.
7. Ensure that all stakeholders (coaches, strength and conditioning coaches, athletic trainers, student-athletes, student-athlete affairs administrators and athletics department staff) are educated about the factors that put athletes at risk for disordered eating.
8. Understand your institution's referral protocol for student-athletes who are in need of assistance with nutrition or disordered eating issues.
9. Encourage help-seeking for all mental health concerns, including disordered eating.
10. Develop a plan with other stakeholders (such as university counselling services or a sports registered dietitian) for how to identify and treat student-athletes with eating disorders.

Finally, sports medicine physicians should use the preparticipation evaluation as an opportunity to educate the parents of younger athletes about disordered eating and common health consequences. Emphasising the role of nutrition in optimising performance and health is an important strategy to avoid unhealthy dietary manipulation.

While females are affected more commonly than males (at nearly a 9:1 ratio), both sexes are at greatest risk for eating disorder in sports where leanness confers a competitive advantage. Athlete medical teams need to systematically screen athletes (both male and female) as a part of the preparticipation evaluation. Once diagnosed, referral to an experienced multidisciplinary team is considered best practice. In addition to the team physician, dietitian and mental health professional, athletic trainers play a key role as the 'eyes and ears' of the healthcare team on the practice field and in the training room and oftentimes serve as the confidant and support person for the athlete who is struggling with and recovering from an eating disorder.

Sports medicine physicians play a key role in evaluation, diagnosis and treatment, including clearance and return to play. Utilising established recommendations that guide clearance and return to play decision-making can ease difficult decisions, and promote transparency and accountability in support of a healthy athlete.

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