Workplace Safety Implications Associated with Cannabidiol (CBD) in the Workplace

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Abstract

This paper evaluates the perceived workplace safety implications and negative impacts associated with the use and/or consumption of cannabidiol- (CBD) products containing up to 0.3% tetrahydrocannabinol (THC). While cannabidiol has been around for decades, it has recently increased in popularity due to the various claims of health and wellness benefits by CBD manufacturers and distributors. However, due to a lack of federal regulations pertaining to over-the-counter (OTC) CBD products, many workers in the United States are unsure as to what may be involved with CBD products, particular while at work. This article reviews various workplace issues associated with CBD use and/or consumption, the perception of worst-case scenarios, and the overall understanding of CBD's chemical properties and characteristics. Based on the data, many people have mixed feelings and levels of understanding when it comes to CBD in the workplace – some saying that it's completely safe to use, whereas others feel that employers should be more conservative and implement restrictions. This paper will differentiate between what is perceived by the surveyed population versus what actually occurs when a person uses and/or consumes CBD-related products.

Index Terms— Cannabidiol, CBD, Workplace Safety

INTRODUCTION

As cannabidiol (CBD) products are becoming more popular across the United States due to their advertised therapeutic benefits, one thing that is lagging is the number of studies pertaining to the potential level of impairment caused when consuming these products. When workers who are in safety-sensitive functions use these products, impairment is not an option. While many CBD products advertise that their levels of delta 9-tetrahydrocannabinol (commonly referred to as "THC") are below the 0.3% threshold, only one CBD-related product is currently approved and regulated by the U.S. Food and Drug Administration, meaning you're taking a wild guess as to what the contents of the product truly are [42].

Statement of the Problem

This study will aim to determine the potential for impairment when employees in safety-sensitive functions are consuming CBD-related products with unverified levels of THC. While the U.S. Department of Transportation (DOT) clearly states that any level of THC is unacceptable, some companies allow employees to have up to the drug test threshold amount without any type of disciplinary action being initiated [37]. This relaxed stance due to the lack of definitive, published research can potentially lead to a work-related injury caused by the employee's impairment levels. Particularly, this study will try to address the following problems:

- Is there a measurable amount of impairment when human subjects consume cannabidiol (CBD) products containing delta 9-tetrahydrocannabinol (Δ9-THC)?
    - If so, is the measured impairment level significant enough to increase the risk of workplace accidents for employees in safety-sensitive functions?

- When consuming CBD products containing THC, how long after the consumption of the product will the highest level(s) of impairment be noticed?

According to a 2016 research study published in the *Journal of the American Medical Association*, 69% of the 84 CBD products analyzed from 31 different companies were mislabeled in regard to the actual CBD content, with only 31% of the products being accurately labeled. This, in turn, will cause additional areas of speculation since you may (or may not) know what is in your product [9]. In 2015, the National Institute of Health (NIH) published a paper stating "*While the existing data show promise, it is still too soon to tell whether and for whom CBD will be effective. Like most medical treatments, it doesn't seem to work for everyone*." [26]. This lack of beneficial information and research can lead to additional confusion and misunderstanding among the workforce when determining if a CBD-related product is considered safe, healthy, or compliant to use and/or consume.

THEORY

CBD products containing tetrahydrocannabinol (THC) can potentially be detected on a drug screen, giving businesses and organizations a negative stigma about CBD as a whole. The lack of understanding causes organizations to create inaccurate and/or misinforming policies pertaining to substance abuse. Some organizations may believe that CBD (both with and without THC) will cause mental and psychomotor impairment enough to cause concerns for employees in safety-sensitive positions. This stance could be partly due to a misunderstanding of the chemical structure of CBD, causing the layperson to believe it is similar to marijuana.

Due to the overwhelming level of uncertainty within the CBD industry in regard to label accuracy, potential side effects, and the risk of "failing" a drug test, this research will help provide guidance to employers, employees, and the general public about the risks they may be taking while consuming CBD products.

HYPOTHESIS

Null Hypothesis:
CBD-related products containing up to 0.3% THC pose a high risk of a work-related injury or illness.

Alternative Hypothesis:
CBD-related products containing up to 0.3% THC will not pose a higher risk of a work-related injury or illness.

SIGNIFICANCE OF THE STUDY

The amount of scientific studies in regard to impairment levels associated with the use of CBD-related products is very minimal. Of the results that have been published, it is difficult to determine the correlation between the various manufacturers who sell and market CBD products. The results of this study can be very beneficial for workers who are in safety-sensitive positions.

This study will improve the level of understanding associated with the general public's use of CBD-related products by explaining the correlation (or lack thereof) between CBD-related products and worker impairment levels. This study will be beneficial for workers in a variety of industries; however, it will be very insightful for those in industries where there is zero tolerance for any THC levels (such as with employees covered by U.S. Department of Transportation's federal drug and alcohol testing requirements).

The results of this study will be applicable to a variety of company roles. For company employees responsible for the administration of the company's drug testing program, this will allow them to better advise employees of the risks they may be taking by consuming CBD-related products. For employees covered by federal drug testing requirements, a positive drug test result can stay on an employee's record for several years, potentially preventing that person from getting hired by a potential employer. However, even if the levels of THC in the products are below the 0.3% threshold, the impairment levels will vary between test subjects due to several factors, such as the weight, age, and overall health of the test subjects.

Summary

CBD products have often been a controversial topic among people across the United States. Some of the reasoning may be due to lack of understanding, whereas other reasoning may be due to the lack of credible research. This research aims to provide the public with more information that can be understood and interpreted by the lay person, which will allow that person to make an informed decision in regard to taking CBD products, particularly those containing THC.

While the opioid crisis doesn't exclusively affect the construction industry, it has helped bring the opioid addiction issue to light for everyone to see the potency and potential risk(s) associated with opioid use, whether it is legally prescribed or illegal. There will always be the potential risk of an injury or illnesses, so being able to evaluate potential alternatives to opioids may reduce the addiction issue across the United States while helping the general public understand the toxicology and potential benefits of various CBD products containing legal amounts of THC.

In order for the results of this study to be effective and impact the largest population possible, the public needs to ensure they maintain an open mind and rely on the facts at hand, rather than public opinion that may be allowing confirmation bias to affect an organization's decision-making process. If an organization decides to allow the use of CBD products by employees, company policies and procedures need to be created in accordance with all applicable local, state, and federal regulations and guidelines. Contents of the policies and procedures implemented within an organization should include topics such as acceptable limits of THC (if any), the scope of the policies and procedures, and impairment detection methods.

LITERATURE REVIEW

History of Cannabidiol (CBD) Products

In recent years, CBD products have drawn a large amount of negative criticism due to the overall perception and relatedness to marijuana (also known as cannabis). However, many of the people who do not consume or otherwise use CBD-related products may not fully understand the chemical composition of CBD and how it relates to marijuana. While the two components have their similarities, they also have numerous differences that are noteworthy.

Marijuana, which has a wide variety of other names, is a species of plant that belongs to the cannabaceae (or hemp) family [36]. According to professors Oakley Ray and Charles Ksir , there are over 400 chemicals found in marijuana, but only 80 of them are considered unique to the cannabis plant. The 80 chemicals that are unique to the cannabis plant are known as cannabinoids [29]. One of the most popular and pharmacologically-active cannabinoids is delta 9-tetrahydrocannibinol (Δ^9-THC). THC is the main psychoactive chemical found in marijuana that is responsible for most of the mind-altering effects sought out by marijuana users [25].

Cannabidiol (CBD), on the other hand, is the second most prevalent active ingredient found in marijuana (cannabis). According to Peter Grinspoon, a medical doctor and professor at Harvard Medical School, claims that while CBD may be an essential component of medical marijuana, it is derived directly from the hemp

plant, which is a "cousin" of the marijuana plant [15]. This is where a large portion of the population develop the mentality that CBD is the same as marijuana. While they may be similar, the chemical composition is drastically different.

While many people believe that CBD is a relatively new line of products, they can actually be traced back to the 1940s. In 1940, Dr. Roger Adams was reported to have been the first person to successfully extract CBD from the cannabis plant while working at the University of Illinois. Adams' article, "Structure of Cannabidiol, a Product Isolated from the Marihuana Extract of Minnesota Wild Hemp", provides vast details about the chemical structure of this plant and how he was able to extract the new compound from the purified red oil of Cannabis sativa. While Adams was able to successfully isolate CBD through bis-3,5-dinitrobenzoate, at the time he was still unsure of the exact molecular formula, stating that it could either be $C_{21}H_{30}O_2$ or $C_{21}H_{32}O_2$ [1]. It would later be determined that both CBD and THC share the exact same molecular formula, $C_{21}H_{30}O_2$.

However, Adams' success wasn't noticed until 1946 when Dr. Walter S. Loewe conducted the first CBD test on lab animals and documented that there was not an altered mental status [27]. In that same year, Dr. Ralph Mechoulam, a chemist at the Hebrew University of Jerusalem, began research that identified the three-dimensional structure of CBD, which led to additional related research findings, including being able to isolate and identify THC for the first time, providing evidence that although they share the same molecular structure, CBD and THC were, in fact, two separate components.

Overall, very little research has been conducted on this topic and CBD product contents vary from one manufacturer to the next due to CBD products not being regulated by the U.S. Food and Drug Administration (FDA). This research will provide beneficial information for both the construction industry and the medical field in regard to safe uses of CBD products. The overall benefits of this research will be significant due to the lower risks associated with it compared to opioids, as well as a lower risk of addiction and lower product costs.

Prior Research Related to CBD Products Containing Delta 9-Tetrahydrocannabinol (Δ^9-THC)

According to the FDA, they have acknowledged the significant level of interest associated with utilizing CBD-related products for therapeutic use. However, they also note that there are numerous companies marketing products that contain cannabis or cannabis-derived compounds that violate the Federal Food, Drug and Cosmetic Act (FD&C Act), which may place consumers at risk of various health and safety concerns [43]. This stance and lack of support by the FDA has posed two distinctive views in recent years:

1. CBD products can be a beneficial therapeutic treatment alternative with little to no risks, and
2. CBD products pose too much of a risk for workers in safety-sensitive functions to consume without placing themself and/or others at risk of injury.

In late 2018, President Donald Trump signed the farm bill, which legalized hemp at the federal level, thus making it easier for farmers to cultivate the crop. According to the bill, hemp was defined as cannabis plants containing less than 0.3 percent THC, which also removed hemp from the U.S. Drug Enforcement Agency's (DEA) Schedule 1 classification (Congress.gov Staff, 2018). Since this bill was passed, the CBD market has skyrocketed across the United States, boosting interest from both famers and consumers. However as of January 2021, there is only one prescription drug containing CBD that is used to treat two rare forms of epilepsy that has been approved by the FDA [42].

In March 2020, the FDA posted a webpage containing facts about products containing cannabis or cannabis-derived compounds, including CBD. The FDA's website states that they are "concerned that people may mistakenly believe that consuming CBD "can't hurt" and they "want to be clear that we have seen only limited data about CBD's safety and these data point to real risks that need to be considered." [45]. Some potential issues addressed by the FDA include:

- Liver injury,
- Drug interactions, and
- Male reproductive toxicity.

According to a Harvard health blog, however, there are several benefits that can be achieved by consuming CBD products. As mentioned previously, the FDA has approved the first-ever cannabis-derived medicine (Epidiolex®), which has shown strong scientific evidence for its effectiveness in treating various childhood epilepsy syndromes, such as Dravet syndrome and Lennox-Gastaut syndrome (LGS), both of which don't typically respond to anti-seizure medicines [15]. In addition, CBD has been commonly used by consumers to treat anxiety, insomnia, as well as chronic pain.

The treatment of chronic pain is a key driving factor in the use of CBD products, especially within the construction industry. According to a study by the Midwest Economic Policy Institute, the injury rate for construction workers is 77 percent higher than the national average for other occupations. In addition to this, an estimated 15 percent of construction workers have a substance abuse disorder, which is almost double the national average of 8.6 percent. With an estimated 1,000 construction workers dying in 2015 from an opioid overdose, plus over $5 million in opioid epidemic costs in the Midwest's construction industry alone, the case for a safer alternative seems to be a pressing issue that can save countless lives and millions of dollars [22].

Some of the research regarding potential benefits of CBD use is simply less advanced and, therefore, considered inconclusive due to the lack of "properly controlled clinical trials", such as its use for treating anxiety and depression [6]. Over recent years, most of the clinical research has been directed towards gaining FDA approval for Epidiolex® since it is used to treat a more serious medical condition compared to chronic pain.

Controversies Related to CBD Product Use and Consumption

With research providing various levels and views of guidance, it leads us to the ultimate question – are CBD-related products containing THC a safe alternative to opioids for chronic pain management, as well as medications for other medical conditions, such as seizures, sleep disorders, etc.? As previously mentioned, many people view CBD and marijuana as the same thing, leading to misconceptions about the ingredients being consumed by the human body. However, the other side of the spectrum understands the concept of the two items, but due to the lack of scientific evidence and clinical research, they are not able to form an educated opinion as to whether or not it's safe to use within the workplace.

Under section 201(g)(1) of the Federal Food, Drug, and Cosmetic Act (the FD&C Act), 21 U.S.C. 321(g)(1), a "drug" is defined as a substance intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease and/or intended to affect the structure or any function of the body of man or other animals [44]. In order for the FDA's Center for Drug Evaluation and Research (CDER) to approve a new drug or treatment, it must enter a clinic trial process and pass three phases of testing before it can become eligible for FDA approval. During each phase of the clinical trials, the drug or treatment must prove to be safe and promising at each phase before being allowed to proceed to the next phase of clinic trials. If all phases of the clinic trials are successfully passed, the drug works correctly, and the health benefits outweigh the known risks, then it can move forward in the approval process [39].

Of the list of potential benefits that CBD can potentially provide, treatment of Dravet syndrome and Lennox-Gastaut syndrome (LGS) are the only two medical conditions that the U.S. Food and Drug Administration (FDA) has accepted and approved the use and/or consumption of CBD products for. All other potential benefits have been banned for marketing purposes in various FDA cases due to the lack of substantial research

and scientific evidence. Numerous companies have been warned by the FDA for making "unapproved new and misbranded human drug products", with claims of the CBD products helping with chronic pain, reduced anxiety, and several others. [43]

One of the major reasons that companies have been given formal warnings by the FDA is due to marketing and advertising of various medical benefits without approved, valid scientific testing. According to the FDA, the first step that companies must do if they intend to sell a drug in the United States is test it via laboratory and/or animal testing. This testing allows the drug company and/or sponsor to discover how the drug works, as well as if it is going to work safely and effectively in humans. After the tests have been conducted, the evidence and results must be forwarded to the CDER so that they can ensure the drug is safe and effective for the intended use. The evidence and results are reviewed by various medical professionals, such as physicians, statisticians, chemists, pharmacologists, and other scientists so that the data and proposed labeling can be validated. If all of the CDER approval criteria are met and the testing process submitted by the drug company and/or their sponsor is reliable, the drug can then be approved for sale within the United States. [39]

Potential Benefits of CBD Product Use and Consumption

According to numerous sources, there are a wide variety of potential benefits associated with CBD use and consumption. Potential benefits of CBD use and consumption include, but are not limited to, the treatment of:

- emotional improvements,
- childhood epilepsy syndromes (such as Dravet syndrome, Lennox-Gastaut syndrome (LGS), and tuberous sclerosis complex (TSC)),
- insomnia,
- chronic pain,
- inflammation, and
- gastrointestinal (GI) conditions

Emotional Improvements

There is evidence that CBD may be a useful treatment for a number of medical conditions, including anxiety and other emotion-related disorders caused by mental illnesses. In a 2017 study published in the *British Journal of Pharmacology*, results of the study show that CBD reduces anxiety via 5-hydroxytryptamine (serotonin 1A) receptor (5-HT_{1A}) and indirect cannabinoid receptor activation in paradigms assessing innate responses to threat [21]. This study utilized and summarized results from various other research projects on both animals and humans. In one group of test subjects, a 300-milligram oral dose of CBD prevented public speaking-induced increases in anxiety. In a 2016 case report involving a 10-year old girl with post-traumatic stress disorder (PTSD), the test subject consumed at least 25 milligrams of CBD daily for five months, resulting in reduced overall anxiety and improved sleep. Two additional studies noted in this article showed decreased subjective anxiety in patients with generalized anxiety disorders, abstinent heroin users, and test subjects with heroin cue-induced anxiety.

Childhood Epilepsy Syndromes

As of the time of this study, the only FDA-approved prescription containing CBD is the Epidiolex® oral solution, which was developed by GW Pharmaceuticals and marketed in the United States by its subsidiary, Greenwich Biosciences [13]. Epidiolex®, an antiepileptic drug (AED), is currently indicated for use in patients one year of age and older. Epidiolex® contains 100 milligrams (mg) of CBD per milliliter (mL) of solution, with the active ingredient being nearly 100% CBD. In the clinical trials published by Greenwich Biosciences, Epidiolex® reduced the frequency of seizures during the corresponding treatment period by 37% to 48% in patients with TSC, LGS, and/or Dravet Syndrome [14]. In addition, some people taking Epidiolex®

reported having no additional TSC-, LGS-, and/or Dravet Syndrome-associated seizures, while others reported up to a 75% reduction in the amount of seizures experienced.

According to Greenwich Biosciences, Epidiolex® is believed to work differently from other prescription seizure medicines, but the exact mechanisms of action and how it actually works are still unknown. The company also states that CBD does not appear to exert its anticonvulsant effects through interaction with cannabinoid receptors since it neither binds to nor activates the cannabinoid-1 ($CB_{1)}$ and/or cannabinoid-2 (CB_2) receptors [13]. However, despite the uncertainty, a progress report issued at the Thirteenth Eilat Conference on New Antiepileptic Drugs and Devices (EILAT XIII) in 2016 suggested that an effect on adenosine reuptake and antagonism of G protein-coupled receptor 55 (GPR55) may play an important role in CBD anti-seizure activity [7].

Insomnia

The amount of stress and anxiety in someone's life can play a major factor in the quality of their sleep. Throughout multiple studies, CBD has been evaluated as a way to increase the quality and effectiveness of a person's sleep [19]. When CBD is consumed, it helps relieve stress by triggering the serotonin receptors in the brain, causing an increase in the production of cortisol. Cortisol is a steroid hormone that is made in the adrenal glands and is ultimately responsible for a wide variety of bodily functions, such as regulating your blood pressure, keeping inflammation down, and regulating your sleep/wake cycle (also known as your body's circadian rhythm). A person's circadian rhythm supports alertness during the day by boosting cortisol production in the morning, before gradually decreasing cortisone levels throughout the remainder of the day. The HPA axis, which consists of the hypothalamus, pituitary gland, and adrenal gland, drops to its lowest levels in the middle of the night so that the body's own internal sleep drive and other hormones, such as adenosine and melatonin, can rise and bring about sleep [16].

Chronic Pain and Inflammation

While pure CBD products may not have many benefits, the CBD products that contain THC in various amounts are believed to provide benefits to people suffering from chronic pain and/or inflammation. THC has twenty times the anti-inflammatory potency of aspirin and twice that of hydrocortisone. The anti-inflammatory properties of THC include inhibition of PGE-2 synthesis, decreased platelet aggregation, and stimulation of lipoxygenase. However, in contrast to all nonsteroidal anti-inflammatory drugs (NSAIDs), the THC demonstrates no cyclo-oxygenase (COX) inhibition at physiological concentrations. It has also been claimed that the CBD reduces the potential psychoactive effects of the THC, thus lowering the potential drug abuse liability posed by the active ingredients of the drug [30].

Gastrointestinal (GI) Conditions

Nausea, which is defined as a feeling of sickness with an inclination to vomit, is a potential side effect encountered by some consumers of CBD products. A clinical condition known as cannabinoid hyperemesis syndrome (CHS), which was first described in 2004, is characterized by chronic cannabis use, cyclic episodes of nausea and vomiting, and frequent hot bathing. Although the mechanism in which this condition occurs is unknown, it is known that THC, CBD, and cannabigerol (CBG) are three cannabinoids found in the cannabis plant that have opposing effects on the emesis response (Galli, Sawaya, and Friedenberg, 2011)..

The gastrointestinal (GI) actions of cannabinoids are mainly facilitated by CB_1 receptors, which result in the prevention of gastric acid secretion, lower esophageal sphincter relaxation, alternated intestinal motility, visceral pain, and inflammation. In humans, THC given at doses used to prevent chemotherapy-induced nausea and vomiting causes a significant delay in gastric emptying. Additionally, intermittent administration of THC results in hypersensitization of the delayed gastric emptying effect. THC's effect on gastric motility is a paradox, as a delay in gastric emptying would be expected to promote nausea and vomiting. However,

nausea and vomiting traditionally do not occur with cannabis use, likely due to the anti-emetic properties of THC on the central nervous system [11].

In a study published in the *British Medical Journal* in 2001, the research authors attempted to quantify the antiemetic efficacy and adverse effects of cannabis used for chemotherapy-induced sickness. The study, which consisted of 1,366 patients, observed data in which the patients consumed THC orally, with follow-up observations lasting 24 hours after consumption. The results showed that cannabinoids were more effective antiemetics than prochlorperazine, metoclopramide, chlorpromazine, thiethylperazine, haloperidol, domperidone, or alizapride. Across all trials, six to eight patients needed to be treated with cannabinoids for one to benefit who would have vomited or had nausea had they all received a conventional antiemetic. In addition, between 38% and 90% of patients preferred cannabinoids as a treatment method [35].

Potential Risks Related to CBD Product Use and Consumption

On the opposite end of the spectrum, potential risks include, but are not limited to:

- psychoactive effects,
- nausea,
- fatigue,
- increased levels of certain medications in the participant's blood (such as Coumadin®),
- hypotension (low blood pressure),
- xerostomia (dry mouth),
- diarrhea,
- vomiting,
- skin rash,
- paranoia,
- lightheadedness,
- headaches,
- visual disturbances, and/or
- changes in appetite.

Psychoactive Effects

CBD, in itself, does not product any psychoactive effects on the human body. The main psychoactive component of cannabis that is responsible for this reaction is delta 9-tetrahydrocannabinol (Δ^9-THC). These psychoactive effects are created by the THC interacting with specific cannabinoid (CB) receptors present in the brain and periphery. Psychoactive effects can potentially include a feeling of euphoria, relaxation, altered time perception, lack of concentration, and impaired learning [32].

Endogenous cannabinoids, such as anandamide, function as neurotransmitters because they send chemical messages between nerve cells (neurons) throughout the nervous system. They affect brain areas that influence pleasure, memory, thinking, concentration, movement, coordination, and sensory and time perception. Because of this similarity, THC is able to attach to molecules called cannabinoid (CB) receptors on neurons in these brain areas and activate them, disrupting various mental and physical functions and causing the effects previously mentioned. The neural communication network that uses these cannabinoid neurotransmitters, known as the endocannabinoid system, plays a critical role in the nervous system's normal functioning, so interfering with it can have profound effects [25].

In addition, memory and mood changes, such as panic and paranoid reactions, have also been reported with cannabis use due to the presence of delta 9-tetrahydrocannabinol (Δ^9-THC). Based on a 2012 article in the *Iranian Journal of Psychology*, cannabis users can experience mania-like psychosis when consuming large amounts of the drug (30-50 mg oral or 8-30 mg smoked) [32]. This is due to THC's chemical structure being

similar to a chemical found in the brain called anandamide (ANA) (also known as N-arachidonoylethanolamine or AEA). This similarity in structure allows the body to recognize THC and to alter normal brain communication [25].

For example, THC is able to alter the functioning of the hippocampus and orbitofrontal cortex, parts of the brain that enable a person to form new memories and shift his or her attentional focus. As a result, THC consumption causes impaired thinking and interferes with a person's ability to learn and perform complicated tasks. THC also disrupts functioning of the cerebellum and basal ganglia, brain areas that regulate balance, posture, coordination, and reaction time. This is the reason people who have used marijuana may not be able to drive safely and may have problems playing sports or engaging in other physical activities.

People who have taken large doses of the drug may experience an acute psychosis, which includes hallucinations, delusions, and a loss of the sense of personal identity. THC, acting through cannabinoid receptors, also activates the brain's reward system, which includes regions that govern the response to healthy pleasurable behaviors, such as sex and eating. Like most other drugs that people misuse, THC stimulates neurons in the reward system to release the signaling chemical dopamine at levels higher than typically observed in response to natural stimuli. This flood of dopamine contributes to the pleasurable "high" that those who use recreational marijuana seek [25].

Fatigue

As discussed previously, CBD products can affect a person's circadian rhythm. When it binds to the CB1 receptors, it triggers a release of various hormones, such as serotonin and melatonin, both of which are instrumental in helping people sleep [16]. However, when taken at the wrong time of the day or when consumed with other depressants (e.g., alcohol), it can cause unwanted fatigue throughout a person's day. When taken properly by someone experiencing insomnia (that is, difficulty falling asleep), the release of serotonin and melatonin work in a positive manner and assist the person in falling and staying asleep. However, if taken in the morning, for example, a person may feel fatigued throughout the day. According to the Epidiolex® product information, one of the most common adverse reactions in patients with LGS, TSC, and/or Dravet syndrome that are taking Epidiolex® is sleepiness and feeling tired [13]. Epidiolex® consumers are advised not to drive or operate machinery until they have been able to adequately evaluate how their body will react to the drug in order to reduce the risk of injury.

Drug Interactions

According to a 2017 report published in *Epilepsy & Behavior Case Reports*, there has been a clinically-significant interaction between pharmaceutical-grade CBD (Epidiolex® oral solution containing a 100 mg/mL CBD concentration) and warfarin (Coumadin®), a widely used oral [12]. The patient in the case study, who was a 44-year old Caucasian male enrolled in an adult CBD program the University of Alabama at Birmingham (UAB) between 2015 and 2017, had several pre-existing medical conditions, including Marfan Syndrome, a mechanical mitral valve replacement, post-stroke epilepsy, and warfarin therapy. At the time of enrollment in the program, the patient had been taking 7.5 milligrams (mg) of warfarin each day for at least six months with a goal International Normalized Ratio (INR) of between two and three. The INR is calculated from a prothrombin time (PT) result and is used to monitor how well the blood thinning medication (anticoagulant) warfarin (Coumadin®) is working to prevent blood clots [4].

During the trails of the adult CBD program, the participant's international normalized ration (INR) was monitored. At the time of enrollment in the program, the patient's INR had been ranging from 2.0 to 2.6 and baseline INR was obtained to reference. Per study protocol, the patient was initially placed on a starting dose of CBD at 5 mg/kg/day divided twice daily, with an additional 5 mg/kg/day incremental increase every two weeks thereafter. As the CBD levels were increased, a non-linear increase in the patient's INR was observed and documented. During this time, the patient's dosage of warfarin was adjusted by his primary care

physician (PCP) in an effort to maintain an INR within his therapeutic range. At the time of the patient's most recent study visit over one year later, his adjusted dose of warfarin was down to 5.36 milligrams (mg) while consuming a 35 mg/kg/day dose of CBD. The adjusted dosage of warfarin was nearly a 30 percent decrease from his initial dosage at the beginning of the study. The results of the case report suggest an interaction between warfarin and cannabidiol (CBD), and therefore recommend that INR monitoring be conducted during initiation and up-titration of cannabinoid for patients taking warfarin [12].

Hypotension

A 2017 study suggests that CBD can potentially reduce a person's blood pressure (BP), as well as increase their heart rate (HR). The study, which was intended to test the hypothesis that CBD would reduce the cardiovascular response to stress in healthy volunteers, evaluated ten male subjects with a mean age, weight, and height of 23.7 ± 3.2 years, 77.5 ± 6.4 kg, and 178.6 ± 4.5 cm respectively. The subjects of the study were each given 600 mg of CBD or placebo in a randomized, placebo-controlled, double-blind, crossover study. The study evaluated the effect of CBD on resting cardiovascular parameters via a mental stress test, exercise stress test, and cold stress test [17]. The blood pressure responses during the stress tests were documented in the four minutes preceding the test, the peak response during stress, and the average recovery response in the four minutes following the stress test. The study produced the following results [17]:

- CBD treatment reduced resting systolic blood pressure (SBP) (mean difference –6 mmHg; 95% CI, –1 to –12, $P < 0.05$).
- Six of nine subjects had a lower SBP before or during the mental stress test, and all of the subjects had a lower SBP in the recovery period after taking CBD. Five of nine subjects had a lower DBP during the mental stress test, and six of nine subjects had a lower DBP in the recovery period after taking CBD.
- Six of nine subjects had a lower SBP during isometric exercise and eight of nine subjects had a lower SBP in the recovery period after taking CBD. Five of nine subjects had a lower DBP during exercise, and eight of nine subjects had a lower DBP in the recovery period after taking CBD.
- Eight of the nine subjects had a lower SBP during the cold stress and in the recovery period after taking CBD. Six of nine subjects had a lower diabolic blood pressure (DBP) during the cold pressor, and seven of nine subject had a lower DBP in the recovery period after taking CBD.

Xerostomia

Xerostomia is an unusually dry mouth, often caused by medication, and is a common side effect of many products containing CBD, as well as marijuana in pure form. This medical condition is caused by a decrease in saliva secretion upon CBD consumption. When a person consumes a product containing CBD, it activates the cannabinoid receptors (CBs), which are located in the salivary glands. Human tissue contains at least two types of CBs (CB_1 and CB_2), which are mainly located in the nervous system and peripheral tissues respectively. A 2006 report published in *Experimental Biology and Medicine* demonstrated that both CB_1 and CB_2 receptors found in the submandibular gland (SMG, a major salivary gland) of male rats are coupled to Gi protein and respond by inhibiting the activity of adenylyl cyclase, which is the enzyme that synthesizes cyclic adenosine monophosphate (cAMP) from adenosine triphosphate (ATP). [28] Anandamide (AEA), a commonly-known endocannabinoid, binds with high affinity to both of the CBs and noticeably reduced forskolin-induced increase of cAMP content in vitro (outside of the rats). This effect was blocked by AM-251 and AM-630 (inverse antagonists of CB_1 and CB_2, respectively), indicating that both receptors are implicated in SMG physiology.

In addition, the study showed that AEA injected intraglandularly to anesthetized rats inhibited norepinephrine (NE)- and methacholine (MC)-stimulated saliva secretion in vivo (within or inside the rats) and that both AM-251 and AM-630 prevented the inhibitory action of AEA. The intraglandular injection of AM-251 increased saliva secretion induced by lower doses of NE or MC. This increase was synergized after

coinjection with AM-630. Therefore, it is concluded that AEA decreases saliva secretion in the SMG by acting through CB_1 and CB_2 receptors [28].

Headaches

Xerostomia, as mentioned previously, can potentially lead to dehydration due to the decrease in saliva secretion. Dehydration, in turn, can cause consumers of CBD products containing THC to experience headaches. When you become dehydrated, your brain tissue loses water, and in an attempt to conserve water, causes your brain to shrink and pull away from the skull. This condition, in turn, triggers the pain receptors surrounding the brain, causing a headache [8].

A clinical trial published in 1985 evaluated potential measurable subjective or other behavioral effects in the morning after smoking marijuana. The delayed onset of the medical condition (commonly known as a "hangover") includes symptoms such as fatigue, weakness, and headaches [23]. The study, which consisted of thirteen males who smoked marijuana, had test subjects smoking either active (2.9% Δ^9-THC) or placebo (0.0% Δ^9-THC) marijuana cigarettes according to a standardized smoking regimen. Smoke inhalation was monitored by measuring expired air carbon monoxide (CO) levels before and after smoking. Acutely, active marijuana produced significant changes in heart rate, carbon monoxide (CO) level, various measures of subjective effects, and behavioral tasks of card sorting, free recall, and time production. When the test battery was repeated the following morning (approximately 9 hours after smoking), significant changes were observed on two subjective effects scales and on the time production task after active, but not placebo, marijuana. These apparent "hangover" effects were different from the acute effects of marijuana. The findings suggest that marijuana smoking can produce residual (hangover) effects the day after smoking [10]. It is important to note, however, that most current day marijuana has a THC content of nearly 30% which is almost ten times the level of THC used in the 1985 clinic trial [34].

Visual Disturbances

Nystagmus is a vision condition in which the eyes make repetitive, uncontrolled movements. This condition often results in effects such as reduced vision and depth perception, as well as decreased balance and coordination. This involuntary jerking motion can occur from side to side, up and down, or in a circular pattern, causing a person to be unable to steadily view objects. According to the American Optometric Association, nystagmus is most commonly caused by a neurological problem that is present at birth or develops in childhood, but it can also be an indicator of intoxication [5].

Law enforcement officers use the horizontal gaze nystagmus test during a standardized field sobriety test (SFST) in order to help determine if a person is intoxicated. During the test, the officer will hold a small object (stimulus) approximately 12-15 inches away from the person's nose and slightly above eye level. The officer will slowly move the stimulus from one side to the other, instructing the person to follow the object with their eyes while keeping their head still. Officers are trained to look for three different indicators of intoxication in each eye during this procedure. The three clues are lack of smooth pursuit (eyes jerking or bouncing while following the stimulus), nystagmus that sets in before the eyes reach a 45-degree angle, and finally nystagmus that develops at maximum deviation (meaning the eyes begin jerking within four seconds while looking all of the way to the side). The horizontal gaze nystagmus test is considered the first and most accurate test in the SFST battery [24].

Traditional teaching has held that horizontal gaze nystagmus (HGN) is a sign of intoxication by sedatives such as alcohol, but not marijuana. However, a 2013 case report published in the *Journal of Forensic and Legal* Medicine provided a possible exception to this mentality. In the report, an adult male presents with three days of visual disturbance and dizziness following marijuana use. The subject's exam was notable for gaze-evoked nystagmus (a drift of the eye which is only present for certain directions of gaze away from straight ahead) and ataxia (a degenerative disease of the nervous system that often causes impaired

coordination) [2]. The subject's lab test results were normal except that urine drug screening was positive for marijuana only. Imaging conducted included computed tomography (CT) and magnetic resonance imaging (MRI) scans of the head with no other indicators shown. This case presented a possible exception to the generalization that marijuana (more specifically THC) is not associated with nystagmus.

Changes in Appetite

It has been known that people who use marijuana have an increased appetite, also known as the "munchies". Hunger arouses sensory perception, eventually leading to an increase in food intake, but the underlying mechanisms remain poorly understood. In a 2014 study published in *Nature Neuroscience*, the authors found that cannabinoid type-1 (CB_1) receptors promote food intake in fasted mice by increasing odor detection. The study noted that the CB_1 receptors were abundantly expressed on axon terminals of centrifugal cortical glutamatergic neurons that project to inhibitory granule cells of the main olfactory bulb (MOB), which makes food smell and taste more intense and affects how much a person eats. Local pharmacological and genetic manipulations revealed that endocannabinoids and exogenous cannabinoids increased odor detection and food intake in fasted mice by decreasing excitatory drive from olfactory cortex areas to the MOB. Consistently, cannabinoid agonists dampened in vivo optogenetically stimulated excitatory transmission in the same circuit [33].

The data from the study indicated that cortical feedback projections to the MOB crucially regulate food intake via CB_1 receptor signaling, linking the feeling of hunger to stronger odor processing. Therefore, CB_1 receptor–dependent control of cortical feedback projections in olfactory circuits couples internal states to perception and behavior [33]. In essence, the neurons that are typically associated with shutting down eating were being activated, therefore promoting hunger, even when the person is not hungry. The researchers found that THC caused a reaction in a mouse's hypothalamus (the part of the brain responsible for appetite control), which causes the hunger sensation.

Additional Risk Factors

In addition to the risks associated with the consumption of the CBD product itself, the fact that the products have not been evaluated and/or approved by the FDA poses product contaminant issues. If there are product contaminants present, it may lead to:

- headaches,
- allergic reactions,
- skin rashes,
- memory loss,
- confusion,
- nausea/vomiting, and/or
- vision loss

Detection of CBD Product Use

Currently, marijuana is considered a schedule 1 drug due to the THC content within it. A schedule 1 drug, as defined by the United States Drug Enforcement Administration (DEA), is a drug with no currently-accepted medical use and a high potential for abuse [38]. Although CBD and marijuana are different chemicals, they both have the potential to contain THC. The THC content of various CBD products may cause the consumer to become addicted and, subsequently, dependent upon it. This potential for addiction and/or dependency may lead to an increased risk of detection on a drug screen.

The ability to detect CBD in the human body depends on several factors, including, but not limited to, the amount of CBD consumed, frequency of consumption, THC content of the CBD product, the method of use, etc. CBD consumers may choose to consume the product via inhalation (e.g., smoking, vaping), orally (e.g.,

pills, edibles, oral liquid), or topical products (e.g., creams, salves, oils). Each form of consumption is going to provide a varying level of effects, and with that, a varying level of detection.

Pure cannabidiol (CBD) without any THC will not show up on a drug screen. However, if the CBD product contains THC in detectable amounts, then impairment may be noticed and it may show up on the results of a drug screen, depending on the type of drug screen performed. The THC consumed by the user breaks down into several inactive metabolites (e.g., THC-COOH, 11-nor-carboxy-delta-9-tetrahydrocannabinol). Most drug screenings detect the presence of these metabolites in urine since the metabolites stay in the body for a longer period of time than the THC does. However, there are some tests that are able to detect the active compound, THC – primarily when conducting blood and/or saliva testing [3].

According to the Substance Abuse and Mental Health Services Administration (SAMHSA), the initial test cutoff concentration for marijuana metabolites is 50 nanograms per milliliter (ng/mL). If detection of marijuana metabolites (which includes THC and THC metabolites) are below the applicable cutoff level(s), the drug test is considered to be negative. If the initial screening shows above 50 ng/mL, then a second confirmatory test is performed. The confirmation test specifically looks for the presence of delta-9-tetrahydrocannabinol-9-carboxylic acid (THCA), with a confirmatory test cutoff concentration of 15 ng/mL. If the second test does not show at least 15 ng/mL of THCA, then the drug test is considered to be negative. If the initial and confirmatory screening both meet or exceed the designated cutoff concentrations for the applicable analyte, then the test is presumed to be positive [31]. To place things into perspective, a gram is only thirty-five thousandths (0.035) of an ounce, and a nanogram is one-billionth (0.000000001 or 10^{-9}) of a gram. This equates to microscopic particles measurable in only a few drops of urine. Consequently, even infrequent, recreational drug use might cause a worker to have a positive drug screen result.

Approximately 90% of THC in blood is circulated in plasma and the rest in red blood cells. Following inhalation, THC is detectable in plasma within seconds after the first puff and the peak plasma concentration is attained within 3-10 minutes (51–55). However, the bioavailability of the THC varies according to the depth of inhalation, puff duration and breath-hold. In comparison to smoking and inhalation, after oral ingestion, systemic absorption is relatively slow resulting in maximum THC plasma concentration within 1-2 hours which could be delayed by few hours in certain cases. After oral administration, maximum THC plasma concentration was 4.4-11 ng/mL for 20 mg and 2.7-6.3 ng/mL for 15 mg. Much higher concentration of 11-OH THC was produced after ingestion than inhalation. Following assimilation via the blood, THC rapidly penetrates in to fat tissues and highly vascularized tissues including brain and muscle resulting in rapid decrease in plasma concentration. This tissue distribution is followed by slow redistribution of it from the deep fat deposits back into the blood stream [32].

The THC is metabolized in the liver by microsomal hydroxylation and oxidation catalyzed by enzymes of cytochrome P450 (CYP) complex. The average plasma clearance rates have been reported to be 11.8± 3 liters per hour (LPH) for women and 14.9 ±3.7 LPH for men. Others have determined approximately 36 LPH for naïve cannabis users and 60 LPH for regular cannabis users. More than 65% of cannabis is excreted in the feces and approximately 20% is excreted in urine. Most of the cannabis (80%-90%) is excreted within 5 days as hydroxylated and carboxylated metabolites. There are eighteen acidic metabolites of cannabis identified in urine and most of these metabolites form a conjugate with glucuronic acid, which increases its water solubility. Among the major metabolites (Δ^9-THC,11-OH-THC, and THCCOOH), THCCOOH is the primary glucuronide conjugate in urine, while 11-OH-THC is the predominant form in feces. Since THC is extremely soluble in lipids, it results in tubular re-absorption, leading to low renal excretion of unchanged drug. Urinary excretion half-life of THCCOOH was observed to be approximately 30 hours after seven days and 44-60 hours after twelve days of monitoring. After smoking approximately 27 mg of THC in a cigarette, 11-OH-THC peak concentration was observed in the urine within two hours in the range of 3.2-53.3 ng/mL,

peaking at 77.0 ng/mL ± 329.7 after 3 hours and THCCOOH peaking at 179.4 ng/mL ± 146.9 after 4 hours [32].

Among the various types of drug screening, hair follicle testing has the longest detection period and can typically detect drug use for up to three months prior to the date of the drug screen. In addition, depending on the drug(s) used, a hair follicle sample can sometimes help determine when drug use occurred and whether or not it's been discontinued. According to Laboratory Corporation of America (LabCorp), urine drug screens (lab-based and rapid tests) can detect THC metabolite for up to two weeks, oral fluid lab-based drug screens can detect THC and/or metabolites for up to 12 hours, and hair follicle lab-based drug screens can detect usage for up to three months [20]. The FDA states that THC can continue to show up in a urine drug screen for an average of 1-7 days, which is longer than heroin, cocaine, methamphetamine, and 3,4-Methylenedioxymethamphetamine (MDMA, also known as ecstasy or molly) [40].

Summary

In general, THC has been shown to have varying levels of effects based on several different factors, such as the amount of THC consumed, the frequency of THC consumption, underlying medical conditions, etc. However, since CBD products have not become popular with the general public until the past decade, little research has been done to determine the levels of impairment associated with these products, the potential benefits, the potential side effects, and other critical information.

Although there are various potential side effects listed for CBD and THC use, it's important to note that many of these side effects are also present with some of the most common over-the-counter pain relievers, such as acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs). According to the U.S. National Library of Medicine, Ibuprofen (a popular NSAID) may cause nausea, loss of appetite, excessive tiredness, and visual disturbances, such as blurred vision and changes in color vision [46]. According to Ed Kuffner, Chief Medical Officer for Johnson & Johnson Consumer Inc., it is estimated that approximately 40% of households in the United States purchased Ibuprofen in 2017, with approximately 17% of adults consuming it on a weekly basis [18]. If people who are considering consuming CBD products containing THC realize the similarities in the drugs they are already taking (e.g., Ibuprofen), they may be more inclined to purchase CBD products for various medical purposes.

In regard to potential product contamination issues, this risk is present at every pharmaceutical manufacturer. Some manufacturers may have a higher risk than others due to the type of quality control (QC) methods implemented at the manufacturing facility. If there is a robust quality control program in place at the manufacturing facility, then the likelihood of product contamination is lower. However, if a manufacturing facility has ineffective quality control procedures in place, the likelihood of product contamination may be higher. Since CBD is not currently regulated by the FDA (with the exception of Epidiolex®), the risk of product contamination is unknown and varies from one CBD product manufacturer to the another. In addition, the level(s) of THC contained within the various CBD products may vary from batch to batch due to the same reasons.

Due to these types of risks and potential side effects being present at nearly every pharmaceutical manufacturer, CBD could be a beneficial product for many people suffering from various medical conditions and disorders. CBD products are not known to have ototoxic effects, whereas chronic (long-term) use of NSAIDs, such as Ibuprofen, may lead to chemical-induced hearing loss and/or ringing in the hears (tinnitus) [46]. The level of perceived risk will vary on an individual basis from one person to another, but some people will still want to use CBD products for their advertised therapeutic benefits since it may have fewer and/or less severe side effects than comparable equivalent medications.

METHODOLOGY

This research required a minimum of 100 participants across the United States. Study participants were selected based on a variety of specific demographic backgrounds. In order to participate in the research, participants were required to be at least 18 years old and currently in a full-time supervisory role (e.g., Manager, Supervisor, Leader, Director, etc.). Participants could be either male or female and work in any industry. Prisoners, refugees, minors, and representatives of CBD product companies and distributors were not allowed to participate in this research. Participants were recruited via social media (e.g., LinkedIn, Facebook, Twitter, and Instagram) and face-to-face interactions. Participation in this research was completely voluntary.

The research was conducted using a single electronic survey conducted using Google Forms. The research results included a total of 108 participants, all of which acknowledged that they met the research population's background requirements. The survey included a total of 30 questions, with the first 10 questions being related to this study. The 30-question survey took less than 15 minutes to complete for most participants.

This research was designed to evaluate a business' perception of what would be the worst thing that could happen from someone using and/or consuming CBD products in the workplace. Questions evaluated the perceived impact of using and/or consuming CBD products in various roles within an organization, how likely someone would expect to be able to recognize CBD product usage and/or consumption, and the toxicological effects of these products.

The research survey was started on August 13, 2021 and concluded on September 7, 2021. Participants were asked to participate in a research study to help gain more industry knowledge on CBD-related products and their effects in the workplace. No additional guidance was provided to research participants unless potential research participants had questions prior to beginning the survey. A total of 108 people completed the research survey.

No human research ethics were used to retrieve survey results.

Data Collection Questions

The following is the questionnaire completed by each of the research participants:

1. Do you believe a person can safely operate machinery or equipment while consuming and/or using cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC)?
2. Do you think it's acceptable for **administrative** employees (e.g., C-Suite, Office Workers, Receptionists) to consume and/or use cannabidiol- (CBD) related products?
3. Do you think it's acceptable for **operations** employees (e.g., Machine/Equipment Operators, Maintenance, Field Service) to consume and/or use cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC)?
4. Do you think there has **ever** been safety-related incidents that have been partially caused by a person using and/or consuming cannabidiol- (CBD) related products in the workplace?
5. Do you believe an employee will receive a positive test result on a standard 5-panel drug screen if they've used and/or consumed cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC) within the past 24 hours?
6. How noticeable do you think will it be if someone is using cannabidiol (CBD)?
7. Should a person involved in a workplace incident (regardless of whether or not an injury or illness occurred) that has detectable amounts of cannabidiol (CBD) in their bloodstream be considered "under the influence"?
8. How long do you think cannabidiol (CBD) remains in your bloodstream after consumption/usage via **inhalation** (e.g., vaping)?

9. How long do you think cannabidiol (CBD) remains in your bloodstream after consumption/usage via **absorption** (e.g., creams, salves)?
10. How long do you think cannabidiol (CBD) remains in your bloodstream after consumption/usage via **ingestion** (e.g., capsules, gummies)?

Data, Reliability, Validity, and Analysis

Significant efforts were made to ensure the reliability of the data. Prior to beginning the survey, potential participants were required to review and acknowledge that they met all of the participant requirements. If they did not meet all of the requirements, the survey would automatically prevent them from completing the survey to ensure the accuracy of the survey responses. This enhanced accuracy, in addition to the demographic background requirements, contributed to validity. Appropriate analytical procedures were followed to provide consistency. Such consistency helped control for possible researcher bias.

Google Forms was used to collect and organize the data used for this research. The process of data analysis in qualitative research involves the evaluation of the resulting data by working with the data, breaking the data down, synthesizing data, and searching for themes or patterns to discover the critical or relevant data elements. Based on the pattern of the data sets, key themes were identified. These themes were compared to the reviewed literature, and then viewed through the lens of the concept of due diligence. The findings of this research are not specific any industry, community, or age group. Transferability of qualitative research to a specific setting can be difficult and may require a broader context. Therefore, the judgment of the reader and the findings of future researchers will eventually determine the transferability of the findings of this research.

RESULTS

Question #1

Do you believe a person can safely operate machinery or equipment while consuming and/or using cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC)?

	Number of Responses	Percent of Responses
Yes	60	55.6%
No	48	44.4%

Fig. 1

Question #2

Do you think it's acceptable for ***ADMINISTRATIVE*** employees (e.g., C-Suite, Office Workers, Receptionists) to consume and/or use cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC)?

	Number of Responses	Percent of Responses
Yes	78	72.2%
No	30	27.8%

Fig. 2

Question #3
Do you think it's acceptable for ***OPERATIONS*** employees (e.g., Machine/Equipment Operators, Maintenance, Field Service) to consume and/or use cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC)?

	Number of Responses	Percent of Responses
Yes	54	50.0%
No	54	50.0%

Fig. 3

Question #4
Do you think there has ***EVER*** been safety-related incidents that have been partially caused by a person using and/or consuming cannabidiol- (CBD) related products in the workplace?

	Number of Responses	Percent of Responses
Yes	69	63.9%
No	39	36.1%

Fig. 4

Question #5
Do you believe an employee will receive a positive test result on a standard 5-panel drug screen if they've used and/or consumed cannabidiol- (CBD) related products containing up to 0.3% tetrahydrocannabinol (THC) within the past 24 hours?

	Number of Responses	Percent of Responses
Yes	41	38.0%
No	22	20.4%
I Don't Know/I'm Not Sure	45	41.7%

Fig 5

Question #6
How noticeable do you think will it be if someone is using cannabidiol (CBD)?

	Number of Responses	Percent of Responses
I will be able to notice physical impairments only (e.g., bloodshot eyes, distinct odor)	4	3.7%

I will be able to notice mental impairments only (e.g., slurred speech, impaired balance)	9	8.3%
I will be able to notice both mental and physical impairments	20	18.5%
I will not be able to notice it at all	75	69.4%

Fig. 6

Question #7

Should a person involved in a workplace incident (regardless of whether or not an injury or illness occurred) that has detectable amounts of cannabidiol (CBD) in their bloodstream be considered "under the influence"?

	Number of Responses	Percent of Responses
Yes	52	48.1%
No	56	51.9%

Fig. 7

Question #8

How long do you think cannabidiol (CBD) remains in your bloodstream after consumption/usage via ***INHALATION*** (e.g., vaping)?

	Number of Responses	Percent of Responses
<1 Hour	5	4.6%
1-4 Hours	17	15.7%
>4 Hours to <12 Hours	18	16.7%
>12 Hours to 24 Hours	27	25.0%
>24 Hours	41	38.0%

Fig. 8

Question #9

How long do you think cannabidiol (CBD) remains in your bloodstream after consumption/usage via ***ABSORPTION (e.g., creams, salves)***?

	Number of Responses	Percent of Responses
<1 Hour	9	8.3%
1-4 Hours	13	12.0%
>4 Hours to <12 Hours	23	21.3%

>12 Hours to 24 Hours	24	22.2%
>24 Hours	39	36.1%

Fig. 9

Question #10
How long do you think cannabidiol (CBD) remains in your bloodstream after consumption/usage via ***INGESTION*** (e.g., capsules, gummies)?

	Number of Responses	**Percent of Responses**
<1 Hour	4	3.7%
1-4 Hours	10	9.3%
>4 Hours to <12 Hours	21	19.4%
>12 Hours to 24 Hours	22	20.4%
>24 Hours	51	47.2%

Fig. 10

Conclusion

Based on the questions presented in the survey, we can conclude that the majority of the survey participants have a vague understanding of cannabidiol (CBD) and how it affects the body. While 56% of survey participants believed that a person could safely operate machinery or equipment while consuming and/or using CBD products containing up to 0.3% tetrahydrocannabinol (THC), only 50% stated that they think it's acceptable for operations employees (e.g., machine/equipment operators, maintenance, field service) to consume and/or the CBD products. In the same aspect, the majority of survey participants had a good understanding of how detectable the CBD use and/or consumption would be, with 69% stating that it will not be noticeable when someone is using CBD products.

Based on the results, over 60% of the survey participants believed that there has been a safety-related incident that was partially caused by the use and/or consumption of CBD. This statement is highly unlikely due to CBD not having the psychoactive effects that are present in THC. On a similar note, only 20.4% of the survey participants believed that an employee would "pass" a standard 5-panel drug screen if they've used CBD products containing up to 0.3% THC within the past 24 hours. However, most standard 5-panel drug screens would not detect the THC (or metabolites) in such low concentrations, meaning most of the participants do not have adequate knowledge of common drug screen detection thresholds.

More studies are needed to understand the true levels of impairment associated with the use and/or consumption of CBD products containing up to 0.3% THC so that accurate workplace policies and guidelines can be developed and implemented into occupational safety and health management systems. In addition, businesses and organizations should ensure they are providing accurate, up-to-date information to their employees about what is known about CBD so that each individual can be informed of the potential benefits and health effects associated with CBD usage and/or consumption.

No human research ethics were used to retrieve survey results.

Author Contributions

Drew Hinton was the primary investigator for this research. Drew is a doctoral student at Capitol Technology

University and conducted the research as part of his degree program. Drew collected and analyzed all of the data from the research, and wrote this document with all applicable findings, literature, and recommendations.

Tyler Asher is an Assistant Professor at Capitol Technology University and serves as Drew's current dissertation chair. Tyler Asher assisted with reviewing the article and providing advice on final revisions.

All authors had approved the final version.

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