

# Probing the Use of Cannabidiol (CBD) by Elite-Level Athletes in Canada

Dimitri Karam, MD

Department of Kinesiology and Physical Education

**McGill University** 

Montreal, Qc, Canada

December 2023

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master of Science

© Dimitri Karam, MD, 2023

Table	of	Con	tents
	-		

Abstract	4
Résumé	6
Acknowledgements	8
Contribution of Authors	10
List of Figures & Tables	12
List of Abbreviations	15
CHAPTER 1: INTRODUCTION	16
CHAPTER 2: LITERATURE REVIEW	20
2.1 Cannabis sativa L	21
2.2 Endogenous Cannabinoid System	26
2.3 Cannabidiol (CBD)	29
2.3.1 Formulation & route of administration	
2.3.2 Pharmacokinetics	31
2.3.2.1 Absorption	
2.3.2.2 Distribution	
2.3.2.3 Metabolism	
2.3.2.4 Elimination	
2.3.3 Pharmacodynamics & therapeutic potential	
2.3.4 Dosing & quality control	35
2.3.5 Safety profile	36
2.3.6 Interactions	
2.4 The prevalence of CBD use in athletes	
2.5 The role of CBD in areas of potential relevance to athletes and wi sport and exercise performance	thin the context of
2.5.1 CBD: pain & inflammation	
2.5.2 CBD: neuroprotection & neuromodulation	40
2.5.3 CBD: mental health	41
2.5.4 CBD: sleep and insomnia	43
2.5.5 CBD: nutrition	44
2.6 Legal status of CBD	45
2.7 Conclusion	46

CHAPTER 3: MANUSCRIPT	48
3.1 Introduction	49
3.2 Methodology	51
3.2.1 Overall study design	51
3.2.2 Survey design	52
3.2.3 Data analysis	54
3.3 Results	55
3.3.1 Demographics	55
3.3.2 CBD awareness	64
3.3.3 CBD use experience, efficacy, and rationale	66
3.3.4 Thoughts & assumptions about CBD use	80
3.3.5 End of survey comments	86
3.4 Discussion	87
3.4.1 Demographics	87
3.4.2 Information sources & communication patterns regarding CBD	89
3.4.3 CBD use, safety & concerns	91
3.4.4 CBD products & dosing regimens	94
3.4.5 CBD use benefits & incentives	98
3.4.6 Extra comments on CBD	100
CHAPTER 4: OVERALL CONCLUSION & SUMMARY	102
Reference List	106
Appendix A. Survey Instrument – English Version	
Appendix B. Survey Instrument – French Version	125

#### Abstract

Elite athletes, along with their coaches and support staff, are constantly seeking strategies to support training and recovery efforts that ultimately maximize performance in competition. Cannabidiol (CBD) is a psychoactive and non-intoxicating cannabinoid found in the cannabis plant with purported physiological and psychological effects that may be of benefit to athletes under certain circumstances. CBD is not currently prohibited by the World Anti-Doping Agency (WADA); however, all other cannabinoids currently remain on WADA's prohibited list. Nonetheless, use of CBD products may pose a risk of inadvertent doping due to the presence of other cannabinoids (e.g., tetrahydrocannabinol (THC)) in CBD products. The prevalence, rationale, and subjective benefits of CBD use in elite Canadian athletes has not been explored. Therefore, we recruited elite-level Canadian athletes to complete a survey to gather information on the use of CBD in this population. A self-administered and anonymous online survey, hosted on the LimeSurvey platform in both French and English, was made available to approximately 2000 athletes. A total of 80 athletes from different sports (i.e., team sports, individual sports, artistic sports, and combat sports) completed the survey between October 15, 2021 and June 26, 2023. The included athletes were 1) identified for the 2021-2022 or 2022-2023 season to compete as part of the senior national (Olympic or Paralympic) Canadian team program, or 2) identified by the National Sport Organization as part of the "NextGen" (Next Generation) program with the potential of qualifying for a roster position on the senior national team. Descriptive analysis revealed that 37% (n = 30) of the athletes had used CBD, with 30% (n = 9) of CBD users reporting active/current use. Only 7% (n = 2) of athletes who consumed CBD indicated that they documented their usage. With "oral

tincture/oil" being the most commonly used form of CBD (31% proportion; n = 20 of 64 total selections from 7 formulations), most CBD users relied on the "trial and error" method to find their optimal dose (55% proportion; n = 22 of 40 total selections from 5 methods). The most reported reason for discontinuing CBD use among consumers was the fear of an accidental anti-doping rule violation due to the risk of CBD products being contaminated with THC and/or other banned cannabinoids (52% proportion; n = 14 of 27 total selections from 6 reasons). The overall consensus among the 30 CBD users was that CBD is safe to use (96%; n = 29; agree > strongly agree), improves sleep (93%; n = 28; strongly agree > agree) and relaxation (90%; n = 27; strongly agree > agree), reduces pain from training (77%; n = 23; agree > strongly agree), enhances physical (73%; n = 22; agree > strongly agree) and mental (70%; n = 21; strongly agree > agree) recovery after training or competition, reduces pain from competition (70%; n = 21; agree > strongly agree), and improves symptoms of anxiety (60%; n = 18; agree = strongly agree) and depression (54%; n = 16; agree = strongly agree). Data from this study may help identify key avenues for future research studies in athletes in order to better determine the effects of CBD under more controlled experimental conditions.

#### Résumé

Les athlètes d'élite, ainsi que leurs entraîneurs et leur personnel de soutien, recherchent constamment des stratégies pour soutenir leurs efforts d'entraînement et de récupération qui maximisent finalement la performance en compétition. Le cannabidiol (CBD) est une substance psychoactive et non-intoxicante présente dans la plante de cannabis. On pense que le CBD pourrait offrir des avantages physiologiques et psychologiques aux athlètes dans certaines situations. Le CBD n'est actuellement pas interdit par l'Agence Mondiale Antidopage (AMA); cependant, tous les autres cannabinoïdes demeurent sur la liste des interdictions de l'AMA. Néanmoins, l'utilisation de produits CBD pourrait présenter un risque de dopage involontaire en raison de la présence d'autres cannabinoïdes (p.ex., tétrahydrocannabinol (THC)) dans les produits CBD. La prévalence, la justification et les avantages subjectifs de l'utilisation du CBD chez les athlètes d'élite Canadiens n'ont pas été étudiés. Par conséquent, nous avons recruté des athlètes Canadiens de haut niveau pour remplir un questionnaire afin de recueillir des informations sur l'utilisation du CBD dans cette population. Un sondage en ligne, auto-administré et anonyme, hébergé sur la plateforme LimeSurvey en français et en anglais, a été proposé à environ 2000 athlètes. Au total, 80 athlètes de différents sports (c'est-à-dire sports d'équipe, sports individuels, sports artistiques et sports de combat) ont complété le sondage entre le 15 octobre 2021 et le 26 juin 2023. Les athlètes inclus étaient 1) identifiés pour la saison 2021-2022 ou 2022-2023 pour concourir dans le cadre du programme national senior (Olympique ou Paralympique) Canadien, ou 2) identifiés par l'Organisation Sportive Nationale comme faisant partie du programme "NextGen" avec le potentiel de se qualifier pour une place dans l'équipe nationale senior.

L'analyse descriptive a révélé que 37% (n = 30) des athlètes avaient utilisé le CBD, avec 30% (n = 9) des utilisateurs de CBD déclarant une utilisation active/actuelle. 7% (n = 2) des athlètes ayant consommé du CBD ont déclaré avoir documenté leur utilisation. Avec la "teinture/huile orale" étant la formulation de CBD la plus couramment utilisé (31% de proportion; n = 20 sur 64 sélections totales parmi 7 formulations), la plupart des utilisateurs de CBD ont eu recours à la méthode "essai et erreur" pour trouver leur dose optimale (55% de proportion; n = 22 sur 40 sélections totales parmi 5 méthodes). La raison la plus souvent évoquée pour arrêter le CBD parmi les athlètes était la peur d'une violation accidentelle de la règle antidopage en raison du risque de contamination des produits CBD avec le THC et/ou d'autres cannabinoïdes interdits (52% de proportion; n = 14 sur 27 sélections totales parmi 6 raisons). Le consensus général parmi les 30 utilisateurs de CBD était que le CBD est sûr à utiliser (96%; n = 29; accord > fort accord), améliore le sommeil (93%; n = 28; fort accord > accord) et la relaxation (90%; n = 27; fort accord > accord), réduit la douleur de l'entraînement (77%; n = 23; accord > fort accord), améliore la récupération physique (73%; n = 22; accord > fort accord) et mentale (70%; n = 21; fort accord > accord) après un entraînement ou une compétition, réduit la douleur de la compétition (70%; n = 21; accord > fort accord), et améliore les symptômes de l'anxiété (60%; n = 18; accord = fort accord) et de la dépression (54%; n = 16; accord = fort accord). Les données de cette étude peuvent aider à identifier des pistes clés pour les futures études de recherche sur les athlètes afin de mieux déterminer les effets du CBD dans des conditions expérimentales plus contrôlées.

### **Acknowledgements**

The culmination of this research stands as a testament to the incredible individuals from diverse backgrounds who united around a shared passion. Their belief in me not only boosted my confidence but also empowered me to pursue both our collective goal and my individual scientific/medical aspirations.

To Dr. Tyler A. Churchward-Venne, a distinguished professor, mentor, and dear friend: your boundless patience, unwavering trust, profound wisdom, and in-depth expertise have been pivotal in shaping my journey at the Master's level. Your influence will undoubtedly echo through all my future research endeavors. What I treasure the most is your remarkable ability to understand and nurture every student in the Exercise Metabolism and Nutrition Research lab. Through your adept guidance, you've orchestrated a symphony of young researchers, each with unique talents and aspirations, enabling us to make our mark in the scientific realm. Beyond the research, I eagerly anticipate our next collaboration and, of course, our karaoke session.

To the esteemed professors Dr. Lindsay Duncan and Dr. Dennis Jensen: being under your advisory for this project has been a privilege. Your insights, right from the inception to the culmination of this study, have been invaluable, enriching its global resonance. I'm profoundly grateful and genuinely hope our paths cross again in similar ventures.

To Erik Sesbreno, Kelly Drager, and Susan Boegman, our lead sports nutritionists from various sports institutes across Canada: your dedication to this study is beyond commendable. Orchestrating the private distribution of the survey to elite-level athletes nation-wide was no small feat. Your unwavering commitment and expertise have been indispensable, and I eagerly await our next collaboration.

To my family, Elie & Sana Karam, Sarah Ghannoum, Paul Karam, Ghassan Karam, and Jean-Andre Karam: your unwavering support has been my bedrock. Your sacrifices, both financial and emotional, during these intense academic years, have been the wind beneath my wings. Every page of this thesis resonates with your love and faith in me.

To my dear friends, Dr. Hussein Assi and Sarkis Hannaian: We've always championed each other in our respective scientific journeys. Since the start of this one, your encouragement never withered. Deep gratitude fills every step of the way.

From the depths of my heart, I thank each one of you. May your kindness, support, and contributions be magnified and returned to you manifold.

## **Contribution of Authors**

**Dr. Dimitri Karam (first author & lead researcher):** contributed to the conception and design of the study and survey questionnaire, completed the survey instrument translation from English to French, set-up and monitored the survey on the LimeSurvey platform, ensured that all project material was current and received complete ethics approval by McGill University's Faculty of Medicine and Health Sciences Institutional Review Board (IRB), contributed to the design and execution of participant recruitment/data collection strategies (e.g., email templates, handouts, videos, word of mouth scripts), analyzed the data, interpreted the study findings, prepared the figures and tables, drafted the thesis, read and approved the final thesis, and holds primary responsibility for the content of the published work along with the principal investigator (Dr. Tyler A. Churchward-Venne).

**Erik Sesbreno:** contributed to the conception and design of the study and survey questionnaire, contributed to leading and carrying out participant recruitment, contributed to the design of data collection strategies.

**Kelly Drager:** contributed to the conception and design of the study and survey questionnaire, contributed to leading and carrying out participant recruitment, contributed to the design of data collection strategies.

**Susan Boegman:** contributed to the conception and design of the study and survey questionnaire, contributed to leading and carrying out participant recruitment, contributed to the design of data collection strategies.

**Dr. Lindsay Duncan:** contributed to the conception and design of the study and survey questionnaire, edited the draft thesis.

**Dr. Dennis Jensen:** contributed to the conception and design of the study and survey questionnaire, edited the draft thesis.

**Dr. Tyler A. Churchward-Venne (principal investigator):** contributed to the conception and design of the study and survey questionnaire, contributed to the design of data collection strategies, contributed to the interpretation of the study findings, edited the draft thesis, read and approved the final thesis, and holds primary responsibility for the content of the published work along with the lead researcher.

# List of Figures & Tables

Table 1. Athletes' general comments relating to CBD use among athletes.       86
<b>Figure 1.</b> Biogenesis of THC and CBD. The oxidative cyclization of CBGA to THCA and CBDA is enzyme dependent, whereas the conversion of the acidic precursor phytocannabinoids, THCA and CBDA, to their biologically active and neutral form, THC and CBD, respectively, is by non-enzymatic/artificial decarboxylation. Adapted from Taura et al. (2007) <sup>23</sup>
Figure 2. Potential benefits of CBD use for athletes. Here are some of the potentially beneficial effects of CBD use for athletes
<b>Figure 3.</b> Flow of participants. Here is showcased the strategy for athlete navigation in the online survey study on CBD use by elite-level Canadian athletes, based on language of preference and CBD use status
Figure 4. Athlete age and sex distribution. Here is showcased the distribution of the athletes based on their sex assigned at birth and their age group
Figure 5. Athlete age and CBD use status distribution. Here is showcased the distribution of the athletes based on their age and their CBD use status
Figure 6. Athlete sex and CBD use status distribution. Here is showcased the distribution of the athletes based on their sex assigned at birth and their CBD use status
Figure 7. Athlete CBD use status. Here are showcased the different proportions of athletes based on their CBD use status
Figure 8. Career funding avenues. Here are showcased, in orderly proportions, the different financial support avenues that the athletes relied on for career funding/financial support59
Figure 9. Level of competition and CBD use status. Here is showcased the distribution of the athletes based on their level(s) of competition and their CBD use status
<b>Figure 10.</b> Sex and primary sport contested. Here is showcased the distribution of the athletes based on their primary sport in which they compete. A "(P)" at the end of a sport name distinguishes Para sports from able-bodied sports. The distribution of males and females per sport contested is also included
<b>Figure 11.</b> Primary sport contested and CBD use status. Here is showcased the orderly distribution of the athletes based on their primary sport in which they compete. A "(P)" at the end of a sport name distinguishes Para sports from able-bodied sports. The distribution of CBD use status per sport contested is also included.
<b>Figure 12.</b> Competition season and CBD use status. Here is showcased the distribution of the athletes based on their main competition season and their CBD use status

Figure 13. General sources of knowledge about CBD. Here are showcased, in orderly proportions, the different sources of information about CBD
Figure 14. Internet sources of knowledge about CBD. Here are showcased, in orderly proportions, the different internet sources of information about CBD
Figure 15. Duration of CBD use. Here is showcased the distribution of the athletes based on how long they used CBD for
Figure 16. Reasons for CBD users to discontinue use. Here are showcased, in orderly proportions, the reasons behind CBD users who discontinued use either temporarily or indefinitely
Figure 17. Sources of CBD acquisition. Here are showcased, in orderly proportions, the different sources where athletes acquired their CBD products
Figure 18. Monthly expenditure on CBD products. Here are showcased the different amounts that CBD users spend on CBD products per month
Figure 19. Modes of CBD consumption. Here are showcased, in orderly proportions, the different modes of CBD consumption reported by CBD users
Figure 20. CBD quantity (mg) per single dose. Here is showcased the distribution of the different quantities of CBD, in milligrams, consumed by the CBD users per single dose
Figure 21. Methods for dose determination. Here are showcased, in orderly proportions, the different methods utilized by CBD users to determine the dose for consumption
Figure 22. Certainty level of optimal CBD dosing. Here is showcased the distribution of the level of certainty for each athlete, in percentage, that they are consuming an optimal dose of CBD72
Figure 23. Timing of CBD consumption relative to training. Here are showcased, in proportions, the different timings of CBD consumption in relation to training
Figure 24. Timing of CBD consumption relative to competition. Here are showcased, in proportions, the different timings of CBD consumption in relation to competition
Figure 25. Consistency of CBD use regimens. Here is showcased the orderly distribution of different CBD use regimens based on consistency of use
Figure 26. CBD effect on athletic performance. Here is showcased an orderly distribution of the effect that CBD use has on athletic performance during competition
Figure 27. Agreement level with various reasons for taking CBD. Here is showcased an orderly distribution of the CBD user's agreement level with different intended use scenarios for CBD77
Figure 28. Agreement level with various statements about CBD. Here is showcased an orderly distribution of the CBD user's agreement level with different statements regarding CBD

Figure 29	. Frequency	of reported side	effects with	CBD use.	Here is show	cased an orde	erly distribution of	of
the fr	equency of e	xperienced side	e effects by C	CBD users				79

<ul> <li>Figure 30. Agreement level with various statements about CBD side effects. Here is showcased an orderly distribution of the CBD user's agreement level with different statements regarding CBD side effects.</li> </ul>
<ul> <li>Figure 31. Frequency of CBD related discussions with entourage. Here is showcased an orderly distribution of the different frequencies of discussions about CBD between users and non-users of CBD and their entourage.</li> </ul>
<ul> <li>Figure 32. Perceived prevalence of CBD use among entourage. Here is showcased an orderly distribution of the perceived prevalence of CBD use among the entourage, relative to users and non-users of CBD.</li> </ul>
Figure 33. Likelihood of CBD use in the next year. Here is showcased an orderly distribution of the likelihood of starting, restarting, or continuing CBD use in the next 12 months for non-CBD users, past-only CBD users, and past plus ongoing CBD users, respectively
Figure 34. Valid reasons to never start or to discontinue CBD use. Here are showcased, in orderly proportions, valid reasons to never start or to discontinue CBD use for CBD users and non-users alike.
Figure 35. Likelihood of more CBD use given compelling scenarios involving CBD. Here is showcased an orderly distribution of the likelihood of starting or continuing CBD use given different scenarios, for CBD users and non-users alike
<b>Figure 36.</b> Likelihood of broader acceptance of CBD use among athletes. Here is showcased an orderly distribution of the likelihood of more widespread acceptance of CBD use among athletes given

# List of Abbreviations

2-AG	2-arachidonoylglycerol
5-HT <sub>1A</sub>	Serotonin 1A receptor
ADRV	Anti-doping rule violation
AEA or ANA	N-arachidonoyl-ethanolamide or Anandamide
AUC	The area under the plasma concentration vs. time curve
CAD	Canadian dollars
CB₁R	Cannabinoid receptor type 1
CB <sub>2</sub> R	Cannabinoid receptor type 2
CBD	Cannabidiol
CBDA	Cannabidiolic acid
CCK-GABA	Cholecystokinin-expressing GABAergic interneurons
C <sub>max</sub>	Maximum measured plasma concentration over the time span specified
CNS	Central nervous system
C. sativa	Cannabis sativa L. or cannabis
СҮР	Cytochrome P450
DOMS	Delayed onset muscle soreness
eCB	Endogenous cannabinoids
eCBSS	Endocannabinoid signaling system
ECC	Eccentric exercise
ECS	Endogenous cannabinoid system
EIMD	Exercise-induced muscle damage
ERK	Extracellular signal-related kinase
FAAH	Fatty acid amide hydrolase
FDA	Food and drug administration
GPCR or GPR	G-protein-coupled receptors of the G <sub>i</sub> and G <sub>o</sub> classes
GRK	G-protein-coupled receptor kinase
HDL	High-density lipoproteins, aka "good" cholesterol
HFP	Herbaceous flowering plant
INS	Institut national du Sport du Québec
IRB	Institutional review board
mTBI	Mild traumatic brain injury
NAM	Negative allosteric modulator
PAM	Positive allosteric modulator
PBMCs	Peripheral blood mononuclear cells
PKA	Protein kinase A
PPARy	Peroxisome proliferator-activated receptor gamma
PTSD	Post-traumatic stress disorder
SAD	Social anxiety disorder
SPA	Sports performance anxiety
SPS	Stressful simulated public speaking test
t <sub>1/2</sub>	Final time taken for the plasma concentration to be reduced by half
THC or Δ <sup>3</sup> -THC	$\Delta^{\circ}$ -tetrahydrocannabinol
	I me to the maximum measured plasma concentration
	ransient receptor potential vanilloid
US or USA	United States of America
Usport	University level sport competitions in Canada
WADA	world Anti-Doping Agency

**CHAPTER 1: INTRODUCTION** 

The Cannabis sativa L. plant has been used for both medicinal and recreational purposes for thousands of years and is cited in nearly every ancient handbook on plant medicine<sup>1</sup>. The two major phytocannabinoids (i.e., plant cannabinoids) of *C. sativa*, best known for their therapeutic properties and psychoactive potential, are the intoxicating and first to be isolated  $\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC or THC), followed by its nonintoxicating isomer cannabidiol (CBD), isolated in 1940<sup>2-5</sup>. Although CBD was initially considered to be an inactive substance, with no therapeutic or "subjective" drug effects<sup>6</sup>, several molecular targets of CBD have since been identified<sup>7</sup>, opening up a range of potential therapeutic applications. For example, CBD has been studied for its potential therapeutic effects in treating various medical conditions, and has been shown to have neuroprotective, antiepileptic, anxiolytic, antipsychotic, and anti-inflammatory properties<sup>8</sup>. The legal status of CBD varies from country to country; however, in Canada products are strictly regulated and are only legal when sold in compliance with the Cannabis Act and its regulations. Changes in the legal landscape of cannabis have contributed to increased interest in CBD among the general population as evidenced by an exponential increase in searches for 'CBD' online in the USA<sup>9</sup>. In elite sport, cannabis has been prohibited by the World Anti-Doping Agency (WADA) in competition since 2004. However, in 2018 WADA removed CBD from the list of prohibited substances, allowing CBD use by athletes both in and out of competition. Although CBD is not prohibited by WADA and appears to be both safe and well-tolerated in humans<sup>10</sup>, some CBD products may contain significant levels of other banned phytocannabinoids, potentially leading to a positive doping test. Further, it has been demonstrated that many product label claims of commercially available hemp-derived CBD products in the USA do not accurately reflect actual CBD

content, with some products exceeding the maximum legal  $\Delta$ 9-THC limit of <0.3% weight of the dried flowers of the plant<sup>11</sup>. This is particularly relevant given the growing interest in CBD use by elite athletes in professional and amateur sport<sup>12,13</sup>. Indeed CBD products are widely marketed to athletes for claimed beneficial effects such as decreased anxiety, fear memory extinction, improved sleep, anti-inflammatory properties, relief of pain, and enhanced recovery from exercise<sup>14</sup>.

The primary objective of the present research project is to study the prevalence and rationale for CBD use by elite-level athletes in Canada. The secondary objectives are to 1) identify the expected and perceived benefits (e.g., improved sleep quality, hastened recovery of sport-related muscle soreness) of CBD use, 2) identify barriers or deterrents to the use of CBD, 3) identify the sources of information which influence the use of CBD, 4) explore age-, sex-, and sport-related differences regarding the use of CBD, and 5) explore the range of CBD products/brands, dosages (the amount and frequency of administration), formulations, and routes of administration reported. Given the quasirecent legalisation of CBD in all sports, we hypothesized that the prevalence of CBD use (both past and present) by elite Canadian athletes would likely exceed 30% and be underreported by CBD users (<20%) due to persistence of stigmas surrounding cannabinoid supplements and risks of an accidental anti-doping rule violation (ADRV). Data from this study will help pinpoint key avenues for future clinical intervention studies to better determine the effects of CBD under more controlled experimental conditions. Findings might also promote transparency around taboo topics between athletes and their support staff along with the development of educational tools and guidelines for

safeguarding the use of novel supplements, such as CBD, by elite-level amateur and professional athletes.

The following literature review will provide an overview of cannabis research with emphasis placed on the phytocannabinoid CBD. Specific attention is given to the biochemical, physiological, and psychological effects of CBD that may be of relevance to athletes within the context of and sport and exercise performance. **CHAPTER 2: LITERATURE REVIEW** 

#### 2.1 Cannabis sativa L.

*Cannabis sativa* L. (*C. sativa* or cannabis) holds the title for one of the oldest agricultural and multiuse crops known to man<sup>4</sup>. It is currently the world's most popular and widely consumed botanical drug, in crude forms (dry flower, hashish, or hash oil), recreationally, illicitly, or for medicinal purposes<sup>15,16</sup>. Since its domestication, the story of *C. sativa* became deeply woven to that of human civilisations. Evidence of it being utilized for its fibre-rich long stalks, (i.e., bast fibre - to produce fabrics, rope, and other textiles), seed (food, seed oil), and flowering tops (in religious rituals, medicinal and psychoactive drugs) is abundant and well established<sup>1,3,17</sup>. However, the full extent of its medicinal indications has yet to be scientifically uncovered.

*Cannabis sativa* L. is an anemophilous, i.e., wind-pollinated, and annual herbaceous flowering plant (HFP) <sup>4</sup>, meaning a plant lacking a persistent woody stem above the ground and undergoes complete death at the conclusion of the yearly growing season or after flowering and fruiting, only to regenerate from seeds in the subsequent growth cycle. *C. sativa* is also classified as an "arctic forb" <sup>18</sup>, meaning an HFP native to the arctic tundra, can tolerate very cold climatic conditions, and belongs to the order *Urticales* and the family *Cannabaceae*<sup>4,19</sup>. At odds with conventional wisdom which places the center of origin of *C. sativa* in Asia<sup>1,4,15</sup>; elaborate fossil pollen studies (FPS) indicate the plant is more likely indigenous to Europe<sup>18</sup>. Temperature variations during the Holocene Epoch, coupled with prior cycling between stadial (glacial) and interstadial (warm) periods during the Pliocene, greatly influenced the biogeographic trends, meaning the distribution of living organisms across different geographic regions, of Eurasia<sup>18</sup>. It is therefore argued that past climate variability pushed the flora to cyclically expand inland

and then retract, thus likely contributing to the early spread of C. sativa from its native region, corresponding to what is now Europe<sup>18</sup>. It has been hypothesized that subsequent geographic speciation, meaning when biological populations (including plants or all living things) experience a level of geographical isolation that hinders or disrupts the exchange of genes between them, gave rise to *Cannabis'* botanical subspecies (subspp. or spp.)<sup>18</sup>, i.e., cultivars or strains, thus offering further support to the premise that the cultivation of C. sativa arose simultaneously and independently in several places<sup>18</sup>. Cannabis sativa L. has two recognized subspecies; Cannabis sativa subsp. sativa, aka "fiber-type hemp", originally cultivated for industrial use, and C. sativa subsp. indica originating in Southern Asia (India) <sup>1,19</sup>. Unlike fiber cannabis plants found in Europe, the varieties found in India were rich in bioactive compounds<sup>1</sup>, which explains why, in accordance with the literature, the plant had also spread from Asia towards the West<sup>1,4,15,18</sup>. Some researchers recognize a third cultivar, C. ruderalis, a smaller, weedy plant originally from Central Russia<sup>1,15</sup>. In fact, since its early domestication, C. sativa has undergone intensive breeding which has resulted in extensive variations in its morphology and chemical composition<sup>20</sup>, thus resulting in confusion and controversy over the taxonomic organization of the genus. Most authors circle back to the botanical taxonomy of C. sativa, subclassifying it based on its phenotypic traits. However, there are current debates over the usefulness of either a chemotaxonomy, a vernacular taxonomy, and/or more recently genetic sequencing. Noteworthy, the more popular vernacular taxonomy, which is used among recreational growers and users of cannabis, also uses the "strains" nomenclature (sativa, indica, and hybrid) when referring to cannabis varieties<sup>1</sup>, thus adding to the confusion. The subjective and scientifically unverified effects of sativa "strains" are

described as uplifting and energetic and are considered more hallucinogenic<sup>1</sup>. In contrast, indica "strains" are described as calming and are said to cause relaxation and stress relief<sup>1</sup>.

In general, male and female plants develop separately<sup>1</sup>. Cannabis' glandular hairs, which are concentrated around the female flowers, also known as "Buds", are called trichomes<sup>1</sup>. They excrete a sticky resin that accumulates in droplets at the tip of each hair and contain the pharmacologically active compounds, including at least 113 cannabinoids and 120 terpenes<sup>1</sup>. The major discriminant factor related to the different intended uses of C. sativa L. is the level of the two major and more known psychoactive phytocannabinoids characteristic of this crop, namely the psychogenic/intoxicating compound of the plant,  $\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC or THC), and the non-intoxicating cannabidiol (CBD) <sup>4,5</sup>. The chemotypes of *C. sativa* subsp. *indica* crops, popularly recognized as "drug-type" cannabis" or "marijuana", which are cultivated for narcotic/recreational purposes are characterized by high-THC levels and those cultivated for medicinal purposes are characterized by both high-THC and high-CBD levels<sup>4,15</sup>. On the other hand, *Cannabis* sativa subsp. Sativa plants grown for an industrial purpose, are cultivated to obtain fibre, seeds, and their derivatives. These plants are popularly called "industrial hemp" or "fibretype hemp", and must contain low-THC levels, i.e., <0.3% weight of the dried flowers of the plant, in Canada and USA<sup>4,15</sup>. Moreover, all parts of the hemp plant can contain cannabinoids except for the seeds<sup>21</sup>. Terpenes, on the other hand, are molecules responsible for the unique flavor and scent of cannabis<sup>19</sup>. Mono- and sesquiterpenes have been discovered in both the roots and aerial parts of the plant, with at least 200 different terpenes identified out of the 20,000 known in nature<sup>19</sup>. The common terpenes found in

most hemp varieties include *myrcene*, a monoterpene, and  $\beta$ -caryophyllene and  $\alpha$ humulene, both sesquiterpenes<sup>19</sup>. Other terpenes present in Cannabis sativa subsp. Sativa include  $\alpha$ -pinene, limonene, linalool, bisabolol, and (E)- $\beta$ -farnesene<sup>19</sup>. During the development of flowers, the concentration of sesquiterpenes decreases, while the concentration of monoterpenes increases<sup>19</sup>. By the end of the flowering period, monoterpenes make up more than 50% of the terpenes found in the flowers<sup>19</sup>. Additionally, the terpene profiles in a particular variety of hemp may differ depending on the geographic location in which it is grown<sup>19</sup>. Once the female flower gets fertilized, the plant shifts its metabolic energy to making seeds and away from the biosynthesis of cannabinoids and terpenes<sup>1</sup>, which explains why male plants are usually removed from indoor growing operations to prevent the plants from developing seed. Hempseeds are the edible fruits of the Cannabis sativa L. plant<sup>15</sup>, and when pressed, the oil from the hempseed is very nutritious and a good alternative to fish oil as a source of omega-3-type fatty acids<sup>1</sup>. Interestingly, while the CBD:THC ratio varies in different strains of cannabis, the total amount of cannabidiol plus THC across strains is roughly constant<sup>22</sup>. The more THC, the less cannabidiol, and vice versa<sup>22</sup>.

Cannabis plants synthesize primarily the carboxylic acid forms of  $\Delta^9$ -THC and CBD, namely,  $\Delta^9$ -tetrahydrocannabinolic acid (THCA) and cannabidiolic acid (CBDA) <sup>16</sup>. A common precursor of the main cannabinoids, in both their neutral (pharmacologically active) and acidic forms (direct precursors), is the compound *cannabigerolic acid* (CBGA) <sup>4,23</sup>. Being quite similar in their structural and functional properties, *CBDA synthase* and *THCA synthase* are the enzymes that catalyze the stereospecific oxidative cyclization of the geranyl group (monoterpene moiety) of CBGA into CBDA and THCA, respectively<sup>23</sup>.

Thereafter, the pharmacologically active  $\Delta^9$ -THC and CBD are derived artificially from their acidic precursors THCA and CBDA by non-enzymatic decarboxylation<sup>23</sup> (Fig. 1). Although a key precursor in the process of biosynthesis of phytocannabinoids, CBGA can also undergo non-enzymatic decarboxylation to produce *cannabigerol* (CBG)—a biologically active phytocannabinoid that is present in much smaller quantities<sup>24</sup>. In fresh plants, the concentrations of neutral cannabinoids are much lower than those of cannabinoid acids, hence decarboxylation is an important step for efficient production of the major active components in cannabis<sup>16,23</sup>. The acidic cannabinoids are thermally unstable and can be decarboxylated when exposed to light or heat via smoking, baking, or refluxing<sup>16</sup>.



**Figure 1.** Biogenesis of THC and CBD. The oxidative cyclization of CBGA to THCA and CBDA is enzyme dependent, whereas the conversion of the acidic precursor phytocannabinoids, THCA and CBDA, to their biologically active and neutral form, THC and CBD, respectively, is by non-enzymatic/artificial decarboxylation. Adapted from Taura et al. (2007)<sup>23</sup>.

#### 2.2 Endogenous Cannabinoid System

The "endogenous cannabinoid system" (ECS), also known as the "endocannabinoid system" or "endocannabinoid signaling system" (eCBSS), was discovered in the early 1990s and named in honor of the cannabis plant which led to its discovery<sup>1,22</sup>. It is an extensive neuromodulatory system that performs crucial functions in the development of the central nervous system (CNS), synaptic plasticity, and responding to both internal and external stressors<sup>25</sup>. The ECS is also involved in fundamental functions such as appetite regulation, the immune response, reproduction, and pain management<sup>26</sup>. The system is composed of cannabinoid receptors, endogenous cannabinoids (eCB), (i.e., endocannabinoids), and enzymes that are responsible for creating and breaking down eCB<sup>25</sup>. This unique network of signaling pathways is selectively triggered by the binding of endogenous or exogenous cannabinoids to specific cannabinoid receptors in the brain, organs, connective tissues, glands, and immune cells<sup>22</sup>. The two primary endocannabinoids, namely N-arachidonoylethanolamine (also called anandamide and abbreviated AEA or ANA) and 2-arachidonoylglycerol (2-AG)<sup>27</sup>, are lipid-derived compounds that are naturally produced by the body. The two other exogenous classes of cannabinoid compounds that originate outside the body are C. sativa plant cannabinoids<sup>1</sup> and synthetic cannabinoids (e.g., WIN55212-2, CP55940)<sup>28,29</sup>. To date, the major biological effects of cannabinoids are said to be mediated by two members of the G-protein-coupled receptors (GPCRs or GPRs of the Gi and Go classes), namely the cannabinoid receptors 1 (CB<sub>1</sub>R or CB<sub>1</sub> receptor) and 2 (CB<sub>2</sub>R or CB<sub>2</sub> receptor) <sup>25,28</sup>. Other additional endocannabinoids (e.g., virodhamine and 2-arachidonoyl glycerol ether) and cannabinoid receptors (e.g., orphan receptor GPR55) exist, but either their

molecular identification and/or true purpose remain to be further explored<sup>25,28,30,31</sup>. Neurons that release neurotransmitters (e.g., GABA or glutamate) into the synaptic cleft are designated as "pre-synaptic", whereas target neurons that express receptors for neurotransmitters are "post-synaptic". In the context of cannabinoids, these lipid ligands have the power to modulate neurotransmitter and gliotransmitter release depending on their individual nature (agonist, antagonist, etc.), their binding affinity, and their predilection to bind at the orthosteric (primary) or allosteric (secondary) site on specific endocannabinoid receptors. Allosteric molecules can attach themselves to areas that are not part of the primary binding pocket and affect the binding or signaling of the primary ligand<sup>27</sup>. These allosteric modulators can either inhibit (negative allosteric modulator or NAM) or enhance (positive allosteric modulator or PAM) the signaling of the primary agonist. Like primary ligands, allosteric modulators can demonstrate bias<sup>27</sup>. Additionally, fatty acid amide hydrolase (FAAH) is a membrane-bound homodimeric enzyme that is able to hydrolyse (inactivate) AEA and, to a lesser extent, 2-AG, thus controlling their biological activity<sup>32</sup>.

CB<sub>1</sub> receptors are concentrated in several important brain regions, such as the neocortex, hippocampus, basal ganglia, amygdala, striatum, cerebellum, and hypothalamus<sup>22</sup>. These regions are responsible for regulating various advanced behavioral functions, such as learning and memory, executive function (decision making), sensory and motor responsiveness, emotional reactions (e.g., regulation of reward, anxiety), as well as feeding and other homeostatic processes<sup>22,27</sup>. Essentially, CB<sub>1</sub> receptors are abundantly expressed by different subtypes of neurons in the central nervous system (including all types of glia, projection neurons and interneurons), and are

ten times more abundant in cortical and hippocampal cholecystokinin-expressing GABAergic (CCK-GABA) interneurons (low threshold spiking interneurons) than glutamatergic principal neurons (but still in functionally important quantities)<sup>25,27,30</sup>. Being present on pre-synaptic buttons (nerve terminals), CB1Rs associate with Gi/o proteins, ßarrestins and GPCR kinases (GRKs) to differentially modulate cell function depending on the nature of their stimulation (acute versus sustained)<sup>22,27,30</sup>. Current studies indicate that acute stimulation (milliseconds to seconds) of CB<sub>1</sub>R inhibits presynaptic N-type calcium channels and activates inwardly rectifying potassium channels, thereby reducing neurotransmission<sup>22,30</sup>. Therefore, inhibiting the release of excitatory or inhibitory neurotransmitters into the synaptic cleft is a major mechanism by which endogenous and exogenous CB<sub>1</sub> receptor agonists alter brain function<sup>27</sup>. Suppression of excitatory transmitter release (e.g., glutamate) tends to dampen excitation, while suppression of inhibitory transmitter release (e.g., GABA) favors neuronal network excitation. On the other hand, sustained stimulation (for minutes to hours) of CB1R regulates effector proteins such as protein kinase A (PKA) and extracellular signal-related kinase (ERK), thereby modifying enzymatic activities and gene expression<sup>30</sup>. Like most GPCRs, the CB<sub>1</sub>Rs are regulated by clathrin-mediated endocytosis following phosphorylation by Gprotein receptor kinases and binding to ß-arrestin<sup>27</sup>. The two eCBs, 2-AG and AEA, can function as primary endogenous agonists of the CB1 receptor, however 2-AG binds with lower affinity but higher efficacy than AEA<sup>25,27</sup>.

CB<sub>2</sub> receptors share 44% protein identity with CB<sub>1</sub>Rs and exhibit a distinct pharmacological profile and expression pattern<sup>30</sup>. Mainly expressed in neuronal somatodendritic areas (post-synaptic), CB<sub>2</sub>Rs signal through both G<sub>i</sub> proteins and ß-

arrestin-pathways, and ligands can exhibit bias for these signaling pathways<sup>27,28</sup>. Two distinct human isoforms of the CB<sub>2</sub> receptor exist and display tissue specific expression patterns<sup>29</sup>. While the classical CB<sub>2</sub> isoform is predominantly found in spleen and other immune tissues (microglia, tonsils, peripheral blood mononuclear cells [PBMCs such as lymphocytes and monocytes], and thymus), the novel isoform was detected in higher levels in brain regions that are part of the reward system as well as the testes<sup>29</sup>. In fact, it has been shown that CB<sub>2</sub> receptors exert an important role in the fertility of both sexes<sup>29</sup>. Although not highly prevalent in healthy brain tissue, it would be inaccurate to conclude that CB<sub>2</sub> receptors are never present in the brain, as their expression can be induced in immune cells, whether it is the resident microglia, often referred to as the "macrophages of the brain", or invading immune cells (human lymphocytes, including B and T cells and peripheral macrophages) <sup>27,30</sup>. Given this dynamic and inducible nature, under pathological conditions (e.g., brain injury, addiction, inflammation, anxiety, epilepsy, etc.) CB<sub>2</sub>Rs can be upregulated (up to 100-fold) in the brain, suggesting their involvement in various psychiatric and neurological diseases<sup>25,28</sup>. As to the action of endocannabinoids, 2-AG is a full (high-efficacy) agonist at the CB2 receptor and is considered the primary endogenous ligand for the CB<sub>2</sub>R<sup>25,27</sup>. In contrast, AEA is a very low efficacy agonist with weak affinity for the CB<sub>2</sub> receptor, which implies that it can only trigger this receptor when its concentration is exceedingly high<sup>25,27</sup>.

#### 2.3 Cannabidiol (CBD)

Cannabidiol ( $C_{21}H_{30}O_2$ ) was first isolated from the *Cannabis sativa* L. plant in 1940 and characterized structurally in 1963<sup>2,3,19</sup>. CBD is a lipophilic, psychoactive, and nonintoxicating isomer of THC<sup>5,26</sup>. However, unlike in some animal species, CBD does not convert to  $\Delta^9$ -THC in the human body<sup>33</sup>. CBD is relatively less lipophilic than THC, yet it has a 10-fold higher skin permeability<sup>34</sup>. CBD is the dominant cannabinoid constituent of the "fibre-type hemp" *Cannabis sativa*, whereas  $\Delta^9$ -THC is the major cannabinoid in the "drug-type Cannabis" plants<sup>23</sup>.

#### 2.3.1 Formulation & route of administration

In clinical trials and research studies, CBD is generally administered orally as either a capsule, or dissolved in an edible oil solution (e.g., sunflower, hemp, olive, or sesame oil)<sup>8,26</sup>. Alternatively, it can be administered through smoking, vaporisation liquids, tinctures (alcohol-based extracts), skin creams, transdermal patches, chewing gums, and the sublingual, intravenous, or intranasal routes<sup>8,26</sup>. CBD has conventionally been administered through smoking cannabis for recreational purposes, making inhalation the most popular method of delivery<sup>8,35</sup>. In this method, CBD is efficiently absorbed into the bloodstream through the lungs. Alternatively, oral-mucosal (oromucosal) preparations (e.g., CBD spray) get absorbed guickly through the oral mucosa, making them generally suitable for relieving symptoms that require immediate relief (e.g., spasticity in multiple sclerosis)<sup>2,35</sup>. Nevertheless, some of the sprayed dose might end up getting ingested and absorbed orally, i.e., through the digestive system<sup>35</sup>. Oromucosal preparations have been reported to produce higher plasma CBD concentrations relative to oral preparations (e.g., capsules), but lower relative to inhalation<sup>35</sup>. Hence, oral formulations may be useful for symptomatic relief over a longer period<sup>35</sup>. For various reasons, oil has become a preferred method of consuming phytocannabinoids for many medical marijuana users<sup>26</sup>. Using cannabis oil allows consumers to be discreet about their usage, as there is no identifiable smell as in

smoking. It can be consumed in social settings, such as at work or around family, without drawing attention. Additionally, dosing can be accurately measured by counting the number of drops consumed. These benefits were also noted in a 2013 survey of medicinal cannabis users, which indicated a trend towards using concentrated extracts such as cannabis oil as a favored mode of ingestion<sup>26</sup>. Transdermal patch administration is currently not used clinically, but absorption via this route can be influenced by factors such as local blood flow and skin permeability<sup>35</sup>.

#### 2.3.2 Pharmacokinetics

Pharmacokinetics explores what the body does to a drug after its ingestion. While the route of administration and drug formulation are pivotal, a multitude of factors, including physiological, pathological, and external, can influence the pharmacokinetic properties of a drug (i.e., how it is absorbed, distributed, metabolized, and excreted). Among these influences, for CBD, the formulation and route of administration hold particular significance<sup>35</sup>. For instance, the pharmacokinetics of inhaled cannabinoids, whether vaporized or smoked, closely resemble those of cannabinoids administered intravenously<sup>35</sup>.

#### 2.3.2.1 Absorption

The maximum (or peak) serum concentration ( $C_{max}$ ) and the area under the curve (AUC) of the plotted plasma concentration of CBD versus time post-ingestion increase in a dose-dependent manner and are reached quicker following smoking/inhalation compared to oral or oromucosal routes<sup>35,36</sup>. The C<sub>max</sub> for CBD is increased when CBD is consumed in the fed vs. fasted state and within lipid formulations, whereas the time required to reach maximum CBD concentration in the plasma (T<sub>max</sub>) is delayed in the fed

state<sup>36</sup>. A recent systematic review on the pharmacokinetics of CBD in humans reported that the T<sub>max</sub>, for all routes of administration combined, occurs between 0 and 5 hours, and does not appear to be dose-dependent<sup>36</sup>. More precisely, plasma  $T_{max}$  (for both CBD and THC), after inhalation, occurs within 3 to 10 minutes<sup>35</sup>. The bioavailability of a substance represents the extent to which it enters the bloodstream. Aerosolized CBD (smoking, vaporization) has been reported to have an average systemic bioavailability of 31%, while bioavailability from oral delivery was estimated to be as low as 6% due to gastric acid exposure, intestinal enzymes degradation, and significant first-pass hepatic metabolism<sup>8,19,35,36</sup>. Differences in bioavailability post-inhalation can be attributed to various factors, including individual variability among and within subjects, such as the number, duration, and interval of inhalations, the length of time the breath is held, the size of the particles inhaled, the device used to inhale, and where in the respiratory system the particles are deposited<sup>35</sup>. In fact, frequent smokers reach higher AUC and C<sub>max</sub> than occasional smokers, which is likely due to more efficient smoking techniques<sup>35</sup>. Moreover, delivery of cannabinoids through inhalation, oromucosal, or transdermal routes can circumvent or lessen the significant first-pass metabolism seen after oral administration of cannabinoids<sup>35</sup>. However, the bioavailability from oromucosal and sublingual routes remains less variable but similar to oral delivery<sup>8</sup>.

#### 2.3.2.2 Distribution

Cannabinoids distribute quickly into organs that are well-vascularized such as the brain, heart, liver and lungs, before spreading into organs with less blood flow<sup>35</sup>. Factors such as body size, body composition and disease states that affect blood-tissue barriers can influence the distribution of cannabinoids<sup>35</sup>. CBD has a high volume of distribution of

~32 L/kg (calculated following intravenous administration) which means that it is rapidly distributed into the tissues, likely accumulating in adipose tissues due to its high lipophilicity<sup>8,35</sup>. It is also highly bound to plasma proteins and circulating blood cells<sup>8</sup>. Subsequent release and redistribution from adipose tissue following chronic use (e.g., in the context of weight loss) may result in the persistence of cannabinoid activity for several weeks post-administration<sup>35</sup>.

#### 2.3.2.3 Metabolism

CBD undergoes cytochrome P450 (CYP) hepatic metabolism, primarily by isozymes CYP3A4- and CYP2C19-dependent phase I metabolism via hydroxylation to the *7-hydroxy cannabidiol* (7-OH-CBD) metabolite, which is further metabolized in the liver and subsequently excreted, more in feces than in urine<sup>8,35</sup>. CBD is additionally metabolized by CYP1A1, CYP1A2, CYP2C9 and CYP2D6<sup>35</sup>. Our current knowledge of the pharmacological effects of CBD metabolites in humans is limited<sup>35</sup>.

#### 2.3.2.4 Elimination

The elimination half-life ( $t_{1/2}$ ) of CBD, i.e., the time required for the concentration of CBD in the plasma to decrease by half, ranges from 1.4 to 10.9 hours after oromucosal spray, 2 to 5 days after repeated daily (or chronic) oral administration, 24 ± 6 hours after intravenous injection, and 31 ± 4 hours post-inhalation, via smoking<sup>35,36</sup>. CBD has an estimated clearance rate of 57.6–93.6 L/hour<sup>8</sup>.

#### 2.3.3 Pharmacodynamics & therapeutic potential

Pharmacodynamics examines a drug's mechanisms of action within the body. For CBD, its pharmacodynamic properties encompass its effects and interactions in organisms, be they humans or rodents, that ingest it. Upon review of the literature, it is

evident that the impact of phytocannabinoids on the body is not solely limited to or mediated by the endocannabinoid system and its receptors. In fact, in-vitro, animal, and human studies indicate that CBD may exert its effects through mechanisms not exclusively related to the ECS<sup>33</sup>. Therefore, CBD exhibits multiple therapeutic effects by modulating a series of receptors, including, but not limited to, CB<sub>1</sub>R, CB<sub>2</sub>R, GPR55, transient receptor potential vanilloid (TRPV), peroxisome proliferator-activated receptor gamma (PPAR<sub>y</sub>), and 5-HT<sub>1A</sub> (serotonin 1A receptor)<sup>37</sup>.

In the case of C. sativa phytocannabinoids interacting with the ECS, THC behaves as a partial agonist of the CB<sub>1</sub>R, whereas CBD can dampen or prevent certain pharmacological impacts of THC and other agonists that bind to the CB<sub>1</sub> receptor<sup>27</sup>. In fact, CBD has minimal attraction to the primary binding pocket of the CB<sub>1</sub>R, so it acts as an allosteric antagonist at moderate dosages<sup>27</sup>. In other words, CBD acts as a negative allosteric modulator for the CB1 receptor, thereby diminishing both its ß-arrestin recruitment and G protein-mediated signaling responses<sup>27</sup>. In comparison to the CB<sub>1</sub>R, THC binds the CB<sub>2</sub> receptor with moderate affinity but does not inhibit adenylyl cyclase<sup>27</sup>. More precisely, THC is a ß-arrestin-biased agonist at the human CB<sub>2</sub> receptor, with little or no effect on Gi-mediated signaling<sup>27</sup>. As for CBD, in-vitro and receptor modeling studies favor the hypothesis that it is a NAM of the CB<sub>2</sub> receptor<sup>27</sup>. Therefore, CBD functions as an indirect/allosteric antagonist to human  $CB_1$  and  $CB_2$  receptors, thus reasonably preventing them from being overly activated by a multitude of primary ligands, including AEA, 2-AG, and THC<sup>26,37</sup>. For instance, CBD has been shown to potentially decrease negative psychotropic and cardiovascular effects (e.g., increased heart rate) associated with THC when taken together<sup>35</sup>. In fact, clinical trials have shown that CBD modifies the

intoxicating effects of THC<sup>5,38</sup>. For example, one study revealed that when vaporized together, low doses of CBD (4 mg) increased the intoxicating effects of THC (8 mg), while high doses of CBD (400 mg) reduced them. In contrast, the intoxication levels from 8 mg of THC alone fell between these two extremes<sup>5</sup>. Additionally, another study indicated that psychotic symptoms induced by a 1.25 mg intravenous dose of THC were significantly lessened when preceded by a 5 mg dose of intravenous CBD, compared to a placebo pretreatment<sup>38</sup>.

A collection of preclinical studies involving CBD, either used alone or when coadministered with THC, have highlighted its potential therapeutic efficacy against various medical conditions, such as seizure disorders (e.g., Epilepsy, Lennox–Gastaut syndrome, Dravet syndrome), mental health disorders (e.g., psychotic symptoms, depression, anxiety), cancer, cardiovascular diseases, neurodegenerative disorders (e.g., Alzheimer's disease, Parkinson's disease, Multiple sclerosis), and chronic pain<sup>2,3,8,26,33,36</sup>. Again, CBD is often praised for its anti-inflammatory, anti-oxidative and anti-necrotic protective effects<sup>8,23,26,36,39</sup>. Other studies have also highlighted its potential use as a nutritional supplement, or sleep aid compound<sup>19,37</sup>. Moreover, according to some studies, hemp terpenes exhibit antidepressant, anti-inflammatory, and anxiolytic effects<sup>19</sup>.

#### 2.3.4 Dosing & quality control

Oral doses of CBD in research have varied widely, with most doses ranging from 100 to 800mg per day<sup>8</sup>. In the USA, there is a significant issue with mislabeling of CBD products, with independent research showing that almost 70% of CBD products available online could be mislabeled<sup>3</sup>. Of these mislabeled products, 43% were found to be underlabeled and 26% were found to be over-labeled for actual CBD content<sup>3</sup>. In another study,

the contents of 25 hemp oil products were analyzed for the presence of synthetic cannabinoids using full scan gas chromatography<sup>11</sup>. It was concluded that of the 25 products, only three were within plus or minus 20% of the amount claimed on the label<sup>11</sup>. An additional research investigation revealed that among 80 hemp-derived products and Epidiolex® (cannabidiol drug), available for purchase online and from local stores in central Kentucky, THC was found in 52 of the samples<sup>40</sup>. Notably, 21 products were advertised as "THC-Free," yet THC was detected in 5 of these<sup>40</sup>. This highlights the need for strict FDA and Health Canada enforcement and oversight in the CBD industry to ensure that consumers are getting accurate and safe products<sup>3</sup>.

#### 2.3.5 Safety profile

CBD is known to be well tolerated, i.e., not harmful, in humans while maintaining a good safety profile with neither abuse nor dependence potential<sup>2,8,36</sup>. Although some studies have demonstrated no adverse effects with CBD use, other studies have previously reported adverse effects such as dry mouth, sedation/fatigue, decreased appetite, and diarrhea<sup>2</sup>. For example, a survey study evaluating CBD use by the public, via social media dissemination, reported the top five most stated adverse effects to be dry mouth, euphoria, hunger, red eyes, and sedation/fatigue<sup>2</sup>. Those adverse effects could well be related to dosage, drug-drug interactions, or both<sup>2</sup>. Other possible explanations could stem from the route of administration and/or the use of a purified CBD solution as opposed to whole plant (marijuana or hemp) extract which may contain THC beyond expected thresholds<sup>2</sup>. On the other hand, a randomized placebo-controlled trial reported that high doses (400 mg) of CBD alone, when vaporised, induce a dissociationdriven intoxication that may be dose-dependent, and is long lasting<sup>5</sup>. Furthermore, a
clinical trial using CBD (20 mg per kilogram body weight per day) for the management of drug-resistant seizures in children with Dravet syndrome reported that the adverse events that occurred more frequently in the CBD group than in the placebo group included diarrhea, vomiting, fatigue, pyrexia, somnolence, and abnormal results on liver-function tests<sup>41</sup>. On the other hand, prior research has suggested that CBD is not harmful, even when given to humans on a long-term basis or in high dosages orally [up to 1,500 mg/day] <sup>26,39</sup>.

## 2.3.6 Interactions

There is a paucity of drug-drug interaction information for CBD<sup>35</sup>. Nonetheless, it is possible for both THC and CBD to pharmacokinetically interact with other drugs through inhibition or induction of enzymes or transporters, as well as through pharmacodynamic drug-drug interactions<sup>35</sup>. For example, smoking cannabis and tobacco both lead to the induction of CYP1A2, an effect characterized by increased expression of the CYP1A2 gene<sup>35</sup>. This upregulation subsequently results in elevated levels of the CYP1A2 enzyme (protein). Notably, the primary site of CYP expression, including CYP1A2, is the liver. Furthermore, the inductive effect on CYP1A2 is even more pronounced when cannabis and tobacco are smoked simultaneously, as is often the case in recreational hashish smoking<sup>35</sup>. This could have important implications for a patient taking a drug that is metabolized by CYP1A2<sup>35</sup>. Additionally, CBD has been found to significantly inhibit Pglycoprotein-mediated drug transport in an in-vitro study, which suggests that it may affect the absorption and distribution of other drugs taken concurrently<sup>35</sup>. CBD has shown potent inhibitory activity against CYP2C, CYP2D6, and CYP3A isoforms in preclinical studies, raising concerns of drug-drug interactions with other substrates of the enzymes<sup>8</sup>. For

instance, when administered with the antibiotic rifampicin, a CYP3A4 inducer, the peak plasma concentrations of CBD were significantly reduced<sup>35</sup>. Conversely, when administered with the CYP3A4 inhibitor ketoconazole (an antifungal drug), the peak plasma concentrations of CBD nearly doubled<sup>35</sup>. Furthermore, other in-vitro studies have shown that CBD is a strong inhibitor of CYP2C19 enzymes<sup>35</sup>. This is notable in the case of the active metabolite of clobazam (benzodiazepine drug used as an anticonvulsant) which is also converted by CYP2C19 into an inactive metabolite<sup>35</sup>. Hence, the CBDmediated inhibition of clobazam metabolism has been demonstrated to result in an up to eight-fold increase in clobazam concentration<sup>35</sup>. Hence, because most commercially available antiepileptic drugs are metabolized through the CYP pathways, drug interactions with CBD have been shown (e.g., clobazam) and are to be expected (e.g., phenytoin and carbamazepine)<sup>8</sup>. It is also worth noting that CBD has been reported across the literature to interact with certain medications which could also potentially affect sleep cycles<sup>42</sup>.

# 2.4 The prevalence of CBD use in athletes

There are a limited number of studies that have investigated the prevalence of CBD exclusively, in athletes. A survey investigated the use of CBD among 517 male professional rugby players in the United Kingdom, revealing that more than 25% of players had used or were currently using CBD<sup>13</sup>. Another study examined CBD use in 823 new patients at a sports medicine clinic, reporting a prevalence of over 19%<sup>43</sup>. In addition, a community-based survey of adult athletes reported a 67.6% prevalence of cannabis use, not exclusively CBD, among 1161 respondents<sup>42</sup>.

# 2.5 The role of CBD in areas of potential relevance to athletes and within the context of sport and exercise performance

## 2.5.1 CBD: pain & inflammation

For elite athletes, effectively managing pain and inflammation is paramount, not only to optimize performance but also to ensure long-term health and career sustainability. A community-based survey of adult athletes indicated a significant number turning to cannabis for medical reasons, especially for pain management<sup>42</sup>. Of those surveyed, 61% reported using cannabis as a treatment for pain<sup>42</sup>. Additionally, the study suggests that a combination of THC and CBD may offer enhanced relief for pain than CBD alone, though the survey did not delve into specific ratios<sup>42</sup>.

Another study was conducted in Europe and surveyed 517 professional rugby players anonymously to assess their use of CBD<sup>13</sup>. The study found that almost 40% of older players (age: over 28 years) used CBD for pain relief and recovery<sup>13</sup>.

CBD plays an important role in suppressing inflammation by inhibiting CB<sub>2</sub> receptors, which ultimately reduces the release of mast cells and neutrophils near areas of pain<sup>37</sup>. CBD can also affect the GPR2 receptor, found in the brain and spinal cord, which is involved in the perception of pain<sup>37</sup>. Moreover, CBD has the potential to regulate both the serotonin 5-HT<sub>1A</sub> receptor and TRPV1, which can help alleviate pain<sup>37</sup>. Essentially, CBD affects different markers of inflammation such as cytokines, prostaglandin E2, cyclooxygenase activity, nitric oxide, oxygen-derived free radical production, and edema<sup>44</sup>. In brief, CBD exerts analgesic effects in different models of inflammatory and chronic pain by regulating pro-inflammatory agents and affecting targets involved in nociception<sup>44</sup>.

Delayed onset muscle soreness (DOMS) is typically felt within 24-72 hours after bouts of unaccustomed exercise or high volumes of eccentric exercise (ECC) <sup>45</sup>. It has been hypothesized that swelling, oxidative stress and inflammation during DOMS could be attenuated by CBD's anti-inflammatory properties, triggering a decrease in muscular soreness induced by strenuous exercise, and therefore promoting performance recovery<sup>44</sup>. Interestingly, in animal models, the intra-articular injection of CBD was able to reduce the acute phase of inflammation by decreasing leucocytes and synovial hyperaemia<sup>44</sup>. Therefore, CBD's ability to regulate inflammation by reducing immune cell accumulation, stimulating the production of anti-inflammatory cytokines, and inhibiting the production of pro-inflammatory cytokines make it a potentially useful tool for reducing the negative effects of exercise-induced muscle damage (EIMD) and injuries, improving muscle function, and attenuating the DOMS<sup>46</sup>.

# 2.5.2 CBD: neuroprotection & neuromodulation

Concussions are a prevalent injury among athletes, and research has suggested that cannabis could assist in managing pain and concussion-related symptoms<sup>42,44</sup>. CBD has been shown to have the potential to mitigate the neurological and biochemical changes that typically occur following a brain injury, thus reducing the associated symptoms<sup>44</sup>. Research has shown that CBD is able to inhibit oxidative stress and neuroinflammation<sup>44</sup>. However, the neuroprotective effects observed with CBD were not influenced by a cannabinoid receptor antagonist, implying that it may function independent of endogenous cannabinoid receptors<sup>39</sup>. In fact, a study utilizing a rodent model of mild traumatic brain injury (mTBI) showed that repeated treatment with CBD attenuated behavioral abnormalities, including anxious and aggressive behavior.

impaired social interactions, and pain-related behaviors<sup>46</sup>. Therefore, CBD may be a potentially useful therapeutic agent for the treatment of oxidative neurological disorders such as cerebral ischemia<sup>39</sup>.

On June 25<sup>th</sup>, 2018, Epidiolex (cannabidiol) became the first *C. sativa* L. derived oral solution to be approved as a drug by the United States (US or USA) Food and Drug Administration (FDA) for the treatment of two pediatric seizure disorders, Lennox–Gastaut syndrome and Dravet syndrome<sup>2,3</sup>. Another *C. sativa* L. derived drug, Sativex (nabiximols), with equal part combination of CBD and THC, is currently approved to treat spasticity due to multiple sclerosis in >30 countries worldwide but is not approved in the USA<sup>2</sup>.

## 2.5.3 CBD: mental health

For elite athletes, maintaining and enhancing mental health is as crucial as physical conditioning, as it plays an indispensable role in performance, resilience, and overall well-being. A recent review of cannabis use in elite athletes concluded that there was no evidence for cannabis use as a performance enhancing drug<sup>42</sup>. However, athletes' performance can be hindered when exposed to anxiety-provoking situations in their respective sports, which makes anxiety management important for improving performance<sup>44</sup>. There is some evidence to suggest that CBD may be helpful in managing anxiety and stress, and it has been used by some athletes to help them relax and recover after training or competition<sup>44</sup>. Moreover, CBD's ability to facilitate fear extinction in healthy humans suggests that it could potentially be beneficial for athletes who suffer from post-traumatic stress disorder (PTSD) after experiencing musculoskeletal injuries or concussions<sup>44</sup>. Additionally, pre-competition stress or sports performance anxiety (SPA)

can have negative effects on athletic performance<sup>46</sup>. Hence, CBD's anxiolytic properties make it a potential option for alleviating SPA, in addition to the preferred treatment of cognitive-behavioral therapy<sup>46</sup>. Multiple mechanisms may account for the anti-depressive and anxiolytic activities of CBD. The proposed anti-anxiety activity may result from CBD inhibiting the inactivation of AEA, an eCB neurotransmitter, and/or CBD interacting with 5-HT<sub>1A</sub> receptors<sup>37</sup>.

A community-based survey of adult athletes highlighted the therapeutic use of cannabis, particularly in the management of anxiety<sup>42</sup>. Less than 30% of respondents reported using cannabis for recreational reasons<sup>42</sup>. The study indicated that the combination of THC and CBD might be more potent in reducing anxiety than using CBD on its own, even though specific THC:CBD ratios weren't specified in the survey's findings<sup>42</sup>.

A double-blind, placebo-controlled study comparing the pre-treatment with 600 mg CBD orally in healthy control patients vs. treatment-naïve social anxiety disorder (SAD) patients in a stressful simulated public speaking (SPS) test demonstrated a significant reduction in anxiety, cognitive impairment and discomfort in speech performance on the test<sup>1.37</sup>. A similar study revealed that a treatment with 300 mg CBD in comparison to another anxiolytic compound (ipsapirone) in healthy adults can decrease anxiety after an SPS test<sup>37</sup>. Another study demonstrated an inverted U-shaped curve dose response in healthy volunteers on the SPS test, with a significant reduction in anxiety observed in the 300 mg CBD cohort compared to those receiving 100 mg or 900 mg orally<sup>37</sup>. Furthermore, studies suggest that CBD has little influence on anxiety under "low stress" conditions in

healthy adults, as opposed to "stress-inducing" conditions in both healthy participants and those with SAD<sup>46</sup>.

CBD has shown promising results in improving fear memory processes<sup>44</sup>. In animal models of schizophrenia, it was found to impede the acquisition of fear learning, whereas in healthy humans, it was observed to facilitate the process of fear extinction<sup>44</sup>.

#### 2.5.4 CBD: sleep and insomnia

For elite athletes, securing restorative sleep is paramount, as it not only aids in physical recovery but also sharpens focus and decision-making, pivotal elements in peak performance<sup>47</sup>. Among the potential health benefits of CBD use, the ability to improve sleep is recorded in the literature but the evidence on its effectiveness in athletes is limited. However, emerging evidence suggests that many athletes are using CBD on a regular basis to help improve sleep<sup>47</sup>.

In the 1970s, researchers discovered that CBD had an impact on sleep in humans<sup>44</sup>. In fact, CBD was identified as a potential tool for managing sleep after studies conducted on mice revealed that CBD could act as either a sleep-promoting or a wake-promoting agent, depending on the dosage administered<sup>44</sup>. Lower doses were found to increase wakefulness, while higher doses had sedative effects that could promote sleep<sup>44</sup>. The first placebo-controlled, double-blinded crossover trial in humans found that a single 160 mg CBD oral dose increased self-reported sleep duration in individuals with insomnia<sup>46</sup>. Similarly, a reduction in symptoms of rapid eye movement sleep-behavior disorder was observed in four individuals with Parkinson's disease using 75-300 mg of oral CBD per day<sup>46</sup>. Additionally, ~25 mg per day of oral CBD improved subjective sleep quality in a young girl with post-traumatic stress disorder (PTSD)<sup>46</sup>.

Currently, there are no published studies assessing the effects of CBD on sleep in people with physician confirmed chronic insomnia disorder<sup>37</sup>. However, CBD has demonstrated the potential to increase concentrations of the major endogenous cannabinoid, AEA, by inhibiting the enzyme degrading it, FAAH<sup>32,37</sup>. In line with this, preclinical research suggests that AEA may promote slow wave sleep, potentially by increasing extracellular adenosine, which is congruent with the finding that increasing endogenous AEA via FAAH inhibition normalized deficits in stage N3 sleep in cannabis-dependent men experiencing withdrawal<sup>37</sup>.

## 2.5.5 CBD: nutrition

Hemp seeds are commonly processed in food manufacturing to extract oil and produce hemp flour, as well as being ground into a source of plant-based protein and dietary fiber. <sup>19</sup> The health effects of consuming products derived from hemp seeds have not been completely determined, but some reported benefits include lowering total cholesterol and blood pressure, while increasing the high-density lipoproteins (HDL), *aka* "good" cholesterol, in those who consume them<sup>19,37</sup>. The proteins derived from hemp seeds, such as albumin, globular protein, and estidine, can help regulate human metabolism when consumed<sup>19</sup>. Among them, estidine is the most prevalent component, making up around 82% of the total protein found in hemp seeds<sup>19</sup>. This protein also contains all the necessary amino acids<sup>19</sup>. The amino acid composition of hemp seed protein is similar to that of chicken eggs and soybeans, which are both abundant in arginine, glycine, and histidine<sup>19</sup>.

#### 2.6 Legal status of CBD

The worldwide regulatory status of CBD is complex and constantly changing<sup>2</sup>. Canada became the second nation (after Uruguay) in the world to legalize Cannabis for recreational use on June 19<sup>th</sup>, 2018<sup>2</sup>. Alternatively, the legal status of CBD in the US is complex due to varying state laws on medicinal or recreational cannabis, which conflict with federal law prohibiting cannabis consumption<sup>26</sup>.

In Canada CBD products are strictly regulated and are only legal when sold in compliance with the *Cannabis Act* and its regulations. In the US, hemp-derived CBD products are not controlled substances and can currently be purchased as dietary supplements both online and over the counter throughout most of the US. However, the FDA does not recognize CBD as a dietary supplement ingredient because of its status as an Investigational New Drug (as in Germany and the UK) <sup>2</sup>. Furthermore, a CBD supplement may be deemed illegal as a component of a nonapproved cannabis extract with a THC content exceeding 0.2% (particularly in European countries), 0.3% (Canada and USA), or 1% (Switzerland) weight of the dried flowers of the plant<sup>2,26</sup>.

CBD is no longer prohibited by the World Anti-Doping Agency (WADA) as of 2018 and appears to be safe and well-tolerated in humans<sup>47</sup>. Alternatively, THC is prohibited in competition only, and only when the urinary concentration exceeds a threshold of 150 ng/mL. Although the use of CBD continues to increase in athletes according to literature, there remains a lack of well controlled safety studies in athlete populations<sup>47</sup>. Most of the data available on CBD comes from pre-clinical and/or clinical studies using one specific pharmaceutical product called Epidiolex, the first and only FDA-approved prescription CBD<sup>47</sup>. The use of synthetic CBD is becoming increasingly popular in the United States as an alternative to plant-based CBD products, because the latter carry a higher risk of anti-doping rule violations (ADRV) due to possible contamination with other cannabinoids<sup>21,47</sup>. However, the wide availability of products is leading to a diversity in quality<sup>11</sup>.

# 2.7 Conclusion

While the investigation into the therapeutic benefits of CBD is rapidly expanding, the majority of current applications of CBD lack clinical evidence<sup>26</sup>. Despite this, the widespread utilization of CBD products may lead to healthcare providers encountering patients and athletes who have used CBD, even if the physicians or nutritionists themselves did not recommend it.

Although the literature supports the safety and minimal side effects of CBD use, the potential hazards associated with CBD products may not be primarily related to CBD as a pure compound, but rather stem from uncertainties about the composition and quality of the products being sold or unforeseen interactions with other compounds in circulation.

Despite limited research on CBD in professional athletes, CBD has demonstrated potential to aid athletes in managing injury, anxiety, stress, sleep disorders, and more (Fig. 2). Therefore, more research is needed to fully understand the impact of CBD supplementation on athletic performance in professional male and female athletes from diverse sports. Future research should also focus on determining the appropriate dosage and route of administration, as desired effects appear to be dose dependent<sup>44</sup>.



**Figure 2.** Potential benefits of CBD use for athletes. Here are some of the potentially beneficial effects of CBD use for athletes.

**CHAPTER 3: MANUSCRIPT** 

## **3.1 Introduction**

Cannabidiol (CBD) and delta-9-tetrahydrocannabinol (THC), two of over one hundred cannabinoids derived from the cannabis plant<sup>4</sup>, are both considered to be psychoactive, with CBD inducing brain functional alterations opposite to THC<sup>5,38</sup>. Relative to THC, which makes users "high/stoned", CBD is non-intoxicating<sup>5,38</sup>, i.e., it does not produce cognitive impairment and brain structural alterations in long term users of cannabis<sup>5</sup>, and appears to be safe and well tolerated in humans<sup>15,22</sup>. A wide range of CBD-containing products (e.g., in the form of oils or capsules) are currently available online or over the counter. As a compound, CBD has been cited to possess anti-oxidative, anti-inflammatory, analgesic, and neuroprotective properties, in both sporting and clinical environments<sup>47</sup>. In fact, CBD is currently being used for a variety of purposes, including pain management, anxiety and stress reduction, improved sleep, and as a possible treatment for neurological conditions such as epilepsy and Parkinson's disease<sup>13,41,42,48</sup>. CBD is also being studied for its potential to mitigate symptoms of concussions and other traumatic brain injuries<sup>46</sup>. Furthermore, self-reported rates of cannabis use and misuse among US collegiate and professional athletes are on the rise<sup>49</sup>. In 2018, the World Anti-Doping Agency (WADA) removed CBD from its list of banned substances<sup>13,47</sup>. Although CBD has been removed from WADA's list of banned substances, athletes and their support staff should be cautious when using commercial CBD products. This is because many of these products may contain other cannabinoids, including THC, which are still prohibited in competition by WADA. Therefore, use of CBD supplements may still cause a positive drug test for athlete's subject to anti-doping regulations. Hence, the presence of these banned substances in CBD products may present risks that far outweigh any

potential benefits for athletes. Either way, it is important for athletes to ensure that the CBD products they use are free of banned substances and have been properly tested and labeled.

Numerous studies have explored the reported therapeutic potential of Cannabis (both THC and CBD) or CBD alone, employing various methodologies like systematic reviews, narrative reviews, randomized controlled trials, and open survey studies that target individuals or athletes online. However, data on prevalence and rationale for CBD use alone is limited, particularly as it pertains to athletes. One notable survey investigated CBD use among 517 male professional rugby players in the United Kingdom, and revealed a prevalence of over 25%<sup>13</sup>. Another study examined CBD use in 823 new patients at a sports medicine clinic and reported a prevalence of over 19%<sup>43</sup>. Finally, a community-based survey of adult athletes showed a 67.6% prevalence of cannabis use, not exclusively CBD, among 1161 respondents<sup>42</sup>. Hence, CBD appears to be used within the context of sport and exercise by both recreational and elite athletes alike. However, information on CBD use by elite-level Canadian athletes from diverse sports is currently lacking.

Therefore, the aim of this study was to to assess and describe, by means of an anonymous and private online survey (i.e., e-survey), the prevalence and rationale for CBD use by elite-level athletes in Canada. The secondary objectives were to 1) identify the expected and perceived benefits of CBD use, 2) identify barriers or deterrents to the use of CBD, 3) identify the sources of information which influence the use of CBD, 4) explore age-, sex-, and sport-related differences regarding the use of CBD, and 5) explore the range of CBD products/brands, dosages, formulations, and routes of administration

reported. We hypothesized that the prevalence of CBD use (both past and present) by elite Canadian athletes would exceed 30% and be underreported by CBD users (<20%) due to persistence of stigmas surrounding cannabinoid supplements and risks of an accidental anti-doping rule violation (ADRV). These estimates were derived from a recent survey on CBD use among professional male rugby players<sup>13</sup>.

# 3.2 Methodology

#### 3.2.1 Overall study design

The methods of this private, anonymous, cross-sectional survey study are reported in accordance with the Checklist for Reporting Results of Internet E-surveys (CHERRIES) <sup>50</sup>. The research team consisted of both McGill researchers and lead sports nutritionists from various sports institutes across Canada. In our survey study, we extended invitations to professional and amateur adult athletes aged 18 years and older. To meet our inclusion criteria, athletes were required to compete as part of the 2021-2022 or 2022-2023 senior national (Olympic or Paralympic) Canadian team program. Additionally, athletes identified by the National Sport Organizations as part of the "NextGen" (Next Generation) program with the potential of qualifying for a roster position on the senior national team were invited to participate. Athletes were recruited nationwide (i.e., within Canada) through the Canadian Olympic and Paralympic Sport Institutes Network. All Canadian Sport Institutes participated, with the assistance of their nutrition department leads and sometimes their communications lead. The main channels for recruitment included direct contact with the sports teams, or indirect contact with them via their corresponding team lead dietitian and regional communications department of the Canadian Sport Institute Network. If approached directly by a member of the integrated support team, Registered Dieticians

were the point of contact with athletes, thus providing them with the links to the online survey. If approached indirectly, a group email notification, containing the links to the online survey, was sent by the communications lead of each institute. The survey was disseminated to approximately 2000 nationally carded athletes, some of whom had Olympic experience, from different sports, including team sports, individual sports, artistic sports, and combat sports. Recruitment efforts took place during the in-season and off-season for various sports programs. Data were collected from October 15, 2021 to June 26, 2023. Assumed consent was provided upon electronic signing of the Information & Consent Form and submission of the survey. The study was approved by McGill University's Faculty of Medicine and Health Sciences Institutional Review Board (IRB) (A09-B50-21B, 07/09/2021).

#### 3.2.2 Survey design

The research team, comprising multiple disciplines, designed a self-administered and anonymous online/electronic survey (e-survey), with no paper version in circulation, hosted on the LimeSurvey (Version 3.28.52) platform. The content and face validity of the survey were assessed by both the team and experts versed in content and survey methodology. To cater to the Canadian athlete community, the survey was made available in both official languages - English and French (see Appendix A. & B., respectively). The lead researcher (D.K.), carried out both the translation of the survey instrument into French and its subsequent back-translation into English. Structured into five distinct sections, the survey featured 52 questions, a mix of multiple-choice and type-in answer formats. These sections were: (A.) *Athlete information* with 12 questions; (B.) *Knowledge about CBD* with 3 questions; (C.) *CBD consumption* comprising 27 questions;

(D.) Assumptions about CBD use with 9 questions; and (E.) Comments with one question. The multiple-choice questions varied, with some that required a single answer selection, while others permitted multiple selections. Also, there were 11 questions in total where athletes were specifically prompted to type-in their response, although answering some of these questions was optional, and for added convenience, an on-screen keyboard was available. Moreover, some multiple-choice questions included an "Other" option. If needed, this allowed athletes to type-in a personal response when the predetermined answer choices did not adequately represent their thoughts or experiences. The survey incorporated "Skip logic" (i.e., adaptive questioning) to tailor the survey's flow and length according to individual responses, with a specific emphasis on athletes' relationship with CBD use. Rather than presenting each question independently, the survey adopted a guestion list view in a grouped format, dividing the content into the five distinct sections, each housed on a separate page. This design, coupled with the embedded skip logic, ensured that all athletes initially encountered universally visible questions, irrespective of their CBD association. However, based on specific responses to certain questions, conditional questions—initially hidden—became visible, refining the survey experience to the athlete's unique situation. To clarify potential confusion, athletes were informed alongside key questions that, based on select answer choices, certain subsequent questions may or may not be presented. For transparency, conditions dictating the skip logic's operation are detailed (in Red Font color) in their related questions within the attached questionnaires (see Appendix). To streamline navigation, each section's mandatory questions, marked with an asterisk (\*)-as illustrated in the annexed questionnaires—required completion to grant athletes access to the subsequent section.

Athletes benefited from both "Previous" and "Next" buttons, granting them the flexibility to revisit completed sections and modify their responses. With an aim for efficiency, participants were informed to set aside an average of nine minutes for the survey, supported by an activated progress bar to track their advancement. Beyond an initial welcome message, upon submitting the completed survey, athletes received a thank-you message and were then directed to the WADA website page to verify CBD's current status and clarification on its permitted use in professional sports. No incentives were offered to athletes for completing the survey.

# 3.2.3 Data analysis

Only fully completed survey responses are included in the data analysis. Missing data checks were performed to verify data integrity. Data are arranged per demographic information for age group (<18, 18-21, 22-25, 26-30, 31-35, 36-40, >40), sex, the sport competed in, and the level of competition (provincial, national, and/or international/Olympic/Paralympic). Descriptive statistics (mean, median, and mode for continuous data; or counts and percentages for categorical data) are presented for responses to closed-ended questions.

Data from multiple-choice questions allowing a single answer selection was presented in figures illustrating the count (No. of responses) for each option, and/or described in text using a mix of counts and proportions (%). Some figures were specifically designed to highlight trends, while combining both percentage and count data for each answer choice. On the other hand, multiple-choice questions allowing multiple answer selections had their data detailed in text similarly to single-answer questions and/or in figures. These figures displayed the proportions (%) of total selections attributed

to each answer option for the question in focus. Data from certain type-in response questions were grouped into coherent categories and depicted through figures and/or described in text.

#### 3.3 Results

## 3.3.1 Demographics

The outreach of the CBD survey was approximately 2000 nationally carded elitelevel Canadian athletes. 115 athletes accessed the online survey after signing the online consent form. 80 of those athletes submitted completed surveys while the other 35 discontinued the survey at various stages, yet most frequently at its start. 55% of the completed surveys were filled out in English, and the rest in French. None of the 80 athletes were excluded from the study despite 2 athletes completing the survey who reported being <18 years of age. The 16-year-old female and 17-year-old male were retained in our analysis since they both reported being non-users of CBD. All 80 (100%) athletes who submitted a completed survey at minimum provided their "Athlete information", a glimpse into their "Knowledge about CBD", and their "Assumptions about CBD use". Moreover, the 30 out of 80 (37%) athletes who reported CBD use have also provided details on their "CBD consumption". All athletes were invited to leave a comment at the end of the survey, of whom 10 did. Due to "Skip logic" implementation, the mean online survey interview time was 8 min. 45 sec., with a median of 6 min. 35 sec., and a range from 2 min. 58 sec. to 42 min. 20 seconds. Figure 3 shows the flow of participants through the study.



**Figure 3.** Flow of participants. Here is showcased the strategy for athlete navigation in the online survey study on CBD use by elite-level Canadian athletes, based on language of preference and CBD use status.

The age of the athletes ranged from 16 to 47 years. The mean age was 21 years, with a median of 24 years, and a mode of 21 years. 51 out of 80 (64%) athletes reported being male and 36% reported being female. When prompted about gender identity, sex and gender identity for each athlete were interchangeable (i.e., males reported being men and females reported being women). No athletes reported being transgender or other. **Figure 4** shows the age and sex distribution of the athletes, whereas **Figure 5** shows the age and CBD use status distribution. 70% of CBD users fell in the age range of 18-25 years, with 23% falling in the range of 26-30 years. In other words, the mean usage of CBD in the 18-21 year group, 22-25 year group, 26-30 year group, and 31-35 year age group reached 28%, 50%, 29%, and 29%, respectively.



**Figure 4.** Athlete age and sex distribution. Here is showcased the distribution of the athletes based on their sex assigned at birth and their age group.



**Figure 5.** Athlete age and CBD use status distribution. Here is showcased the distribution of the athletes based on their age and their CBD use status.

Aside from non-CBD users, the 30 of 80 (37%) athletes who reported CBD use can be further divided into two groups; those who reported using CBD in the past (26%), and those who reported CBD use in the present (11%). In other words, 30% of CBD users have reported ongoing CBD use. **Figure 6** shows the distribution of athletes based on their sex and CBD use status. 28% of female athletes reported being CBD users, whereas 43% of male athletes reported being CBD users. Additionally, 16% of male athletes

reported ongoing use of CBD, in comparison to only 4% of female athletes. **Figure 7** shows the proportion of athletes in each of the CBD use categories.



**Figure 6.** Athlete sex and CBD use status distribution. Here is showcased the distribution of the athletes based on their sex assigned at birth and their CBD use status.



**Figure 7.** Athlete CBD use status. Here are showcased the different proportions of athletes based on their CBD use status.

When prompted, 63 of the 80 (79%) athletes acknowledged receiving sport science support and/or medical support through either a Canadian Sport Institute, I'Institut national du Sport du Québec (INS), or a Canadian Sport Centre. Moreover, when it comes to athletic career funding and financial support, **Figure 8** uses the 116 multiple-choice selections made by the 80 athletes, from a list of 5 different career funding avenues, to show their proportions.



**Figure 8.** Career funding avenues. Here are showcased, in orderly proportions, the different financial support avenues that the athletes relied on for career funding/financial support.

Of the 80 athletes, 50 (63%), 5 (6%), and 2 (3%) reported competing exclusively at the Olympic/international, national, and provincial level, respectively. The rest of the athletes, 23 of the 80 (29%) reported competing at multiple levels and in different combinations, with some also competing at university level sport (Usport) competitions. 71 of the 80 (89%) athlete respondents reported competing at the Olympic/international level, either solely or in combination with one or more of the other levels of competition (i.e., national, provincial, Usport). Similarly, 24 of the 80 (30%) athletes reported competing at the national level, 11 of the 80 (14%) reported competing at the provincial level, and 8 of the 80 (10%) reported competing at the Usport level. **Figure 9** shows the distribution of the 80 athletes' level(s) of competition and CBD use status. Among the 71 athletes who reported competing at the Olympic/international level, solely or in combination, 28 athletes were CBD users, meaning that 40% of Olympic/international level athletes reported being CBD users. Similarly, 11 of the

24 (46%) National level athletes were CBD users. Considering provincial level athletes, 3 of the 11 (28%) were CBD users.



**Figure 9.** Level of competition and CBD use status. Here is showcased the distribution of the athletes based on their level(s) of competition and their CBD use status.

Both **Figure 10** and **Figure 11** show the distribution of the athletes (including Para athletes), based on their primary sport of competition. However, Figure 10 also shows the distribution of sex, whereas both Figure 10 and Figure 11 show the distribution of the athletes (including Para athletes) based on their primary sport of competition. Figure 10 also shows the distribution of sex, whereas Figure 11 shows the distribution of CBD use status. The athletes competed in 27 different primary sports, 4 of which were Para sports. The volleyball discipline includes court, indoor, and beach. The gymnastics discipline includes mogul,

dual moguls, aerials, cross, half-pipe, slopestyle, big air, and ballet. The canoeing/kayaking discipline includes sprint and slalom. The wrestling discipline includes freestyle and Greco-Roman. The cycling discipline includes mountain bike, BMX (freestyle or racing), road, and track. The disciplines water polo, artistic swimming, swimming, and diving are part of the Olympic aquatics. The high diving discipline is not currently contested at the Olympics. The sports with a higher ratio of CBD users to non-CBD users were volleyball (62%), Para ice hockey (60%), rowing (80%), freestyle skiing (60%), rugby sevens (75%), and canoeing/kayaking (67%). Moreover, 8 of the 80 (10%) athletes were Para athletes, meaning athletes with a disability, including physical and/or intellectual disabilities, and who compete in Para sports. In fact, 3 of the 8 (38%) Para athletes were CBD users. Only 3 athletes declared secondary sports of competition in addition to their primary sports of competition. The secondary sports were not included in Figures 10 and 11.



**Figure 10.** Sex and primary sport contested. Here is showcased the distribution of the athletes based on their primary sport in which they compete. A "(P)" at the end of a sport name distinguishes Para sports from able-bodied sports. The distribution of males and females per sport contested is also included.



**Figure 11.** Primary sport contested and CBD use status. Here is showcased the orderly distribution of the athletes based on their primary sport in which they compete. A "(P)" at the end of a sport name distinguishes Para sports from able-bodied sports. The distribution of CBD use status per sport contested is also included.

Sport disciplines from Figure 11 are usually contested in either summer or winter competitions. **Figure 12** shows the distribution of athletes and their CBD use status by season of competition. In fact, 83% of the athletes mainly competed in summer sports, whereas 17% competed in winter sports. Moreover, 36% of summer sports athletes reported CBD use, yet 43% of winter sports athletes reported CBD use.



**Figure 12.** Competition season and CBD use status. Here is showcased the distribution of the athletes based on their main competition season and their CBD use status.

When prompted about the number of people each athlete trained with, the responses showed that most (55%) of the 80 athletes trained with 10 or more people, 20% trained with 5 to 9 people, 20% trained with 1 to 4 people, and the remaining 4 athletes (5%) trained alone.

## 3.3.2 CBD awareness

9 of the 80 athletes (11%), or 9 of the 50 non-CBD users (18%), reported not having any prior knowledge of CBD's existence, thereby never using it, until learning about it via the information and consent form that granted them access to the survey. Due to "Skip logic" implementation in the survey, those 9 athletes were spared further questioning on their knowledge about CBD, as opposed to the other 71 athletes. **Figure 13** uses the 156 multiple-choice selections made by 67 of those 71 athletes, from a list of 9 different sources where information could be gathered about CBD, to show their proportions. Moreover, 9 of the 71 athletes selected the option "Other", thus sharing additional sources of information or comments. 4 of those 9 athletes did not make any additional selections, which explains why the figure considers 67 athlete responses only.

5 of the 9 athletes mentioned school/university, another 2 mentioned books, 1 mentioned a sponsor, and 1 athlete declared being uncertain because they knew about CBD for a long time. In the survey, the "Other health practitioner" selection included examples such as "massage therapist", "physiotherapist", and "chiropractor". Similarly, the "Internet" selection included examples such as "social media", "news media", and "advertisements".



**Figure 13.** General sources of knowledge about CBD. Here are showcased, in orderly proportions, the different sources of information about CBD.

Again, due to "Skip logic" implementation, the 38 out of 71 athletes (54%) who had included "Internet" in their selections on Figure 12, went on to provide 71 multiple-choice selections from a list of 5 different internet sources of information about CBD, with proportions being showcased in **Figure 14**.



**Figure 14.** Internet sources of knowledge about CBD. Here are showcased, in orderly proportions, the different internet sources of information about CBD.

#### 3.3.3 CBD use experience, efficacy, and rationale

As reported above, 50 out of the 80 (63%) athletes in this study reported having never used CBD. On the other hand, 21 of the 80 (26%) athletes only used CBD in the past, whereas 9 (11%) athletes reported past and ongoing CBD use. Therefore, due to "Skip logic" implementation, only the CBD users (26% + 11%) provided details on their "CBD consumption". The age at which CBD-using athletes started taking CBD ranged from between 16 to 37 years of age. The mean age was 21 years, with a median of 22, and two modes of 20 and 22. When asked to type-in the duration of their CBD use, 8 of the 30 (27%) athletes reported using CBD between 1 day to 1 week, or occasionally. Furthermore, of the 30 athletes, 5 (17%) used CBD between 3 to 8 months, 12 (40%) used CBD between 1 to 2 years, 3 (10%) used CBD between 3 to 5 years, and 2 (7%) used CBD between 9 to 10 years. **Figure 15** shows the distribution of the 30 athletes based on their reported duration of CBD use. In the figure, the side column for "Occasional" covers written responses by athletes such as "Once every 3 months", "A couple times", and "Few times, very occasional". Three athletes who used CBD for two,

three, and five years, respectively, also mentioned that their use of CBD was "on and off" during those periods of time.



**Figure 15.** Duration of CBD use. Here is showcased the distribution of the athletes based on how long they used CBD for.

When later prompted, 20 out of the 30 CBD users made 27 multiple-choice selections, when applicable, from a list of 6 reasons for stopping CBD use either completely or temporarily at any point during their period of use, with proportions being showcased in **Figure 16**. The figure omits 10 athletes because 7 of the 30 (23%) athletes reported never discontinuing the use of CBD since they started taking it, with the remaining 3 athletes having selected the option "Other", without making any additional selections, thus sharing different reasons for discontinuing CBD use. 1 of the 3 athletes stated that they stopped CBD use for no reason, another athlete mentioned avoiding CBD

use around competition time, and the third athlete mentioned difficulty accessing trusted brands.



**Figure 16.** Reasons for CBD users to discontinue use. Here are showcased, in orderly proportions, the reasons behind CBD users who discontinued use either temporarily or indefinitely.

When asked about the source of CBD products used, 29 of the 30 athletes made 38 multiple-choice selections from a list of six probable sources, with proportions being showcased in **Figure 17**. Moreover, only 1 out of the 30 athletes selected the option "Other", thus adding that he acquired CBD from a store. That athletes did not make any additional selections, which explains why the figure considers 29 athlete responses.



**Figure 17.** Sources of CBD acquisition. Here are showcased, in orderly proportions, the different sources where athletes acquired their CBD products.

When prompted about the brand of CBD products used, 22 out of 30 (73%) athletes were unable to provide names because they either did not know or could not remember. On the other hand, 8 of the 30 (27%) athletes reported the following brands: "Organigram [Canada], Cureganics [USA], Everie [Ontario, Canada], Solei [Ontario, Canada], SQDC [Quebec, Canada], Brains Pure [Vancouver, Canada], Color Cannabis [Ontario, Canada], and Pharmalabs." After a careful search for "Pharmalabs", we could only find MediPharm Labs [Ontario, Canada] as the possible CBD brand under a similar name.

Subsequently, 17 of the 30 (57%) athletes declared that they did not know if the CBD products they used were "third-party" batch-tested (e.g., by NSF, Informed Sport, or Informed Choice) for contamination with other prohibited substances such as THC. 27% of the athletes declared that their CBD products were not batch-tested, 7% declared that their products were batch-tested, and 10% reported that some products were, while others weren't batch tested. Furthermore, when CBD users were prompted about the amount of money they spent per month in Canadian dollars (CAD), on CBD products, responses varied as showcased in **Figure 18**.



**Figure 18.** Monthly expenditure on CBD products. Here are showcased the different amounts that CBD users spend on CBD products per month.

When asked about their form of CBD consumption, the 30 CBD using athletes made 64 multiple-choice selections from a list of seven formulations, with proportions being showcased in **Figure 19**.



**Figure 19.** Modes of CBD consumption. Here are showcased, in orderly proportions, the different modes of CBD consumption reported by CBD users.

When CBD users were prompted about the quantity of CBD they consume with each dose, responses varied as showcased in **Figure 20**. The figure considers 29 athlete

responses since 1 of the 30 athletes only selected the "Other" option, thus stating that the quantity of CBD he consumes per single dose varies, in dry flower it is about 15 mg and in oil 100 mg and more.



Figure 20. CBD quantity (mg) per single dose. Here is showcased the distribution of the different quantities of CBD, in milligrams, consumed by the CBD users per single dose.

When asked about how they determined the dose of CBD to consume, 29 of the 30 CBD users made 40 multiple-choice selections from a list of 5 probable methods, with proportions being showcased in **Figure 21**. Moreover, 3 of the 30 athletes selected the option "Other" to add comments. 1 of the 3 athletes did not make any additional selections, which explains why the figure considers 29 athlete responses. One of the three athletes added "Book" as a method for determining the dose to consume, whereas the other two athletes said, "I do not know" and "It can vary".



**Figure 21.** Methods for dose determination. Here are showcased, in orderly proportions, the different methods utilized by CBD users to determine the dose for consumption.

The 30 athletes then shared their certainty level (%) about consuming an optimal dose, with the distribution being showcased in **Figure 22**. The median for the reported certainty of optimal dosing was 35%, whereas the mode was 0%.



**Figure 22.** Certainty level of optimal CBD dosing. Here is showcased the distribution of the level of certainty for each athlete, in percentage, that they are consuming an optimal dose of CBD.
To shed more light on the dosing regimen, the 30 CBD users were prompted about the timing of their CBD consumption in relation to training and competition. When asked about the typical timing of CBD consumption in relation to training, 28 of the 30 athletes made 38 multiple-choice selections from a list of 4 probable timings, with proportions being showcased in **Figure 23**. Moreover, 2 of the 30 athletes selected the option "Other", thus adding comments. Those two athletes did not make any additional selections, which explains why the figure considers 28 athlete responses. One of the two athletes denied any relation between CBD use and training, whereas the other athlete stated that they take CBD on Saturday night. On the other hand, when asked about the typical timing of CBD consumption in relation to competition, the 30 athletes made 42 multiple-choice selections from a list of 3 probable timings, with proportions being showcased in **Figure 24**. Additionally, 1 of the 30 athletes also selected the option "Other", thus stating that they discontinue CBD use 10 days before any competition.



**Figure 23.** Timing of CBD consumption relative to training. Here are showcased, in proportions, the different timings of CBD consumption in relation to training.





To further explore the dosing regimen, the 30 athletes were prompted about the frequency and consistency of their CBD consumption. On any given day of CBD consumption, 24 of the 30 (80%) CBD users reported taking CBD at most "Once a day". Alternatively, 10%, 7%, and 3% of athletes used CBD twice daily, three times daily, and four or more times per day, respectively. As to the frequency of CBD consumption per month, the distribution of responses ranges from less than once, on average, to 30 times and over. The median was 10 times per month, whereas the mode was 30 times and over.

When CBD users were prompted about the consistency of their CBD use regimens, responses varied as showcased in **Figure 25**. The figure considers 29 athlete responses since one of the 30 athletes only selected the "Other" option, thus stating that they only use CBD outside of competition.



*Figure 25.* Consistency of CBD use regimens. Here is showcased the orderly distribution of different CBD use regimens based on consistency of use.

Of the 30 CBD users, only 2 (7%) reported documenting their CBD use. Furthermore, when prompted about transparency in sharing information on their CBD use with members of their integrated support team, sport support team or health care team, one of the thirty CBD users declared not having an integrated support team. Of the other 29 CBD users, 6 (21%) reported disclosing their use of CBD to their support teams.

The subjective effect that CBD had on performance during competition of the 30 athletes who consumed it, is showcased in **Figure 26**. In fact, none reported a worsening of their performance, while the majority reported that their performance was about the same, with or without CBD.



**Figure 26.** CBD effect on athletic performance. Here is showcased an orderly distribution of the effect that CBD use has on athletic performance during competition.

Different intended use scenarios for CBD were proposed to the 30 CBD users, and their agreement level with each scenario was recorded, as showcased in **Figure 27**. Beyond the scenarios listed in the figure, 2 of the 30 athletes added that CBD helps them better visualize and improve their game and become more sociable. Subsequently, different statements regarding CBD were proposed to the 30 CBD users, and their agreement level with each statement was recorded, as showcased in **Figure 28**.



**Figure 27.** Agreement level with various reasons for taking CBD. Here is showcased an orderly distribution of the CBD user's agreement level with different intended use scenarios for CBD.



**Figure 28.** Agreement level with various statements about CBD. Here is showcased an orderly distribution of the CBD user's agreement level with different statements regarding CBD.

When prompted about the frequency of experienced side effects with CBD use, the majority of the 30 CBD users declared having rarely or never experienced side effects, as showcased in **Figure 29**. Due to "Skip logic" implementation, those 19 athletes (63%) who reported never experiencing side effects were spared further questioning on the matter, as opposed to the other 11 athletes. Of the 11 CBD users who experienced side effects, 8 (73%) reported experiencing drowsiness or fatigue, 4 (36%) experienced dry mouth, 1 (9%) experienced dizziness, and 1 selected the "Other" option, thus reporting anguish. Subsequently, different statements regarding side effects from CBD use were proposed to the 11 CBD users who reported side effects, and their agreement level with each statement was recorded, as showcased in **Figure 30**.



**Figure 29.** Frequency of reported side effects with CBD use. Here is showcased an orderly distribution of the frequency of experienced side effects by CBD users.



**Figure 30.** Agreement level with various statements about CBD side effects. Here is showcased an orderly distribution of the CBD user's agreement level with different statements regarding CBD side effects.

# 3.3.4 Thoughts & assumptions about CBD use

All 80 athletes, including users and non-users of CBD, provided more insight into their thoughts and assumptions about CBD. When prompted about the frequency of discussions pertaining to CBD, between each of the 80 athletes and their entourage, responses varied, as showcased in **Figure 31**. Subsequently, when prompted about the perceived prevalence of CBD use among their entourage, relative to each of the 80 athletes, responses varied, as showcased in **Figure 32**.



**Figure 31.** Frequency of CBD related discussions with entourage. Here is showcased an orderly distribution of the different frequencies of discussions about CBD between users and non-users of CBD and their entourage.



**Figure 32.** Perceived prevalence of CBD use among entourage. Here is showcased an orderly distribution of the perceived prevalence of CBD use among the entourage, relative to users and non-users of CBD.

When all 80 athletes were prompted about the likelihood of them starting, restarting, or continuing CBD use in the next 12 months, responses varied, as showcased in **Figure 33**. On the other hand, **Figure 34** uses the 186 multiple-choice selections made by 79 of the 80 athletes, from a list of 7 different reasons not to take or to discontinue CBD use, to show their proportions. Moreover, 2 of the 80 athletes selected the option "Other", thus sharing additional reasons. 1 of those 2 athletes did not make any additional selections, which explains why the figure considers 79 athlete responses. The additional reasons that were noted by the 2 athletes were a lack of trust and hard science in the marketed benefits of CBD, and just a need for change.



**Figure 33.** Likelihood of CBD use in the next year. Here is showcased an orderly distribution of the likelihood of starting, restarting, or continuing CBD use in the next 12 months for non-CBD users, past-only CBD users, and past plus ongoing CBD users, respectively.



**Figure 34.** Valid reasons to never start or to discontinue CBD use. Here are showcased, in orderly proportions, valid reasons to never start or to discontinue CBD use for CBD users and non-users alike.

All 80 athletes then shared the likelihood of them starting, continuing, or increasing CBD use given different compelling scenarios involving CBD, as showcased in **Figure 35**. Subsequently, 13 of the 80 athletes electively shared some personally compelling

scenarios, in French or English, that would entice them to use CBD. Summarized here in English, the additional scenarios included having certified CBD products free from banned substances, more knowledge about the Cannabis plant and CBD benefits for athletes, CBD recommendations for sleep, if CBD was prescribed by a dietician with scientific backing, if THC becomes legalized within competition, if CBD was prescribed for medical reasons, if safety profile, benefits, and indications (e.g., treat insomnia, treat pain) were proven scientifically, and lastly receiving a CBD test sample. To end the section, the 80 athletes selected the likelihood of more widespread acceptance of CBD among athletes given different compelling scenarios involving CBD research, as showcased in **Figure 36**.



**Figure 35.** Likelihood of more CBD use given compelling scenarios involving CBD. Here is showcased an orderly distribution of the likelihood of starting or continuing CBD use given different scenarios, for CBD users and non-users alike.



**Figure 36.** Likelihood of broader acceptance of CBD use among athletes. Here is showcased an orderly distribution of the likelihood of more widespread acceptance of CBD use among athletes given compelling potential scenarios involving CBD research.

## 3.3.5 End of survey comments

At the very end of the survey, 8 of the 80 (10%) athletes electively provided comments, in French or English, relating to CBD use among athletes. The comments are summarized in English and are shown in **Table 1**.

**Table 1.** Athletes' general comments relating to CBD use among athletes.

## **Comments Summary**

I'm not opposed to the idea of CBD supplements in any way. However, with my experience I had a very high-quality product [Brand: Organigram] which I don't think actually aided me that much, was quite expensive, and I was worried from a doping violation if I was constantly ingesting the oil. The THC amounts were considered almost 0% but it still didn't sit well with me.

I believe that athletes are afraid of undergoing an anti-doping test and testing positive.

I don't take CBD because I haven't been shown the scientific proof that CBD can improve athletic performance. Much of what I've read on CBD seems like marketing and/or a one-off situation where someone tells their story about getting amazing benefits out of using CBD (once again marketing). My experience with most supplements is that they are typically more hype-marketing than they are worth. Lastly, while I say I haven't seen scientific based results, I also haven't put much time looking into CBD research and results.

The maximum dosage of CBD oil, cream, etc., in Canada is quite low to feel the benefits of CBD. I had the chance to use a pain-relief cream from the United States that contained 1000mg of CBD, and I truly felt the benefits.

It would be necessary to present to the athletes the potential benefits of the CBD product and any potential drawbacks, if there are any.

The principle of consuming exogenous substances solely for the purpose of performance benefits is not sufficient to justify their consumption; it ultimately comes down to an ethical question of fair play in sports.

It's important to find a balance with CBD. There's no need to make life revolve around this substance, but rather use it at the right moment and for the right reasons.

## **3.4 Discussion**

#### 3.4.1 Demographics

The aim of the present study was to evaluate the prevalence, rationale, and subjective outcomes of cannabidiol (CBD) use by elite-level Canadian athletes, including Para athletes. The utility of conducting this study in elite-level athletes was in part due to the relatively recent legalisation of CBD use in all sports, combined with these athletes' intentionality when adding supplements to their diet, their professionalism in face of sports governing bodies, and their quest for ultimate physical and mental conditioning. To address our research aim, we recruited a total of 80 athletes to complete a private online survey. The survey was designed to be very detail oriented and versatile, which allowed us to dig deep into the athletes' experiences with CBD, while accommodating both English and French speaking Canadian athletes. To that end, having almost half (55%) of our athletes complete the survey in English and the rest in French was gratifying. Moreover, the 16-year-old female and 17-year-old male who violated our inclusion criteria for age were retained because they reported participating in elite competitions but reported no CBD use, which is just as interesting to consider as the alternative had they reported CBD use at that age. With "Skip logic" implementation, the average interview time to complete the survey was longer for CBD users than non-CBD users, because the former had an extra survey section "CBD consumption - questions 17 to 42", completely dedicated to them.

The mean use of CBD in our study was 37%. Our data suggests that male athletes are more prone to be using CBD than female athletes, with more males actively using CBD than females. This is perhaps explained by female athletes being a little more risk

averse due to the lurking possibility of an accidental anti-doping rule violation (ADRV) if their CBD extracts were contaminated with THC. The mean age of the athletes was 21 years old. Our data shows a higher tendency for CBD use by younger athletes, especially in the 22 – 25 year old age group. Similarly, a survey of adult athletes looking at age related differences in cannabis use found that younger adults tend to use cannabis before and after exercise more often than older adults<sup>51</sup>. In contrast, a CBD use study surveying professional rugby players showed increasing prevalence of use with increasing age, with the mean usage reaching 39% in the players aged 28 years and older category<sup>13</sup>. Per that study, older players with longer playing histories may be seeking pain relief more frequently<sup>13</sup>. We suppose that young elite-level athletes strive to win by all means necessary, which includes profiting from CBD's potential benefits, while maybe overlooking or accepting the potential consequences tied to its use, like accidental ADRVs.

The top 3 most reported ways for the athletes to receive funding for their sport was through government sponsorship, followed by self-support, then professional careers. Furthermore, despite having 89% of the athletes compete at the Olympic/international level, solely or in combination with other levels of competition, our data suggests a higher tendency for CBD use among National level athletes and Olympic/international level athletes, in comparison to provincial level athletes. This could be due to higher stakes for athletes at higher levels of competition mixed with ample marketing by CBD brands, thus inciting athletes to explore more ways to gain the edge over their competitors.

Additionally, despite having 83% of our athletes compete mainly in summer sports, our data suggest a somewhat comparable tendency towards CBD use among summer

sports athletes and winter sports athletes, which might indicate a negligible impact of competition season on CBD use. Despite a general mean of 37% for CBD use among all surveyed athletes, the sample size from each individual sport was too small to determine the prevalence or draw conclusions about CBD use specific to each sport. In contrast, a CBD survey study in professional rugby players found that more than 25% of the players had used or were currently using CBD<sup>13</sup>. All in all, the use of CBD continues to increase in athletes according to literature<sup>47</sup>.

## 3.4.2 Information sources & communication patterns regarding CBD

Most (89%) of the athletes who responded to the survey had some prior knowledge about CBD before accessing the survey. The two main sources where the athletes obtained information about CBD were through friends and the internet. In a recent study describing public interest in CBD within the United States, the authors noted that Google searches that mentioned "CBD" or "cannabidiol" were stable from the years 2004 through 2014 but then substantially increased secondary to increased public interest<sup>9</sup>. In fact, searches for CBD during April 2019 eclipsed those for acupuncture by a factor of 7.49, meditation by 3.38, vaccination by 1.63, exercise by 1.59, marijuana by 1.13, and veganism by 1.12<sup>9</sup>. The main internet sources of information/knowledge about CBD reported by athletes in the present study were social media [e.g., Facebook, Instagram] and news media [e.g., cbc.ca], followed by internet advertisements, forums [e.g., Reddit], and blogs. Other sources of information about CBD, per athlete responses include other athletes, other teammates, or family members. Additionally, 17% of athletes who were CBD users, compared to 54% of non-CBD users, reported never discussing CBD with their teammates. Arguably, much of an athlete's time is spent interacting with teammates,

thus increasing the likelihood of shared knowledge via word of mouth. In fact, only 5% of the athletes in the present study reported that they train alone, whereas 55% reported training with 10 or more people. The rest reported training, in equal proportion, with 1 to 4 people or 5 to 9 people.

The least stated sources of information on CBD were health practitioners [e.g., massage therapists, physiotherapists, and chiropractors], nutritionists/dieticians, physicians, and coaches. Additionally, 70% of athletes who were CBD users, in comparison to 92% of non-CBD users, reported never discussing CBD with their coaches. These data suggest that health practitioners in general and coaches may be more cautious about initiating a conversation about CBD with their athletes or that athletes may be hesitant to broach the topic with their support staff. Similar to the present findings, a cross-sectional survey study disseminated to CBD users on social media, reported that the main sources of knowledge on CBD were from the internet, friends, or family members, rather than healthcare professionals<sup>2</sup>. Furthermore, a study conducted in Europe that surveyed professional rugby players found that the main sources of information on CBD for the players were the internet and teammates, with a minor proportion of players obtaining information on CBD from a nutritionist<sup>13</sup>.

In general, the present data also shows that the frequency of CBD related discussions between athletes and their entourage (i.e., teammates, coaches, integrated support team members), though mostly rare, are higher for CBD users, in comparison to non-CBD users. For example, 40% of athletes who were CBD users, in comparison to 74% of non-CBD users, reported never speaking about CBD with their integrated support team members. Additionally, although 44% of our CBD users reported being willing to

disclose their use of CBD, only 21% of CBD users disclosed their use of CBD to members of their integrated support team, sport support team or health care team. This finding may represent hesitancy and/or lack of transparency by athletes in disclosing their CBD use or their potential interest in trying CBD to their support teams. The reason could be due to fear of discrimination, given the stigma surrounding the use of marijuana constituents, especially in the world of elite sports.

Finally, the present findings suggest that discussions surrounding CBD are not rampant among elite-level athletes and their entourage. In other words, our data suggests that, in the world of elite-level athletes, the majority of athletes are aware of CBDs existence, a fair number of athletes use CBD, and their usage is mostly unreported. In fact, the great majority of athletes rarely or never engaged in discussions about CBD with various members of their professional circles, including their teammates, their integrated support teams, and their coaches.

#### 3.4.3 CBD use, safety & concerns

In the present study, 37% of athletes (30/80) reported having used CBD, with 30% (9/30) of CBD users reporting current ongoing CBD use. The mean reported age for starting CBD use was 21 years. The top 3 most reported durations of CBD use were between 1 to 2 years, followed by 1 day to 1 week, or occasionally, then between 3 to 8 months. The rest of athletes reported CBD use durations between 3 to 10 years. These substantial intervals of adherence to CBD use by athletes could be driven by perceived benefits (discussed below). In fact, 23% of CBD users never discontinued its use, ever-since starting.

The most reported reason for discontinuing CBD use, among CBD users only, was concern over an ADRV. This supports our belief that ADRV risk aversiveness is a considerable factor for athletes contemplating CBD use. In fact, when considering the timing of CBD use in relation to competition, risk aversiveness likely explains why only 5% of CBD users consumed CBD in season, during competition. The majority of athletes use CBD similarly off season, or in season, outside of competition. Other reported reasons for stopping CBD use are that CBD is expensive, not effective, has side effects, or that trusted brands are difficult to access. As previously mentioned, most athletes reported relying on government sponsorship or self-support to finance their athletic career. Therefore, high-quality CBD supplements from an athlete-trusted brand may be cost prohibitive for some athletes. Moreover, despite side effects being a deal breaker for some athletes, 63% of athletes never experienced any. Among those who experienced side effects, the reported side effects were mostly drowsiness or fatigue, followed by dry mouth, dizziness, and anguish. Furthermore, those athletes all agreed that the positive effects of taking CBD outweighed the negative effects, and the negative effects were not significant or bothersome enough to stop them from taking CBD again. In general, the great majority of CBD users agreed that CBD is relatively safe to use. On the other hand, different studies have previously reported adverse effects of CBD use such as red eyes, dry mouth, drowsiness, sedation/fatigue, euphoria, hunger, decreased appetite, and diarrhea<sup>2,35</sup>. The reported side effects by CBD users in the present study could possibly be related to either dosage, drug-drug interactions, route of administration (oral solutions, smoke inhalation), and the use of a purified CBD solution or one that contains THC beyond expected thresholds<sup>2</sup>. CBD is considered well-tolerated in humans while

maintaining a good safety profile with neither abuse nor dependence potential<sup>2,8,36</sup> Other research also suggests that cannabidiol is not harmful, even when given to humans on a long-term basis or in high amounts at once [up to 1,500 mg/day]<sup>26,39</sup>. In the present study, all reported reasons for discontinuing CBD appear reasonable given the paucity of reliable information on the risks and benefits of CBD use for athletes, and the undisputable risk of an ADRV associated with available CBD products on the market. Considering that some of the athletes in this study have obtained CBD from the US market; our athletes' concerns are further validated by research showing that almost 70% of CBD products available online in the US could be mislabeled<sup>3</sup>.

When exploring reasons to never start or to discontinue CBD use, for users and non-users of CBD alike, the most reported reason is once more the concern about ADRVs. In fact, 63% of CBD-using athletes agreed on being worried about anti-doping violations with cannabis products like CBD. Other reported reasons to never start or to discontinue CBD use, in descending significance, were that athletes do not see a need for it, do not know enough about it or its benefits, find it expensive, or were advised against its use. Only a few athletes claimed not having a reason to avoid using CBD. As discussed earlier, all the above appear reasonable, especially when taking into consideration the opinion of 50 athletes (63%) who never used CBD. There is not only a lack of trusted information on CBD available, but also a large amount of misinformation. Hence, without the proper qualifications to do so, anyone who advises athletes to either consider or steer away from CBD use, could possibly be misinformed too. In fact, most data available on CBD comes from pre-clinical studies and clinical studies using one specific

pharmaceutical grade product called Epidiolex, the first and only FDA-approved prescription CBD<sup>47</sup>.

Findings from this study indicate that, according to CBD users, the use of CBD appears to be more common among their immediate athletic circle—including teammates/training partners and competitors—as well as among elite athletes at the highest level of their sport, when compared to the perceptions of non-CBD users. These differences in perceptions could be either founded on observations and discussions among peers, or strictly unfounded and result from false consensus effect, a cognitive bias where individuals overestimate the extent to which others share their beliefs, attitudes, or behaviors.

Lastly, non-CBD users reported a high unlikelihood of starting CBD use in the next 12 months. In comparison, past-only CBD users agreed on the likelihood of restarting CBD use in the next 12 months, whereas past plus ongoing CBD users report a high likelihood of continuing CBD use. This data highlights the possible skepticism and avoidance behavior of non-CBD users on the matter of CBD use, while underlining the continued interest of CBD users in the realm of CBD.

# 3.4.4 CBD products & dosing regimens

In this study, CBD using athletes obtained their CBD products mostly from a health Canada approved retailer, followed by a friend or family member. Given our previous findings that friends, and family members combined represented 34% of the sources of information on CBD for athletes, it seems that they also provided the athletes with CBD products to some extent. No CBD product exchanges were reported between teammates. Other reported sources of CBD acquisition, in similar proportions, were online through a provincial retailer or through another source, and via a health care facility or prescription (e.g., pharmacy, clinic). The majority of CBD users reported spending less than \$50 CAD per month on CBD products, whereas others spent between \$50 to \$100 CAD. A small proportion of athletes reported spending more than \$100 CAD per month.

The advertisement and selling of CBD-only products may be deemed illegal as a component of a nonapproved cannabis extract with a THC content exceeding 0.3% weight of the dried flowers of the plant in Canada and USA<sup>2,26</sup>. Furthermore, the WADA states that THC is prohibited in competition only, and only when the urinary concentration exceeds a threshold of 150 ng/mL. Nonetheless, only 27% of CBD users were able to recall the brand name of their CBD supplements. Moreover, 27% of CBD users kept using their CBD products while knowing that they were not "third-party" batch-tested for contamination with prohibited substances such as THC. Likewise, 57% did not know if the CBD products they used were batch-tested. Just 7% declared that their products were batch-tested for contaminants that pose a risk of accidental ADRV. Many athletes are potentially unaware of the risks associated with current CBD use in the world of elite-level sports, and thus do not pay attention to certain important details, such as "batch-testing" when selecting their brand of CBD product.

The principal mode of CBD consumption reported by athletes who were CBD users was the oral ingestion of tincture or oil. In fact, the precise measurement of dosage can be achieved by tallying the oil drops ingested. Other reported methods of CBD consumption, in descending frequency, were inhalation, edibles/confectionary, capsules/softgels, beverages, and topical application such as cream. Aside from smoking dry herbs of cannabis, the use of cannabis oil or any of the remaining methods of CBD

consumption, offer the advantage of discretion, as they lack a distinct odor. This enables consumption in social contexts, like within the training grounds or among family, without attracting attention. These advantages were similarly observed in a 2013 survey of medicinal cannabis consumers, indicating an early trend towards the preference for concentrated extracts like cannabis oil as the primary ingestion method<sup>26</sup>.

Exploring the self-assigned CBD dosing regimen of athletes in this study yields important information. As previously mentioned, when considering the timing of CBD use in relation to competition, most athletes consumed CBD off season, or in season, outside of competition. In relation to training, most athletes consumed CBD after training, or in the evening prior to going to bed. Only 5% of athletes consumed CBD before their training sessions, while none reported taking CBD during their training. The timing of CBD use by athletes could be driven by perceived benefits in performance recovery after exercise and improved sleep (discussed below). Notably, past research has shown that the highest levels of CBD in the bloodstream are achieved within 4 hours after taking oral supplements<sup>36</sup>. However, the bioavailability from oral delivery was estimated to be as low as 6%<sup>8</sup>. Furthermore, on any given day of CBD consumption, 80% of CBD users reported taking CBD at most "Once a day". As to the frequency of CBD consumption per month, the median was 10 times per month, whereas the mode was 30 times and over. When addressing consistency of CBD use, most athletes used CBD on and off, i.e., inconsistently. The rest of the athletes reported using CBD almost always or a few weeks at a time in similar proportions, followed by a few days or a few months at a time in similar proportions.

Interestingly, 27% of CBD users were not sure about the quantity (mg) of CBD they consumed per single dose. Just 7% reported consuming over 100 mg of CBD per single dose, which is considered equivalent to 1.4 mg/kg for an athlete weighing 70 kg. The rest reported consuming under 50 mg per single dose. In contrast, oral doses of CBD in research have varied widely, with most doses ranging from 100 to 800 mg per day<sup>8</sup>. Furthermore, a recent systematic review of CBD dosing in clinical populations reported an average dose of 15 mg/kg/day was used in randomised controlled trials in epilepsy patients<sup>48</sup>. Further, there was a tendency of studies with positive outcomes to have used higher doses of CBD. Optimal dosing of CBD may depend on the desired outcome and be influenced by the route of CBD administration (e.g., oral vs. inhaled). Neutral results with CBD may be secondary to subtherapeutic dosing.

The most reported method for effective dose determination by CBD-using athletes in the present study was trial and error, followed by package labelling, professional guidelines through a practitioner, and to a much lesser extent the internet. Many athletes reported never searching for an effective dose to work with. It is evident that the quantity of CBD consumed by athletes in the present study is largely baseless and less than the quantity applied in the literature in studies involving sport/exercise<sup>52</sup>. In fact, the certainty level of optimal CBD dosing reported by athletes ranged from 0% to 100%, with a median of 35%, and a mode of 0%. Additionally, only 7% of CBD users reported documenting their usage. All in all, 93% of CBD-using athletes in this study reported consuming CBD doses below the lower limit of what is usually administered in different research involving CBD in the literature<sup>8</sup>. The majority of CBD-using athletes were 0% sure of optimal dosing, and often resort to trial and error to attempt finding a beneficial dose.

#### 3.4.5 CBD use benefits & incentives

In general, the great majority of our CBD users agree that they experienced benefits from the use of CBD. Our data shows that elite-level Canadian athletes tend to use CBD with intention, as we expected. The two most agreed upon intended uses among CBD users were to improve sleep and relaxation. Moreover, athletes agreed on using CBD to reduce pain from training and competition. In fact, 67% of CBD users look at CBD as an alternative to conventional pain medications (e.g., lbuprofen, Tylenol) due to concerns over their side effects (e.g., stomach irritation, etc.). Similarly, a study conducted in Europe surveyed 517 professional rugby players and found that almost 40% of older players (over 28 years of age) used CBD for pain relief and recovery<sup>13</sup>. Other agreed upon reasons for CBD use were to enhance physical and mental recovery from training and competition, and to reduce feelings of anxiety and depression. Similarly, a survey conducted on social media among CBD users found that nearly 62% of respondents utilized CBD for addressing a range of various medical conditions, with a primary focus on issues such as pain, anxiety, depression, and sleep disorders<sup>2</sup>. In fact, it is evident that the agreed upon reasons for CBD use by elite-level athletes are congruent with the currently explored therapeutic potential of CBD in the literature. Alternatively, the consensus/agreement level among CBD using athletes in our study is that their intention behind CBD use was not driven by the desire to remain or become more competitive in their sport, or for performance enhancement (as opposed to performance recovery) at the physical and mental/focus level. Some athletes' self-reported comments on the potential benefits of CBD use were to better visualize/improve their game, and to enhance their sociability.

In contrast to a recent review of cannabis use in elite athletes which concluded that there was no evidence for cannabis use as a performance enhancing drug<sup>42</sup>, 67% of CBD using athletes from our study believe that their overall performance was about the same while on CBD. 27% of athletes indicated a slight improvement in their performance, while a smaller proportion, 7%, experienced a significant enhancement. It is important to distinguish direct from indirect improvements in performance. In other words, an athlete whose performance is being hindered by anxiety, depression, inadequate sleep, DOMS, EIMD, or injuries, could experience enough relief using CBD to bring about an indirect improvement in their sub-optimal performance. Therefore, it is plausible that some of our athletes noted an indirect improvement in their performance.

When assessing scenarios that could likely incentivise the use of CBD by eliteathletes, our data shows that some situations appeal to CBD users more than non-CBD users, while others appeal to both or neither. 87% of CBD users and 58% of non-CBD users reported that they were likely to start or continue using CBD if it was prescribed or encouraged by their sports medicine doctor. CBD users were most likely to continue using CBD products if they were assured the products were free from banned substances and confirmed safe by researchers. Their likelihood of continued use also increased if the products were recommended or prescribed by a nutritionist, became more affordable, and were more accessible. Acceptance within the sporting community and having milder or more acceptable side effects also played a significant role in their decision to continue use. The least influential factor, yet still notable, was encouragement from their coach. On the other hand, starting from the least agreement, most CBD users and non-CBD users were least likely to use CBD if it was promoted by a CBD company sponsor,

showing a general skepticism towards commercial endorsements. What the data shows is that there needs to be tangible scientific evidence, coupled with a doctor's approval, for athletes to feel at ease using CBD. Overall, 90% of our CBD users agreed that they will likely continue to use CBD in the future. In parallel, all athletes agreed on the high likelihood of more widespread acceptance of CBD use among athletes if it was confirmed by researchers to be effective at improving recovery, exercise performance, sleep, or anxiety symptoms.

## 3.4.6 Extra comments on CBD

Further self-reported situations, as indicated by our athletes, that might attract elite athletes to consider CBD usage encompass the availability of certified CBD products devoid of prohibited substances, increased understanding of the Cannabis plant and its CBD advantages for athletes, expert recommendations for CBD usage to aid sleep, CBD prescriptions backed by scientific expertise from dieticians, the potential legalization of THC during competition, CBD prescriptions for medical purposes, substantiated scientific evidence regarding safety profiles, benefits, and applications (such as insomnia treatment and pain management), and finally, the receipt of a CBD test sample.

Based on the comments received from athletes at the end of the survey, several key themes emerge regarding the use of CBD among athletes. First, there is a degree of apprehension, primarily driven by concerns about the quality and potential doping violations associated with CBD products. Athletes are cautious about the actual effectiveness of CBD, noting the lack of concrete scientific evidence and the prevalence of marketing-driven narratives. Furthermore, athletes highlight the importance of dosage and product quality, emphasizing that higher concentrations of CBD seem more effective.

To address these concerns, there is a call for comprehensive education on CBD, including its potential benefits and drawbacks. Beyond the practical considerations, a strong ethical dimension is evident, with athletes questioning the moral implications of using exogenous substances for performance enhancement. The overarching sentiment is that CBD should be approached with balance and a clear understanding of its impact on athletic performance and integrity.

**CHAPTER 4: OVERALL CONCLUSION & SUMMARY** 

In conclusion, this thesis has delved into the complex landscape of CBD use among elite-level athletes in Canada, revealing a myriad of insights that contribute to our understanding of this evolving phenomenon.

First and foremost, it is apparent that the motivations behind CBD utilization among elite-level athletes in this study closely aligns with the therapeutic potential attributed to CBD in the limited existing literature. A significant majority of elite athletes who employ CBD do so to enhance their sleep quality and promote relaxation. Moreover, athletes reported CBD use as a means for mitigating the physical toll of training and competition, attesting to its potential for pain management and recovery. The acknowledgment of CBD's role in addressing mental health concerns, such as anxiety and depression, further emphasizes its multifaceted appeal within the athlete community.

Our initial hypothesis regarding the prevalence of CBD usage was substantiated, with 37% of all athletes reporting past and/or current use of CBD. Intriguingly, only 21% of CBD users reported disclosing their usage to their integrated support teams, possibly underscoring the persistence of stigmas surrounding CBD supplements and concerns over accidental anti-doping rule violations (ADRVs). This reluctance to disclose CBD use hints at the necessity for open dialogue and education surrounding CBD's legal status and potential consequences within the sports realm.

Drawing from lessons learned in the United States, where issues of mislabeling in CBD products have been identified, we advocate for stringent enforcement and oversight in the CBD industry to guarantee the accuracy and safety of these products. Such measures are imperative, especially considering the rising interest in CBD among athletes and the need for reliable sources.

This research also highlights the need to expand our comprehension of the intricate interactions between phytocannabinoids like CBD and the human body, transcending the traditional framework of the endocannabinoid system (ECS). As gathered from CBD-using elite-level athletes in this study, CBD shows promise to potentially aid athletes in sleep and relaxation, pain reduction post-training and competition, improvement in physical and mental recovery after training or competition, and improvement in symptoms of anxiety and depression. This expanded understanding will provide critical pathways for future clinical intervention studies, addressing the dearth of well-controlled safety investigations within athlete populations.

In light of the increasing prevalence of CBD usage, both in athletes and the general population, it is essential to embark on a multifaceted research agenda. This should encompass epidemiological studies to delineate CBD users' demographics and motives, detailed examinations of CBD's effects and potential drug interactions, development of robust safety standards for CBD products, and standardized marketing practices to uphold transparency and trust in evidence-based medicine.

In the realm of anti-doping regulations, a nuanced perspective is vital. The relaxation of thresholds for THC detection and the introduction of the 'Substance of Abuse' provision to the World Anti-Doping Code in recent years acknowledge the evolving landscape of cannabis use and prioritize athlete well-being over punitive measures.

Finally, the literature's intriguing suggestion that the combination of THC and CBD may offer enhanced relief for pain and anxiety underscores the need for future investigations into specific cannabinoid ratios and combinations to optimize therapeutic outcomes for elite athletes.

In essence, this thesis serves as a comprehensive exploration of CBD's role in the lives of elite-level athletes in Canada, shedding light on their motivations, challenges, and potential benefits. By fostering a nuanced understanding of CBD use within this community, we hope to contribute to informed decisions by athletes, sports organizations, and policymakers, ultimately promoting athlete well-being and the integrity of competitive sports.

# **Reference List**

1. Klumpers LE, Thacker DL. A Brief Background on Cannabis: From Plant to Medical Indications. *J* AOAC Int. Mar 1 2019;102(2):412-420. doi:10.5740/jaoacint.18-0208

2. Corroon J, Phillips JA. A Cross-Sectional Study of Cannabidiol Users. *Cannabis and Cannabinoid Research*. 2018;3(1):152-161. doi:10.1089/can.2018.0006

3. Corroon J, Kight R. Regulatory Status of Cannabidiol in the United States: A Perspective. *Cannabis and Cannabinoid Research*. 2018;3(1):190-194. doi:10.1089/can.2018.0030

4. Farinon B, Molinari R, Costantini L, Merendino N. The Seed of Industrial Hemp (Cannabis sativa L.): Nutritional Quality and Potential Functionality for Human Health and Nutrition. *Nutrients*. 2020;12(7):1935. doi:10.3390/nu12071935

5. Solowij N, Broyd S, Greenwood L-M, et al. A randomised controlled trial of vaporised  $\Delta$ 9tetrahydrocannabinol and cannabidiol alone and in combination in frequent and infrequent cannabis users: acute intoxication effects. *Eur Arch Psychiatry Clin Neurosci.* 2019;269(1):17-35. doi:10.1007/s00406-019-00978-2

6. Adams R, Hunt M, Clark JH. Structure of Cannabidiol, a Product Isolated from the Marihuana Extract of Minnesota Wild Hemp. I. *J Am Chem Soc*. 1940;62(1):196-200. doi:10.1021/ja01858a058

7. Ibeas Bih C, Chen T, Nunn AVW, Bazelot M, Dallas M, Whalley BJ. Molecular Targets of Cannabidiol in Neurological Disorders. *Neurotherapeutics*. 2015;12(4):699-730. doi:10.1007/s13311-015-0377-3

8. Fasinu PS, Phillips S, Elsohly MA, Walker LA. Current Status and Prospects for Cannabidiol Preparations as New Therapeutic Agents. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*. 2016;36(7):781-796. doi:10.1002/phar.1780

9. Leas EC, Nobles AL, Caputi TL, Dredze M, Smith DM, Ayers JW. Trends in Internet Searches for Cannabidiol (CBD) in the United States. *JAMA Network Open*. 2019;2(10):e1913853. doi:10.1001/jamanetworkopen.2019.13853

10. Bergamaschi MM, Queiroz RH, Zuardi AW, Crippa JA. Safety and side effects of cannabidiol, a Cannabis sativa constituent. *Curr Drug Saf*. Sep 1 2011;6(4):237-49. doi:10.2174/157488611798280924

11. Gurley BJ, Murphy TP, Gul W, Walker LA, ElSohly M. Content versus Label Claims in Cannabidiol (CBD)-Containing Products Obtained from Commercial Outlets in the State of Mississippi. *J Diet Suppl*. 2020;17(5):599-607. doi:10.1080/19390211.2020.1766634

12. Docter S, Khan M, Gohal C, et al. Cannabis Use and Sport: A Systematic Review. *Sports Health*. Mar/Apr 2020;12(2):189-199. doi:10.1177/1941738120901670

13. Kasper AM, Sparks SA, Hooks M, et al. High Prevalence of Cannabidiol Use Within Male Professional Rugby Union and League Players: A Quest for Pain Relief and Enhanced Recovery. *Int J Sport Nutr Exerc Metab.* Jul 30 2020;30(5):315-322. doi:10.1123/ijsnem.2020-0151

14. Lachenmeier DW, Diel P. A Warning against the Negligent Use of Cannabidiol in Professional and Amateur Athletes. *Sports*. 2019;7(12):251. doi:10.3390/sports7120251

15. van Bakel H, Stout JM, Cote AG, et al. The draft genome and transcriptome of Cannabis sativa. *Genome Biol*. Oct 20 2011;12(10):R102. doi:10.1186/gb-2011-12-10-r102

16. Wang M, Wang Y-H, Avula B, et al. Decarboxylation Study of Acidic Cannabinoids: A Novel Approach Using Ultra-High-Performance Supercritical Fluid Chromatography/Photodiode Array-Mass Spectrometry. *Cannabis and Cannabinoid Research*. 2016;1(1):262-271. doi:10.1089/can.2016.0020

17. McPartland JM, Hegman W. Cannabis utilization and diffusion patterns in prehistoric Europe: a critical analysis of archaeological evidence. *Vegetation History and Archaeobotany*. 2018;27(4):627-634. doi:10.1007/s00334-017-0646-7

18. McPartland JM, Guy GW, Hegman W. Cannabis is indigenous to Europe and cultivation began during the Copper or Bronze age: a probabilistic synthesis of fossil pollen studies. *Vegetation History and Archaeobotany*. 2018;27(4):635-648. doi:10.1007/s00334-018-0678-7

19. Kanabus J, Bryła M, Roszko M, Modrzewska M, Pierzgalski A. Cannabinoids—Characteristics and Potential for Use in Food Production. *Molecules*. 2021;26(21):6723. doi:10.3390/molecules26216723

20. Laverty KU, Stout JM, Sullivan MJ, et al. A physical and genetic map of Cannabis sativa identifies extensive rearrangements at the THC/CBD acid synthase loci. *Genome Res.* Jan 2019;29(1):146-156. doi:10.1101/gr.242594.118

21. Mareck U, Fusshöller G, Schertel T, Petring S, Huestis MA, Thevis M. Risk of unintentional antidoping rule violations by consumption of hemp products. *Drug Testing and Analysis*. 2023;15(1):27-41. doi:10.1002/dta.3327

22. Alger BE. Getting high on the endocannabinoid system. *Cerebrum*. Nov 2013;2013:14.

23. Taura F, Sirikantaramas S, Shoyama Y, Yoshikai K, Shoyama Y, Morimoto S. Cannabidiolic-acid synthase, the chemotype-determining enzyme in the fiber-type<i>Cannabis sativa</i>. *FEBS Lett.* 2007;581(16):2929-2934. doi:10.1016/j.febslet.2007.05.043

24. Jastrząb A, Jarocka-Karpowicz I, Skrzydlewska E. The Origin and Biomedical Relevance of Cannabigerol. *Int J Mol Sci*. 2022;23(14):7929. doi:10.3390/ijms23147929

25. Lu H-C, Mackie K. An Introduction to the Endogenous Cannabinoid System. *Biol Psychiatry*. 2016;79(7):516-525. doi:10.1016/j.biopsych.2015.07.028

26. Hazekamp A. The Trouble with CBD Oil. *Medical Cannabis and Cannabinoids*. 2018;1(1):65-72. doi:10.1159/000489287

27. Martinez Ramirez CE, Ruiz-Perez G, Stollenwerk TM, Behlke C, Doherty A, Hillard CJ. Endocannabinoid signaling in the central nervous system. *Glia*. Jan 2023;71(1):5-35. doi:10.1002/glia.24280

28. Wu J. Cannabis, cannabinoid receptors, and endocannabinoid system: yesterday, today, and tomorrow. *Acta Pharmacol Sin*. Mar 2019;40(3):297-299. doi:10.1038/s41401-019-0210-3

29. Turcotte C, Blanchet M-R, Laviolette M, Flamand N. The CB2 receptor and its role as a regulator of inflammation. *Cellular and Molecular Life Sciences*. 2016;73(23):4449-4470. doi:10.1007/s00018-016-2300-4

30. Stella N. Endocannabinoid signaling in microglial cells. *Neuropharmacology*. 2009;56:244-253. doi:10.1016/j.neuropharm.2008.07.037

31. Lauckner JE, Jensen JB, Chen H-Y, Lu H-C, Hille B, Mackie K. GPR55 is a cannabinoid receptor that increases intracellular calcium and inhibits M current. *Proceedings of the National Academy of Sciences*. 2008;105(7):2699-2704. doi:10.1073/pnas.0711278105

32. Dainese E, Oddi S, Simonetti M, et al. The endocannabinoid hydrolase FAAH is an allosteric enzyme. *Sci Rep*. 2020;10(1)doi:10.1038/s41598-020-59120-1

33. White CM. A Review of Human Studies Assessing Cannabidiol's (CBD) Therapeutic Actions and Potential. *J Clin Pharmacol*. Jul 2019;59(7):923-934. doi:10.1002/jcph.1387

34. Stinchcomb AL, Valiveti S, Hammell DC, Ramsey DR. Human skin permeation of Δ8-tetrahydrocannabinol, cannabidiol and cannabinol. *Journal of Pharmacy and Pharmacology*. 2010;56(3):291-297. doi:10.1211/0022357022791

35. Lucas CJ, Galettis P, Schneider J. The pharmacokinetics and the pharmacodynamics of cannabinoids. *Br J Clin Pharmacol*. 2018;84(11):2477-2482. doi:10.1111/bcp.13710

36. Millar SA, Stone NL, Yates AS, O'Sullivan SE. A Systematic Review on the Pharmacokinetics of Cannabidiol in Humans. *Front Pharmacol.* 2018;9:1365. doi:10.3389/fphar.2018.01365

37. Peng J, Fan M, An C, Ni F, Huang W, Luo J. A narrative review of molecular mechanism and therapeutic effect of cannabidiol (CBD). *Basic Clin Pharmacol Toxicol*. 2022;130(4):439-456. doi:10.1111/bcpt.13710

38. Bhattacharyya S, Morrison PD, Fusar-Poli P, et al. Opposite effects of delta-9tetrahydrocannabinol and cannabidiol on human brain function and psychopathology. *Neuropsychopharmacology*. Feb 2010;35(3):764-74. doi:10.1038/npp.2009.184 39. Hampson AJ, Grimaldi M, Axelrod J, Wink D. Cannabidiol and (–)Δ <sup>9</sup> - tetrahydrocannabinol are neuroprotective antioxidants. *Proceedings of the National Academy of Sciences*. 1998;95(14):8268-8273. doi:10.1073/pnas.95.14.8268

40. Johnson E, Kilgore M, Babalonis S. Cannabidiol (CBD) product contamination: Quantitative analysis of Delta(9)-tetrahydrocannabinol (Delta(9)-THC) concentrations found in commercially available CBD products. *Drug Alcohol Depend*. Aug 1 2022;237:109522. doi:10.1016/j.drugalcdep.2022.109522

41. Devinsky O, Cross JH, Laux L, et al. Trial of Cannabidiol for Drug-Resistant Seizures in the Dravet Syndrome. *New England Journal of Medicine*. 2017;376(21):2011-2020. doi:10.1056/nejmoa1611618

42. Zeiger JS, Silvers WS, Fleegler EM, Zeiger RS. Cannabis use in active athletes: Behaviors related to subjective effects. *PLoS One*. Jun 28 2019;14(6):e0218998. doi:10.1371/journal.pone.0218998

43. Deckey DG, Doan M, Hassebrock JD, et al. Prevalence of Cannabinoid (CBD) Use in Orthopaedic Sports Medicine Patients. *Orthop J Sports Med*. Apr 2022;10(4):23259671221087629. doi:10.1177/23259671221087629

44. Gamelin FX, Cuvelier G, Mendes A, et al. Cannabidiol in sport: Ergogenic or else? *Pharmacol Res.* Jun 2020;156:104764. doi:10.1016/j.phrs.2020.104764

45. Cochrane-Snyman KC, Cruz C, Morales J, Coles M. The Effects of Cannabidiol Oil on Noninvasive Measures of Muscle Damage in Men. *Med Sci Sports Exerc.* Jan 21 2021;doi:10.1249/MSS.00000000002606

46. McCartney D, Benson MJ, Desbrow B, Irwin C, Suraev A, McGregor IS. Cannabidiol and Sports Performance: a Narrative Review of Relevant Evidence and Recommendations for Future Research. *Sports Med Open*. Jul 6 2020;6(1):27. doi:10.1186/s40798-020-00251-0

47. Close GL, Gillham SH, Kasper AM. Cannabidiol (CBD) and the Athlete: Claims, Evidence, Prevalence and Safety Concerns. *Sports Science Exchange*. 2021;29(213):1-7.

48. Millar SA, Stone NL, Bellman ZD, Yates AS, England TJ, O'Sullivan SE. A systematic review of cannabidiol dosing in clinical populations. *Br J Clin Pharmacol*. 2019;85(9):1888-1900. doi:10.1111/bcp.14038

49. McDuff DR, Garvin M, Joy C, Thompson D. Substance Misuse in Elite Athletes: Early Detection, Brief Intervention and Referral to Treatment. *Clin Sports Med.* Jan 2024;43(1):127-144. doi:10.1016/j.csm.2023.06.008

50. Eysenbach G. Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res.* 2004;6(3):e34. doi:10.2196/jmir.6.3.e34

51. Zeiger JS, Silvers WS, Fleegler EM, Zeiger RS. Age related differences in cannabis use and subjective effects in a large population-based survey of adult athletes. *Journal of Cannabis Research*. 2019;1(1)doi:10.1186/s42238-019-0006-9

52. Crossland BW, Rigby BR, Duplanty AA, et al. Acute Supplementation with Cannabidiol Does Not Attenuate Inflammation or Improve Measures of Performance following Strenuous Exercise. *Healthcare*. 2022;10(6):1133. doi:10.3390/healthcare10061133
#### Appendix A. Survey Instrument – English Version

#### McGill Cannabidiol (CBD) Questionnaire

#### Probing The Use of Cannabidiol (CBD) by Elite-Level Athletes in Canada

52 Questions Survey

#### Section A. Athlete information

#### 1. What is your age? \*

Please write your answer here:

#### 2. What is your sex assigned at birth? \*

(e.g. male, female, prefer not to disclose etc.)

Please write your answer here:

#### 3. What is your current gender identity? \*

#### (e.g. man, woman, transgender, other)

Please write your answer here:

#### 4. What level do you compete at? \*

Please choose all that apply:

- O Provincial
- O National
- O International level/Olympic

#### 5. Do you compete in USport? \*

Please choose only one of the following:

- O Yes
- O No
- O Do not know

6. Are you receiving sport science support and/or medical support through either a Canadian Sport Institute, l'Institut National du Sport du Québec or a Canadian Sport Centre? \*

Please choose only one of the following:

- O Yes
- O No

#### 7. How are you receiving funding for your sport? \*

Please choose **all** that apply:

- O I am supporting myself
- O I am a government sponsored athlete
- O I am a corporate sponsored individual athlete
- O I am a part of a corporate sponsored team
- O I am a professional athlete

#### 8. Are you a Para sport athlete? \*

Please choose only one of the following:

O Yes

O No

#### 9. What is the primary sport you compete in? \*

Please write your answer here:

#### 10. Do you compete in any other sports? \*

(Based on your answer choice, certain subsequent questions may or may not be presented) [Skip logic: Show question 11 if the athlete answers "Yes" on question 10]

Please choose **only one** of the following:

O Yes

O No

#### 11. What other sports do you compete in?

(If you compete in multiple sports, separate the sports with a comma)

[Skip logic: See question 10]

Please write your answer here:

#### 12. How many people do you usually train with? \*

Please choose only one of the following:

O None (I train alone)

- O 1
- O 2
- O 3
- 04
- O 5
- 06
- 07
- O 8

09

O 10 or more

#### Section B. Knowledge about CBD

13. Have you ever heard of Cannabidiol (CBD) prior to filling out this survey? \* (Based on your answer choice, certain subsequent questions may or may not be presented) [Skip logic: Show question 14 if the athlete answers "Yes" on question 13]

Please choose only one of the following:

O Yes

O No

#### 14. How did you first hear of Cannabidiol (CBD)? \*

(Based on your answer choice, certain subsequent questions may or may not be presented) [Skip logic: See question 13]

**[Skip logic:** Show question 15 if the athlete answers "Internet" on question 14] Please choose **all** that apply:

- O Internet (e.g., social media, news media, or advertisement)
- O Nutritionist/dietitian
- O Physician
- O Other practitioner (e.g., massage therapist, physiotherapist, chiropractor)
- O A friend
- O Another teammate
- O Another athlete
- O Family member
- O Coach
- O Other (please specify)

### 15. If you heard about Cannabidiol (CBD) on the internet, which source did you hear about it from?

[Skip logic: See question 14]

Please choose **all** that apply:

O News media (e.g., cbc.ca)

O Blog

- O Forum (e.g., Reddit)
- O Social media (e.g., Facebook, Instagram)
- O Internet advertisement

#### Section C. CBD consumption

#### 16. Have you ever used Cannabidiol (CBD)? \*

(Based on your answer choice, certain subsequent questions may or may not be presented) [Skip logic: Show questions 17 to 42 if the athlete answers "Yes" on question 16]

Please choose only one of the following:

O Yes

O No

#### 17. Are you currently using Cannabidiol (CBD)? \*

[Skip logic: See question 16]

Please choose only one of the following:

O Yes

O No

#### 18. How long have/did you use(d) Cannabidiol (CBD) for? \*

(e.g., 1 year and 6 months) [Skip logic: See question 16] Please write your answer here:

## 19. If you used Cannabidiol (CBD) in the past, and either stopped completely or stopped for a period of time, what was the reason(s) for you discontinuing use? \*

[Skip logic: See question 16]

- Please choose **all** that apply:
- O Too expensive
- O Worried about a doping violation
- O Not effective
- O Didn't need it
- O Experienced negative side effects
- O Was told to discontinue use
- O I have never discontinued the use of CBD
- O Other (please specify)

20. If you do/did use Cannabidiol (CBD), did you inform a member of your integrated support team, sport support team or health care team? \*

[Skip logic: See question 16]

Please choose **only one** of the following:

- O Yes
- O No
- O I do not have an integrated support team

#### 21. Did you document your Cannabidiol (CBD) use? \*

[Skip logic: See question 16]

Please choose **only one** of the following:

O Yes

O No

#### 22. How do/did you obtain Cannabidiol (CBD)?

[Skip logic: See question 16]

Please choose **all** that apply:

O From a friend / family member

- O From a teammate
- O From a Health Canada approved retailer
- O From a heath care facility/prescription (e.g., pharmacy, clinic)
- O Online through a provincial retailer
- O Online through another source
- O Other (please specify)

#### 23. When during your competition cycle do/did you take Cannabidiol (CBD)? \*

[Skip logic: See question 16]

Please choose **only one** of the following:

O In season, outside of competition

- O In season, during competition
- O Off season
- O Other (please specify)

#### 24. In relation to your training, when do/did you typically consume Cannabidiol (CBD)? \*

[Skip logic: See question 16]

Please choose **all** that apply:

O Before training

- O During training
- O After training
- O In the evening prior to going to bed
- O Other (please specify)

### 25. If you do/did use Cannabidiol (CBD) during competition, how do you feel it affected your performance? It made my performance... \*

[Skip logic: See question 16]

Please choose **only one** of the following:

- O Much better
- O Slightly better
- O About the same
- O Slightly worse
- O Much worse

### 26. In the following questions we are interested in your REASONS for taking Cannabidiol (CBD). For each statement, you take/took Cannabidiol (CBD) to: \* **[Skip logic:** See question 16] Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Agree	Strongly Agree
To improve my sleep	0	0	0	0
To enhance physical recovery from training/competition	0	0	0	0
To enhance mental recovery from training/competition	0	0	0	0
To reduce acute pain from competition	0	0	0	0
To become more competitive (or to remain competitive) in my sport	0	0	0	0
To reduce pain from training	0	0	0	Ο
To reduce anxiety	0	0	0	0
To reduce feelings of depression	0	0	0	Ο
To improve physical performance	0	0	0	0
To improve focus/mental performance	0	0	0	0
To improve relaxation	0	0	0	0

### 27. If any, what other potential benefit(s) beyond those listed in question 26, have you experienced while using Cannabidiol (CBD)?

[Skip logic: See question 16] Please write your answer here:

### 28. If you have taken Cannabidiol (CBD), please indicate your level of agreement with the following statements: \*

[Skip logic: See question 16]

Please choose the appropriate response for each item:

i

	Strongly Disagree	Disagree	Agree	Strongly Agree
I have/had benefits from taking Cannabidiol (CBD)	0	0	0	0
I think Cannabidiol (CBD) is relatively safe to use	0	0	0	0
I will likely continue to use Cannabidiol (CBD) in the future	0	0	0	0
l'm looking at Cannabidiol (CBD) as an alternative to pain medications (e.g., Ibuprofen, Tylenol) due to concerns over their side effect	0	0	0	0
I am worried about anti-doping violations with cannabis products like Cannabidiol (CBD)	0	0	0	0
Although not a banned substance, I am reluctant to disclose my Cannabidiol (CBD) use	0	0	0	0

#### 29. At what age did you start taking Cannabidiol (CBD)? \*

[Skip logic: See question 16]

Please write your answer here:

#### 30. How many times per month do you/did you use Cannabidiol (CBD)? \*

**[Skip logic:** See question 16] Please choose only one of the following:

O Less than once, on average

- O 1
- O 2
- O 3
- O 4
- O 5
- O 6
- Ο7
- O 8
- Ο9
- O 10
- O 11
- O 12
- O 13
- O 14
- O 15
- O 16
- O 17
- O 18
- O 19
- O 20
- O 21
- O 22
- O 23
- O 24

O 25

- O 26
- O 27
- O 28
- O 29
- O 30
- O Over 30 times
- O Other (please specify)

#### 31. How many times a day do/did you take Cannabidiol (CBD) at most? \*

[Skip logic: See question 16]

Please choose only one of the following:

- O Once daily
- O Twice daily
- O Three times daily
- O Four times or more each day

#### 32. How frequently do you take Cannabidiol (CBD)?

[Skip logic: See question 16]

Please choose **only one** of the following:

- O A few days at a time
- O A few weeks at a time
- O A few months at a time
- O Almost always
- O On and off / inconsistently
- O Other (please specify) \_

#### 33. What brand(s) of Cannabidiol (CBD) have you used? \*

(If multiple, separate by a comma)

**[Skip logic:** See question 16] Please write your answer here:

34. To your knowledge, are all the brand(s) of Cannabidiol (CBD) product(s) you use "third-party" batch-tested (e.g., by NSF, Informed Sport, or Informed Choice) for contamination with other prohibited substances? \*

[Skip logic: See question 16]

Please choose **only one** of the following:

- O Yes
- O No
- O Some are, and other aren't
- O I do not know
- O Other (please specify)

### 35. How do/did you use Cannabidiol (CBD)? \*

[Skip logic: See question 16]

Please choose **all** that apply:

- O Inhalation (e.g., dry herb, vaporizer, concentrates)
- O Tincture/Oil
- O Softgels/Capsules
- O Confectionary/Edible
- O Specific Sport Supplement with CBD
- O Beverage
- O Topical (e.g., cream)
- O Other (please specify)

### 36. How much do/did you typically spend on Cannabidiol (CBD) products every month (all amounts are in Canadian dollar)? \*

[Skip logic: See question 16]

Please choose **only one** of the following:

O Less than \$10

- O \$10 \$20
- \$20 \$50
- \$ 50 \$100
- O Over \$100
- O Not sure

#### 37. What dose of Cannabidiol (CBD) did/do you take at a time? \*

[Skip logic: See question 16]

Please choose **only one** of the following:

- O Less than 5 mg
- O 5-10 mg
- O 10-20 mg
- O 20-50 mg
- O 50-100 mg
- O Over 100 mg
- O Not sure
- O Other (please specify)

38. How sure are you that this is the optimal dose of Cannabidiol (CBD) for you? \*

[Skip logic: See question 16]

Please choose only one of the following:

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0	0	0	0	0	0	0	0	0	0	0

#### 39. How did you determine the dose of Cannabidiol (CBD) you took/take? \*

[Skip logic: See question 16] Please choose all that apply:

- O Trial and error
- O Internet
- O Package labelling
- O Professional guidelines through a practitioner
- O Never found an effective dose
- O Other (please specify)

### 40. How often did you/do you experience adverse effect(s) from your use of Cannabidiol (CBD)? \*

(Based on your answer choice, certain subsequent questions may or may not be presented) [Skip logic: See question 16]

**[Skip logic:** Do not show questions 41 and 42 if the athlete answers "Never" on question 40] Please choose **only one** of the following:

Never	Rarely	Sometimes	Often	Always
0	0	0	0	0

#### 41. What side effect(s) did you experience? \*

[Skip logic: See question 16] [Skip logic: See question 40] Please choose all that apply:

- O Dizziness
- O Dry mouth
- O Diarrhea
- O Reduced appetite
- O Drowsiness/fatigue
- O Gastrointestinal side effects
- O Other (please specify)

### 42. Please read each statement and decide the extent to which you agree or disagree: \*

[Skip logic: See question 16] [Skip logic: See question 40] Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Agree	Strongly Agree
I had significant side effects from taking Cannabidiol (CBD)	0	0	0	0
The side effects from taking Cannabidiol (CBD) were bothersome	0	0	0	0
The positive effects of taking Cannabidiol (CBD) outweigh the negative effects	0	0	0	0
I do not intend to take Cannabidiol (CBD) again due to the side effects	0	0	0	0

#### Section D. Assumptions about CBD use

#### 43. Which of these would be reasons for you not to take Cannabidiol (CBD)?

Please choose **all** that apply:

- O Do not see a need for it
- O Do not know enough about it
- O Concerned about anti-doping violation
- O Not aware of the possible benefits
- O Was advised against it
- O Expensive
- O I don't see any reason not to take CBD
- O Other (please specify)

### 44. How likely is it that you will start, restart, or continue to use use Cannabidiol (CBD) within the next 12 months? \*

Please choose only one of the following:

Very unlikely	Unlikely	Likely	Very likely
0	0	0	0

### 45. How many of your teammates/people in your training group do you think use Cannabidiol (CBD)? \*

Please choose only one of the following:

None	Very few	Some	Many	Most
0	0	0	0	0

**46.** How many of your competitors do you think use Cannabidiol (CBD)? \* Please choose only one of the following:

None	Very few	Some	Many	Most
0	0	0	0	0

## 47. How many people at the highest level of your sport (i.e. people who compete internationally) do you think use Cannabidiol (CBD)? \*

Please choose only one of the following:

None	Very few	Some	Many	Most
0	0	0	0	0

## 48. For each of the following, indicate how often Cannabidiol (CBD) is discussed $^{\ast}$

Please choose the appropriate response for each item:

	Never	Rarely	Sometimes	Often	Always
How often do you talk about Cannabidiol (CBD) with your teammates?	0	0	0	0	0
How often do you talk about Cannabidiol (CBD) with your coach?	0	0	0	0	Ο
How often do you talk about Cannabidiol (CBD) with members of your integrated support team?	0	0	0	0	0

### 49. Consider each of the following scenarios. How likely is it that you would start, continue, or increase the use of Cannabidiol (CBD) if... \* Please choose the appropriate response for each item:

	Very unlikely	Unlikely	Likely	Very likely
It was prescribed/encouraged by my coach	Ο	0	0	0
It was prescribed/encouraged by my nutritionist	Ο	0	Ο	0
It was prescribed/encouraged by my sports medicine doctor	0	0	0	Ο
It had been tested and confirmed to be free from banned substances (e.g., by NSF, Informed Sport, or Informed Choice)	0	0	Ο	0
It was confirmed by researchers to be safe	0	0	0	0
It was more affordable	0	0	0	Ο
It was more accessible	0	0	0	0
It was more acceptable by the sporting community	0	0	0	0
It was encouraged by a CBD company sponsor	0	0	0	0
The side effects were milder / more acceptable	0	0	0	0

## 50. What other scenarios would make you more likely to start using Cannabidiol (CBD)?

Please write your answer here:

## 51. The following are scenarios regarding Cannabidiol (CBD) research. Which scenarios do you think would lead to more widespread acceptance among athletes? \*

.

Please choose the appropriate response for each item:

	Very unlikely	Unlikely	Likely	Very likely
It was confirmed by researchers to be effective at improving recovery	0	0	0	0
It was confirmed by researchers to be effective at improving sleep	0	0	Ο	0
It was confirmed by researchers to be effective at improving exercise performance	0	0	0	0
It was confirmed by researchers to be effective at decreasing anxiety	0	0	0	0

#### Section E. Comments

### 52. Please include below any further comments in regard to Cannabidiol (CBD) that you may have:

Please write your answer here:

#### Appendix B. Survey Instrument – French Version

#### Questionnaire de McGill sur le Cannabidiol (CBD)

#### Étude de l'utilisation du Cannabidiol (CBD) par les athlètes d'élites au Canada

#### Sondage de 52 questions

#### Section A. Informations sur l'athlète

#### 1. Quel est votre âge? \*

Veuillez écrire votre réponse ici :

#### 2. Quel sexe vous a été attribué à la naissance? \*

(Ex. femme, homme, préfère ne pas dire, etc.) Veuillez écrire votre réponse ici :

#### 3. Quel est votre identité de genre actuelle? \*

#### (Ex. femme, homme, autre)

Veuillez écrire votre réponse ici:

#### 4. À quel niveau faites-vous de la compétition? \*

Veuillez choisir **toutes** les réponses qui s'appliquent:

- O Provincial
- O National
- O Niveau international/olympique

#### 5. Participez-vous à des compétitions de USport? \*

Veuillez sélectionner une seule des propositions suivantes :

O Oui

- O Non
- O Ne sais pas

#### 6. Recevez-vous un soutien en sciences du sport et/ou un soutien médical par l'intermédiaire de l'Institut Canadienne du Sport, de l'Institut National du Sport du Québec ou d'un Centre Canadien du Sport? \*

Veuillez sélectionner une seule des propositions suivantes :

- O Oui
- O Non

#### 7. Comment recevez-vous du financement pour votre sport? \*

Veuillez choisir toutes les réponses qui s'appliquent:

- O Je me finance moi-même
- O Je suis un athlète parrainé par le gouvernement
- O Je suis un athlète individuel parrainé par une entreprise
- O Je fais partie d'une équipe sponsorisée par une entreprise
- O Je suis un athlète professionnel

#### 8. Êtes-vous un Para athlète? \*

Veuillez sélectionner une seule des propositions suivantes :

O Oui

O Non

#### 9. Quel est le principal sport que vous pratiquez en compétition? \*

Veuillez écrire votre réponse ici:

#### 10. Pratiquez-vous d'autres sports en compétition? \*

(Selon votre choix de réponse, certaines questions subséquentes peuvent apparaître ou non) [Skip logic: Montrer la question 11 si l'athlète répond « Oui » à la question 10]

Veuillez sélectionner **une seule** des propositions suivantes :

O Oui

O Non

#### 11. Quels autres sports pratiquez-vous en compétition?

(S'il y a plusieurs sports, séparer chacun des sports avec des virgules)

[Skip logic: Voir question 10] Veuillez écrire votre réponse ici:

#### 12. Avec combien de personnes vous entraînez-vous habituellement? \*

Veuillez sélectionner une seule des propositions suivantes :

O Zéro (je m'entraîne seul)

O 1

- O 2
- Ο3
- Ο4
- O 5
- O 6
- Ο7
- 0 8
- O 9

O 10 et plus

#### Section B. Connaissances sur le CBD

### 13. Aviez-vous déjà entendu parler du Cannabidiol (CBD) avant de remplir ce questionnaire? \*

(Selon votre choix de réponse, certaines questions subséquentes peuvent apparaître ou non) [Skip logic: Montrer la question 14 si l'athlète répond « Oui » à la question 13] Veuillez sélectionner une seule des propositions suivantes :

- O Oui
- O Non

#### 14. Comment avez-vous entendu parler du Cannabidiol (CBD)? \*

(Selon votre choix de réponse, certaines questions subséquentes peuvent apparaître ou non) [Skip logic: Voir question 13]

**[Skip logic:** Montrer la question 15 si l'athlète répond « Internet » à la question 14**]** Veuillez choisir **toutes** les réponses qui s'appliquent:

O Internet (i.e., les médias sociaux, les médias d'information, ou la publicité)

- O Nutritionniste / Diététicien(ne)
- O Médecin
- O Autre praticien (Ex. massothérapeute, physiothérapeute, chiropraticien)
- O Ami(e)
- O Coéquipier / Coéquipière
- O Autre athlète
- O Membre de la famille
- O Entraineur
- O Autre (veuillez préciser)

### 15. Si vous avez entendu parler du Cannabidiol (CBD) sur internet, quelle source avez-vous consulté?

#### [Skip logic: Voir question 14]

Veuillez choisir toutes les réponses qui s'appliquent:

- O Nouvelles (Ex. cbc.ca)
- O Blogue
- O Forum (Ex. Reddit)
- O Médias sociaux (Ex. Facebook, Instagram)
- O Annonce publicitaire sur Internet

#### Section C. Consommation du CBD

#### 16. Avez-vous déjà utilisé du Cannabidiol (CBD)?

(Selon votre choix de réponse, certaines questions subséquentes peuvent apparaître ou non) [Skip logic: Montrer les questions 17 à 42 si l'athlète répond « Oui » à la question 16]

Veuillez sélectionner une seule des propositions suivantes :

O Oui

O Non

#### 17. Utilisez-vous actuellement du Cannabidiol (CBD)? \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

O Oui

O Non

#### 18. Depuis combien de temps utilisez-vous du Cannabidiol (CBD)? \*

(ex. 1 an et 6 mois) [Skip logic: Voir question 16] Veuillez écrire votre réponse ici:

#### 19. Si vous étiez utilisateur du Cannabidiol (CBD) dans le passé et avez soit arrêté l'usage complètement ou arrêté pour une période de temps, quelles sont les raisons de votre arrêt? \*

[Skip logic: Voir question 16]

Veuillez choisir **toutes** les réponses qui s'appliquent:

O Trop dispendieux

- O Inquiétudes concernant la violation des règles antidopage
- O Pas efficace
- O Pas besoin
- O Subi des effets secondaires négatifs
- O On m'a recommandé de discontinuer l'usage
- O Je n'ai jamais cesser l'usage du CBD
- O Autre (veuillez préciser)

20. Si vous utilisez/avez utilisé du Cannabidiol (CBD), avez-vous informé un membre de votre équipe de soutien intégré, de votre équipe de soutien sportif ou de votre équipe de soins de santé? \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Oui
- O Non
- O Je n'ai pas d'équipe de soutien intégré

#### 21. Avez-vous documenté votre consommation de Cannabidiol (CBD)? \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Oui
- O Non

#### 22. Comment obtenez-vous ou avez-vous obtenu du Cannabidiol (CBD)? \*

[Skip logic: Voir question 16]

Veuillez choisir **toutes** les réponses qui s'appliquent:

- O D'un ami / membre de la famille
- O D'un(e) coéquipier / coéquipière
- O D'un détaillant approuvé par Santé Canada
- O D'un établissement de soins de santé ou d'une ordonnance (Ex. pharmacie, clinique)
- O En ligne chez un détaillant provincial
- O En ligne par une autre source
- O Autre (veuillez préciser)

### 23. Durant vos cycles de compétition, quand prenez-vous ou avez-vous pris du Cannabidiol (CBD)? \*

#### [Skip logic: Voir question 16]

Veuillez choisir toutes les réponses qui s'appliquent:

- O En saison, hors compétition
- O En saison, pendant la compétition
- O Hors saison
- O Autre (veuillez préciser) \_\_\_\_\_

### 24. Dans le cadre de votre entraînement, quand consommez-vous ou avez-vous consommé du Cannabidiol (CBD)? \*

[Skip logic: Voir question 16]

Veuillez choisir toutes les réponses qui s'appliquent:

- O Avant l'entraînement
- O Pendant l'entraînement
- O Après l'entraînement
- O Le soir avant d'aller au lit
- O Autre (veuillez préciser)

## 25. Si vous utilisez ou avez utilisé du Cannabidiol (CBD) pendant la compétition, comment pensez-vous que cela a affecté votre performance ? Ma performance a été... \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Beaucoup meilleure
- O Un peu meilleure
- O Semblablement la même
- O Plus pire
- O Beaucoup plus pire

# 26. Dans les questions suivantes, nous nous intéressons aux RAISONS pour lesquelles vous prenez du Cannabidiol (CBD). Pour chaque affirmation, vous prenez/avez pris du Cannabidiol (CBD):

[Skip logic: Voir question 16]

Choisissez la réponse appropriée pour chaque élément :

	Fortement en désaccord	En désaccord	En accord	Fortement en accord
Pour améliorer mon sommeil	0	0	0	0
Pour améliorer la récupération physique après un entraînement ou une compétition	0	0	0	0
Pour améliorer la récupération mentale après un entraînement/une compétition	0	Ο	0	0
Pour réduire la douleur aiguë de la compétition	0	Ο	0	0
Pour devenir plus compétitif (ou rester compétitif) dans mon sport	0	Ο	0	0
Pour réduire les douleurs d'entrainement	0	0	0	0
Pour réduire l'anxiété	0	0	0	0
Pour réduire les sensations de dépression	0	0	0	0
Pour améliorer la performance physique	0	0	0	0
Pour améliorer ma concentration/performance mentale	0	0	0	0
Pour améliorer la relaxation	0	Ο	0	0

### 27. Si présent, quel(s) autre(s) bénéfice(s), en dehors de ceux énumérés dans la question 26, avez-vous constaté en utilisant le Cannabidiol (CBD)?

**[Skip logic:** Voir question 16] Veuillez écrire votre réponse ici:

### 28. Si vous avez pris du Cannabidiol (CBD), veuillez indiquer votre degré d'accord avec les déclarations suivantes :

[Skip logic: Voir question 16]

Choisissez la réponse appropriée pour chaque élément :

	Fortement en désaccord	En désaccord	En accord	Fortement en accord
J'ai / j'avais des bénéfices en prenant du Cannabidiol (CBD)	0	0	Ο	0
Je pense que l'usage du Cannabidiol (CBD) est relativement sûr, autrement dit sans danger}	0	0	0	0
Je vais probablement continuer à utiliser du Cannabidiol (CBD) à l'avenir	0	0	0	0
Je considère le Cannabidiol (CBD) comme une alternative aux médicaments contre la douleur (e.g., Ibuprofen, Tylenol) due à de l'inquiétude concernant leurs effets secondaires	0	0	0	0
Je m'inquiète des violations des règles antidopage avec les produits à base de cannabis comme le Cannabidiol (CBD)	0	0	Ο	0
Bien qu'il ne s'agisse pas d'une substance interdite, je suis réticent à divulguer ma consommation de Cannabidiol (CBD)	0	0	0	0

29. À quel âge avez-vous commencé à prendre du Cannabidiol (CBD)? \*

[Skip logic: Voir question 16] Veuillez écrire votre réponse ici:

#### 30. Combien de fois par mois utilisez-vous/avez-vous utilisé du Cannabidiol (CBD)? \*

**[Skip logic:** Voir question 16] Veuillez sélectionner **une seule** des propositions suivantes :

O Moins qu'une fois, en moyenne

- O 1
- O 2
- O 3
- O 4
- O 5
- O 6
- Ο7
- O 8
- Ο9
- O 10
- O 11
- O 12
- O 13
- O 14
- O 15
- O 16
- O 17
- O 18
- O 19
- O 20
- O 21
- O 22
- O 23
- O 24
- O 25
- O 26
- O 27
- O 28
- O 29
- O 30
- O Plus que 30 fois
- O Autre (veuillez préciser)

132

### 31. Combien de fois par jour prenez-vous/avez-vous pris du Cannabidiol (CBD) au plus? \*

#### [Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Une fois par jour
- O Deux fois par jour
- O Trois fois par jour
- O Quatre fois ou plus, par jour

#### 32. À quelle fréquence consommez-vous du Cannabidiol (CBD)? \*

#### [Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Quelques jours à la fois
- O Quelques semaines à la fois
- O Quelques mois à la fois
- O Presque toujours
- O Par intermittence / de façon irrégulière
- O Autre (veuillez préciser) \_\_\_\_\_

#### 33. Quelle(s) marque(s) de Cannabidiol (CBD) avez-vous utilisée? \*

(Si plusieurs, séparer avec des virgules)

**[Skip logic:** Voir question 16] Veuillez écrire votre réponse ici:

34. Selon vous, toutes les marque(s) de produit(s) de Cannabidiol (CBD) que vous utilisez ont-elles fait l'objet d'un contrôle de lot par une tierce partie (Ex. par NSF, Informed Sport, ou Informed Choice) pour détecter toute contamination par d'autres substances interdites? \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

O Oui

- O Non
- O Certains oui, et d'autres non
- O Je ne sais pas
- O Autre (veuillez préciser) \_\_\_\_\_

#### 35. Comment utilisez-vous/avez-vous utilisé le Cannabidiol (CBD)? \*

[Skip logic: Voir question 16]

Veuillez choisir toutes les réponses qui s'appliquent:

- O Inhalation (Ex. herbe sèche, vaporisateur, concentrés)
- O Teinture/Huile
- O Gélules/Capsules
- O Confiserie/Comestible « Edible »
- O Supplément sportif spécifique avec CBD
- O Boisson
- O Topique (ex. crème)
- O Autre (veuillez préciser) \_\_\_\_\_

## 36. Combien dépensez-vous habituellement /avez-vous dépensé en produits à base de Cannabidiol (CBD) chaque mois (tous les montants sont en dollar Canadien)? \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Moins que 10\$
- O 10\$-20\$
- O 20\$-50\$
- O 50\$-100\$
- O Plus que 100\$
- O Pas certain(e)

#### 37. Quelle dose de Cannabidiol (CBD) avez-vous pris/prenez-vous à la fois? \*

#### [Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

- O Moins que 5 mg
- O 5-10 mg
- O 10-20 mg
- O 20-50 mg
- O 50-100 mg
- O Plus que 100 mg
- O Pas certain(e)
- O Autre (veuillez préciser)

### 38. Combien êtes-vous certain que c'est la dose optimale de Cannabidiol (CBD) pour vous? \*

[Skip logic: Voir question 16]

Veuillez sélectionner une seule des propositions suivantes :

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0	0	0	0	0	0	0	0	0	0	0

### 39. Comment avez-vous déterminé la dose de Cannabidiol (CBD) que vous avez prise/pris? \*

[Skip logic: Voir question 16]

Veuillez choisir toutes les réponses qui s'appliquent:

O Essai et erreur

- O Internet
- O Étiquetage de l'emballage
- O Directives professionnelles par l'intermédiaire d'un praticien
- O Jamais trouvé de dose efficace
- O Autre (veuillez préciser)

40. À quelle fréquence avez-vous ressenti ou ressentez-vous un ou des effets secondaires liés à votre consommation de Cannabidiol (CBD)? \*

(Selon votre choix de réponse, certaines questions subséquentes peuvent apparaître ou non) [Skip logic: Voir question 16]

**[Skip logic:** Ne pas montrer les question 41 et 42 si l'athlète répond « Jamais » à la question 40] Veuillez sélectionner **une seule** des propositions suivantes :

Jamais	Rarement	Occasionnellement	Souvent	Toujours
0	0	0	0	0

#### 41. Quel(s) effet(s) secondaire(s) avez-vous ressenti(s)? \*

[Skip logic: Voir question 16]

[Skip logic: Voir question 40]

Veuillez choisir **toutes** les réponses qui s'appliquent:

- O Vertiges
- O Sécheresse de la bouche
- O Diarrhée
- O Diminution de l'appétit
- O Somnolence/fatigue
- O Effets secondaires gastro-intestinaux
- O Autre (veuillez préciser)

## 42. Veuillez lire chaque affirmation et décider dans quelle mesure vous êtes d'accord ou non : \*

**[Skip logic:** Voir question 16] **[Skip logic:** Voir question 40] Choisissez la réponse appropriée pour chaque élément :

	Fortement en désaccord	En désaccord	En accord	Fortement en accord
J'ai eu des effets secondaires importants en prenant du Cannabidiol (CBD)	0	0	Ο	0
Les effets secondaires de la prise de Cannabidiol (CBD) étaient dérangeant	0	0	Ο	0
Les effets positifs de la prise de Cannabidiol (CBD) l'emportent sur les effets négatifs	0	0	0	0
Je n'ai pas l'intention de reprendre du Cannabidiol (CBD) à cause des effets secondaires	0	0	0	0

#### Section D. Hypothèses sur l'utilisation du CBD

#### 43. Lesquelles de ces raisons vous inciteraient à <u>ne pas prendre</u> ou <u>à cesser</u> <u>l'usage</u> du Cannabidiol (CBD)? \*

Veuillez choisir **toutes** les réponses qui s'appliquent:

- O Je n'en vois pas la nécessité ou le besoin
- O Je n'en sais pas assez sur le sujet
- O Je suis préoccupé par une violation des règles antidopage
- O Pas conscient des bénéfices possibles
- O On me l'a déconseillé
- O Coûteux
- O Je ne trouve pas de raison pour cesser l'usage du CBD
- O Autre (veuillez préciser)

### 44. Quelle est la probabilité que vous commencez, recommencez, ou continuez à utiliser du Cannabidiol (CBD) au cours des 12 prochains mois? \*

Veuillez sélectionner une seule des propositions suivantes :

Très improbable	Improbable	Probable	Très probable
0	0	0	0

### 45. Selon vous, combien de vos coéquipiers ou de personnes de votre groupe d'entraînement utilisent du Cannabidiol (CBD)? \*

Veuillez sélectionner **une seule** des propositions suivantes :

Aucun	Presque aucun	Quelques-uns	Plusieurs	La plupart
0	0	0	0	0

#### 46. Selon vous, combien de vos compétiteurs utilisent du Cannabidiol (CBD)? \*

Veuillez sélectionner une seule des propositions suivantes :

Aucun	Presque aucun	Quelques-uns	Plusieurs	La plupart
0	0	0	0	0

# 47. Selon vous, combien d'athlètes de haut niveau dans votre sport (c'est-à-dire des personnes qui participent à des compétitions internationales) utilisent du Cannabidiol (CBD)? \*

Veuillez sélectionner une seule des propositions suivantes :

Aucun	Presque aucun	Quelques-uns	Plusieurs	La plupart
0	0	0	0	0

### 48. Pour chacun des éléments suivants, indiquez à quelle fréquence le Cannabidiol (CBD) est discuté \* Choisissez la réponse appropriée pour chaque élément :

	Jamais	Rarement	Parfois	Souvent	Toujours
À quelle fréquence parlez- vous du Cannabidiol (CBD) avec vos coéquipiers ?	0	0	0	0	0
À quelle fréquence parlez- vous du Cannabidiol (CBD) avec votre entraineur/coach ?	0	0	0	0	0
À quelle fréquence parlez- vous du Cannabidiol (CBD) avec les membres de votre équipe de soutien intégré ?	Ο	0	0	Ο	0

# 49. Considérez chacun des scénarios suivants. Indiquez la probabilité que vous débutez, continuez, ou augmentez votre consommation du Cannabidiol (CBD) si... \* Choisissez la réponse appropriée pour chaque élément :

	Très improbable	Improbable	Probable	Très probable
Il a été prescrit/encouragé par mon entraîneur	Ο	0	0	0
Il a été prescrit/encouragé par mon nutritionniste	0	0	0	0
Il a été prescrit/encouragé par mon médecin du sport	0	0	0	0
Il a été testé et confirmé qu'il ne contient pas de substances interdites (e.g., par NSF, Informed Sport, ou Informed Choice)	0	0	0	0
Les chercheurs ont confirmé son innocuité (sans danger)	0	0	0	0
C'était plus abordable (\$)	0	0	0	0
C'était plus accessible	0	0	0	0
C'était plus accepte par la communauté sportive	0	0	0	0
Il a été encouragé par un sponsor de l'entreprise CBD	Ο	0	0	0
Les effets secondaires étaient plus légers / plus acceptables	0	0	0	0

### 50. Quels autres scénarios vous inciteraient à commencer la consommation du Cannabidiol (CBD)?

Veuillez écrire votre réponse ici:

#### 51. Les scénarios suivants concernent la recherche sur le Cannabidiol (CBD). Selon vous, quels scénarios conduiraient à une acceptation plus large parmi les athlètes? \*

Choisissez la réponse appropriée pour chaque élément :

	Très improbable	Improbable	Probable	Très probable
Les chercheurs ont confirmé son efficacité pour améliorer la récupération	Ο	0	0	0
Les chercheurs ont confirmé son efficacité pour améliorer le sommeil	Ο	0	0	0
Les chercheurs ont confirmé son efficacité pour améliorer la performance physique	0	0	0	Ο
Les chercheurs ont confirmé son efficacité pour réduire l'anxiété	0	0	0	0

#### Section E. Commentaires

52. Veuillez inclure ci-dessous tout autre commentaire concernant le Cannabidiol (CBD) que vous pourriez avoir :

Veuillez écrire votre réponse ici: