

DISSERTATION

THE IMPACT OF CANNABIS ON PHYSICAL ACTIVITY EXPERIENCE IN
INSUFFICIENTLY ACTIVE ADULTS: EXPLORING PERCEIVED EXERTION,
MINDFULNESS, AND ENJOYMENT

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ABSTRACT

THE IMPACT OF CANNABIS ON PHYSICAL ACTIVITY EXPERIENCE IN INSUFFICIENTLY ACTIVE ADULTS: EXPLORING PERCEIVED EXERTION, MINDFULNESS, AND ENJOYMENT

Legalization of recreational cannabis has led to increased acceptance and incorporation of cannabis use into the daily lives of millions of Americans, leading researchers to wonder how individuals combine their cannabis use with other behaviors, such as physical activity. Early work established that individuals who use cannabis tend to combine it with physical activity at a notable rate. Their reasons for doing so may be due to subjective benefits (e.g., increased enjoyment, reduced perceived effort, greater experience of runner's high effects) rather than objective benefits (e.g., enhanced performance). Indeed, research has shown that among active adults who use cannabis, acute cannabis use before exercise enhances many subjective aspects of physical activity compared to exercise without cannabis. However, few studies have systematically investigated the effects of cannabis on physical activity specifically among insufficiently active adults who regularly use cannabis, a group who may stand to benefit from interventions that make physical activity feel more enticing and rewarding. This remote, longitudinal crossover study compared participants' experiences of walks without cannabis to walks after acute, self-administered cannabis among insufficiently active adults who regularly use cannabis (N = 59, ages 21-65). The primary goal of this study was to determine whether cannabis impacted perceived exertion, mindfulness, and enjoyment during a low-impact, accessible physical activity (i.e., outdoor walk), and to characterize for whom those benefits

existed. A walk with cannabis appeared to increase mindfulness, positive affect, and enjoyment more than a walk not preceded by cannabis, with no change to perceived exertion between conditions. Although positive experiences were associated with intentions to combine cannabis with physical activity and future physical activity engagement, total activity did not change from baseline to follow-up. The present study expanded the literature and showed that cannabis-related positive subjective experiences were not exclusive to habitual exercisers engaging in moderate-to-vigorous activity but extended to insufficiently active individuals doing lower-intensity physical activity as well. Although not prescriptive, these findings highlight the potential value of pairing an existing behavior, cannabis use, with a healthful behavior, physical activity, among insufficiently active adults.

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DEDICATION

I dedicate this dissertation to my husband, Alex Shapiro, who has supported my academic and professional journey for almost 10 years. Thank you for agreeing to spend the first year of our marriage with me taking on internship a year early while simultaneously completing my entire dissertation. There were so many times during this dissertation when I had nothing left to give. I'd put dirty dishes in the sink only to find them cleaned and back in the cupboard. I'd put laundry in the hamper only to find it washed and put away. I'd sit down at the table, hungry after a long day of writing, and be met with a home-cooked meal. You are every unseen moment behind this dissertation. You are the true reason I was able to make it to the finish line. I can never fully express the endless time, patience, and support you have given me. Thank you for catching me every single time I fell and reminding me, whenever I said I couldn't do it, that I could. For every moment, every quiet sacrifice, every hug, forehead kiss, and wiped tear. I love you immensely, and this milestone is ours to share – though I am very excited to correct anyone who mistakenly refers to you, rather than me, as Dr. Shapiro.

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Finally, to my mother. In preparing to write this dedication, I tried to find the number of women whose mothers also hold PhDs. The number is too small to easily report, which means we are an anomaly. I am who I am because you are who you are. Thank you for forging a path before I knew I wanted to take it, and for reminding me how powerful a well-educated woman is.

The picture of you in your doctoral regalia, with all eight of us kids in tow, carried me through this program.

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CHAPTER 1: INTRODUCTION

Physical Activity in the United States

There is a scientific consensus that regular physical activity provides a host of physiological and psychological benefits including improved cardiovascular health, enhanced muscular strength, reduced stress, and overall emotional well-being (Penedo & Dahn, 2005; P. Salmon, 2001; Warburton et al., 2006; Westcott, 2012). Research continues to support physical activity's unique role in promoting both physical fitness and psychological wellness, and yet, most Americans aren't getting enough of it (CDC, 2025). According to the CDC, only about one in two U.S. adults meet physical activity guidelines for aerobic activity, and only one in four meet guidelines for both aerobic and muscle-strengthening activities (CDC, 2025). Lack of physical activity is linked to a range of adverse health outcomes including increased risk for cardiovascular disease, higher risk of some cancers and type 2 diabetes, negative mental health impacts and premature mortality (Katzmarzyk et al., 2003; Kim et al., 2012; Lee et al., 2012; Rebar & Taylor, 2017; Venables & Jeukendrup, 2009). Beyond health impacts, physical inactivity is also financially burdensome for the healthcare system due to increased medical expenses from inactivity-related illnesses (Ding et al., 2017; Santos et al., 2023).

Evidence suggests that sedentary individuals tend to remain sedentary due actual or perceived psychological and physiological barriers (Koh et al., 2022; Rollo et al., 2016; Skrebutėnaitė & Karanauskienė, 2019). There are a number of factors that are commonly cited when seeking to understand sedentary behavior including physical health limitations, lack of time, environmental barriers, weather conditions, lack of social support, and low motivation or lack of enjoyment (Cerin et al., 2010; Cleland et al., 2015; Martins et al., 2021; Reichert et al.,

2007; J. Salmon et al., 2003; Tucker & Gilliland, 2007). Given persistently high rates of physical inactivity, researchers and public health advocates are seeking novel approaches to promote physical activity, particularly those that target experiential variables such as physical activity enjoyment, affect, perceived exertion, and positive psychological engagement (Creighton et al., 2022; Farias-Junior et al., 2020; Sevil-Serrano et al., 2022) among other subjective variables. One possible pathway to greater physical activity engagement involves factors that shape how physical activity feels during and after participation, including cannabis.

Cannabis and Physical Activity: A Novel Intersection

Concomitant with the recent increase in access and availability of cannabis products on the legal market in the U.S., there has recently been an increasing interest in the relation between cannabis and exercise (Burr et al., 2021; Lisano et al., 2018; Ogle et al., 2022; YorkWilliams et al., 2019). For example, a simple Web of Science search for the key terms “cannabis and exercise” returns 387 total publications, and 200 of those articles have been published in the past five years alone (*Web of Science*, 2026). There are a few reasons for this newfound intrigue in the literature. Cannabis has become increasingly legalized for recreational and medicinal purposes across the United States. As of 2026, 40 states, several U.S. territories, and the District of Columbia have legalized medical cannabis, and 24 of those states, along with D.C. and three U.S. territories have legalized recreational cannabis (National Conference of State Legislatures, 2025). Given these policies, it is not surprising that adult cannabis use in the U.S. continues to increase, while perceived risk of harm continues to decrease (SAMHSA, 2023, 2024, 2025).

These broader cultural shifts may help explain why cannabis is increasingly discussed in relation to health behaviors, including physical activity. Media coverage has highlighted professional athletes’ increasing openness about cannabis use for pain management, recovery,

anxiety, focus, and more (Newsham, 2021). For example, Anna Symonds, a retired Women's Premier League rugby player, uses her platform to advocate for cannabis as a therapeutic option for chronic pain and injuries, while advocating for policy change within sports organizations (Moore, 2021; Nielsen, 2022). Additionally, Al Harrington, a retired NBA player, launched his own cannabis brand, Viola, and uses it to challenge stereotypes and tout the medicinal advantages of cannabis (Morzaria, 2024). Together, these examples suggest that athlete advocacy may be contributing to changing public and institutional perceptions of cannabis in sports and physical activity more broadly.

In research literature, cannabis use in the context of physical activity has largely been studied among individuals who are already physically active, particularly recreational exercisers. While results from cannabis and exercise studies tend to be mixed due to varied methodology and legal restrictions impeding research, many studies report similar conclusions: those who use cannabis regularly tend to be more physically active than those who do not (French et al., 2021; Merrill et al., 2024; Ong et al., 2021; Xue et al., 2024). While this relationship may seem counterintuitive, it does not necessarily indicate that cannabis improves sport or exercise performance.

Indeed, some earlier studies reported that cannabis negatively impacted sport performance (Bird et al., 1980; Kvålseth, 1977; Renaud & Cormier, 1986; Steadward & Singh, 1975), whereas more recent findings have been less consistent. For example, performance-related variables such as peak work capacity, maximal oxygen uptake ($\text{VO}_2 \text{ max}$), and blood pressure have been examined; however, a 2020 literature review (Kramer et al., 2020) found no significant differences between these variables when comparing those who use cannabis to those who do not across four studies (Lisano et al., 2019, 2020; Maksud & Baron, 1980; Wade et al.,

2019). This null finding has been corroborated by subsequent articles as well (Aguilar Jr, 2023; Kennedy, 2022). Taken together, these findings suggest that the observed association between cannabis use and higher levels of physical activity is unlikely explained by objective performance enhancement alone.

The performance-focused literature also has important limitations. Historically, cannabis and physical activity studies predominantly involved participants consuming low doses of low-THC cannabis (Avakian et al., 1979; Bird et al., 1980; Renaud & Cormier, 1986; Steadward & Singh, 1975), which does not reflect the higher-potency products, or typical consumption patterns, prevalent in today's U.S. legal market (Freeman et al., 2021; Smart et al., 2017). As a result, researchers have increasingly turned their attention toward subjective factors that may explain why individuals combine cannabis with physical activity (Lisano et al., 2018; Ogle et al., 2022; Stallsmith et al., 2024; YorkWilliams et al., 2019). This shift has also encouraged the use of more ecologically valid research designs that may better capture how cannabis is used in real-world exercise contexts (Gibson & Bryan, 2023; Stallsmith et al., 2024).

Recent studies suggest that cannabis may influence physical activity through perceived cognitive, affective, and recovery-related benefits rather than objective performance enhancement. YorkWilliams and colleagues (2019) conducted a survey study about cannabis and health among a sample of individuals who use cannabis and reside in states with legalized cannabis. Questions focused on demographics, frequency of cannabis use, exercise patterns, and cannabis use in relation to exercise (i.e., before, during, after). The study found that 87.1% of participants reported using cannabis before and/or after exercise, and indicated doing so to enhance their enjoyment, aid in their recovery, and increase their motivation to exercise (YorkWilliams et al., 2019). This paramount study made it clear that overall, a large number of

those who use cannabis in states with legal cannabis markets combine it with physical activity in some way. Expanding this research, Ogle and colleagues (2022) recruited a sample of individuals who used cannabis recreationally and engaged in physical activity, then provided an extensive list of reasons why individuals might combine the two behaviors. Five responses were endorsed with the greatest frequency including to “help me focus,” “help me concentrate,” “help me enjoy the exercise experience,” “enhance mind/body/spirit connection,” and “to keep me in the zone” (Ogle et al., 2022). This result was then replicated in my recent research, which found that individuals most frequently endorsed combining cannabis with physical activity for the same five experiential reasons, while rarely endorsing performance-related reasons or negative experiences from combining the two behaviors (Stallsmith et al., 2024). Together, these studies suggest that, among individuals who are already physically active, perceived cognitive and affective benefits of cannabis play a meaningful role in shaping how and why they incorporate cannabis into their physical activity routines, potentially enhancing motivation and subjective experiences.

Nevertheless, these studies were conducted exclusively in individuals who were already engaging in physical activity or were otherwise sufficiently active. It remains unclear whether these perceived benefits extend to those who use cannabis and are insufficiently active and may need to increase their levels of physical activity. This distinction is particularly important in light of the high prevalence of both cannabis use and insufficient physical activity in the general population. According to the most recent National Survey on Drug Use and Health Annual National Report (SAMHSA, 2025), 64.2 million Americans aged 12 and older reported cannabis use in the past year (Substance Abuse and Mental Health Services Administration, 2025). Meanwhile, more than half of U.S. adults, or 137 million individuals, do *not* meet physical

activity guidelines for aerobic physical activity set forth by the Centers for Disease Control and Prevention (Elgaddal & Kramarow, 2026). While our field lacks a precise estimate of the overlap between those who use cannabis and those who are insufficiently active, it seems likely that a considerable number of Americans fall into this category. This subset of individuals (i.e., those who use cannabis regularly and do not meet minimum guidelines for physical activity) is important to study, as the health implications for physical inactivity are extensive (González et al., 2017; Katzmarzyk, 2023; Kohl et al., 2012). Understanding how cannabis use interacts with broader health behaviors for this group is a critical next step.

Psychological and Physiological Constructs Relevant to Cannabis and Exercise

As stated previously, there are numerous factors that contribute to the persistence of sedentary behavior. Perceived barriers to physical activity often include lack of time, lack of enjoyment, low motivation, lack of social support, and ecological factors, amongst others (Arzu et al., 2006; Herazo-Beltrán et al., 2017; Ilić et al., 2024; Moreno & Johnston, 2014; Moschny et al., 2011). While each of these domains are important to study, low motivation and lack of enjoyment are variables that have a unique intersection with both the field of psychology and the budding literature on cannabis and physical activity. Cross-sectional and longitudinal studies suggest that cannabis may enhance both enjoyment of and motivation for physical activity in those who are already physically active (Ogle et al., 2022; Stallsmith et al., 2024; YorkWilliams et al., 2019). Accordingly, it is plausible that similar effects could occur among individuals who are insufficiently active, thus enhancing their experience and potentially contributing to increases in physical activity over time.

Beyond enjoyment and motivation, prior research has also examined other subjective responses to cannabis use in the context of physical activity (Gibson et al., 2023; Gibson &

Bryan, 2023; Stallsmith et al., 2024). Variables including ratings of perceived exertion (RPE), mindfulness, and affective responses have all been explored in relation to physical activity and cannabis use, though primarily in samples of individuals who are already physically active (Gibson et al., 2023; Gibson & Bryan, 2023). For example, a 2023 study explored the subjective effects of combining cannabis with exercise (Gibson & Bryan, 2023). Specifically, this study examined psychological and physical outcomes such as enjoyment, affect, pain, perceived exertion, and dissociation using a within-subjects crossover design to compare running experiences under cannabis and non-cannabis conditions. The sample was comprised of 49 participants who regularly used cannabis, were aged 21 to 49, and were already highly physically active. After completing baseline measures, participants completed two runs in randomized order: one following *ad libitum* cannabis use and one without cannabis. Both runs occurred in naturalistic settings (i.e., participant selected running routes), with exercise and experiential data collected using the Nike Run Club app and pre- and post-run surveys, respectively. The surveys documented cannabis use (pre-cannabis-run) and evaluated changes in pain, exertion, enjoyment, affect, dissociation, and runner's high symptoms. Results showed that runs performed after cannabis use were associated with higher levels of positive affect, tranquility, enjoyment, dissociation, and runner's high symptoms (see subsection "The Endocannabinoid System and Affective Responses to Physical Activity" for more detail), as well as lower levels of pain, compared to non-cannabis runs. Perceived exertion was not statistically different between conditions. Although participants ran slightly slower during cannabis runs, this difference was not statistically significant, and outcomes were largely unrelated to cannabis form or cannabinoid content. These findings suggest that cannabis may enhance the subjective experience of exercise

among those who use cannabis regularly, potentially increasing its perceived enjoyment and reinforcing engagement.

The authors of this 2023 study emphasized the need for further research exploring the effects of cannabis on exercise experiences among less active individuals. For those who are insufficiently active, running after cannabis use may not be a realistic intervention. Walking, however, requires little to no equipment, is accessible to most individuals, and poses relatively low physical risk (Better Health Channel, 2023). Additionally, walking has been touted as the “nearest activity to perfect exercise” and is often prescribed successfully to even the most sedentary populations (Morris & Hardman, 1997; Ogilvie et al., 2007).

Building on the foundations of Gibson and Bryan’s work (Gibson & Bryan, 2023), the present study included individuals who did not meet recommended physical activity guidelines and who also regularly used cannabis, as this population is understudied and stands to benefit from interventions that may facilitate greater activity engagement. The study leveraged walking, rather than running, as the intervention because it is a feasible and scalable activity for the population of interest. In addition, the study contributes to the growing body of literature by examining individual differences between participants for whom cannabis may be most beneficial in the context of physical activity. This population is important to study because insufficiently active individuals may benefit from increased physical activity, yet often experience barriers to engagement, including perceptions of effort. Therefore, this study explored not only whether cannabis enhanced the physical activity experience, but also how it shaped perceptions of effort during physical activity.

Perceived Exertion

Ratings of perceived exertion (RPE) are an essential psychological construct in assessing how physically challenging an activity feels to an individual (Hutchinson & Tenenbaum, 2019). The concept of RPE was first proposed by Gunnar Borg in the 1960s, and scales were later developed to capture the personal experience of exertion during physical activity, with a focus on both physical sensations and psychological factors, rather than physiological factors (e.g., heart rate) alone (G. Borg, 1962, 1998; G. A. Borg, 1982). A higher RPE (i.e., higher rating of exertion) has been shown to be correlated with reduced enjoyment and a lower likelihood of adherence to physical activity (Ekkekakis et al., 2005). Research suggests that cannabis, with its potential anxiolytic and sedative effects (Atwood & Mackie, 2010; Martin et al., 2021), may help reduce discomfort, such as pain and inflammation, during physical activity (Gillman et al., 2015). This reduction in discomfort could, in turn, lower RPE, making physical activity feel less intense or difficult. However, in the aforementioned observational, naturalistic study by Gibson & Bryan (2023), no significant differences were found in RPE between the cannabis and non-cannabis runs. Similarly, subjective ratings of perceived exertion in a submaximal and maximal cycle ergometer exercise did not significantly differ across CBD-dominant, THC-dominant, and non-cannabis conditions (Cheung et al., 2024). In contrast, in a lab-based running study, participants actually reported significantly *greater* perceived exertion during cannabis use compared to a non-cannabis use condition, with stronger effects observed in the THC-dominant condition than the CBD-dominant condition (Gibson et al., 2023). Thus, despite the existence of plausible mechanism(s) through which cannabis might serve to reduce RPE, the limited existing studies to date found that cannabis conferred either no effect on RPE or increased RPE. However, at present, there are no published studies exploring this relationship among

insufficiently active individuals (i.e., those not meeting recommended guidelines for physical activity) who regularly use cannabis and engage in walking instead of running.

It is also notable that psychological factors such as mood, motivation, and mindfulness can impact RPE, even for low-impact activities such as walking. For example, individuals reporting negative mood states or low motivation often perceive walking as more effortful, even at moderate intensities (Ekkekakis et al., 2008). Accordingly, it was important to examine how psychological factors may influence RPE during walking sessions both with and without cannabis. For individuals who are less active or who find traditional forms of physical activity uncomfortable, even a walk may be perceived as effortful. A reduction in RPE, potentially influenced by cannabis use, may make physical activity feel more accessible and appealing.

Mindfulness

Mindfulness is another psychological construct often studied alongside physical activity because of their complementary mental and physical health benefits (K. W. Brown et al., 2007). In the literature, mindfulness is generally defined as a mental state where individuals focus intentionally on the present moment, maintaining an open and non-judgmental awareness of their thoughts, emotions, bodily sensations, and environment (Kabat-Zinn, 1994). While the definition provided may be more recent, the practice of mindfulness has been the root of Eastern meditation practices, and a tenant of Buddhism, for millennia (Skilton, 1997). Mindfulness can lead to greater acceptance and a sense of calm. Studies suggest that integrating mindfulness into physical activities such as walking, running, or yoga can enhance the exercise experience by promoting focus, present-moment awareness, positive affect, and stress reduction (Davis et al., 2022; Gothe & McAuley, 2015; Ullrich-French & Cox, 2020). Mindfulness during physical activity has even been shown to increase awareness of physical-activity-related health benefits,

thus improving attitude towards physical activity and increasing adherence long-term (S. Bryan et al., 2012; Li et al., 2014).

Given the potential benefits of mindfulness during physical activity (Blair Kennedy & Resnick, 2015; Schneider et al., 2019), it is important to consider whether cannabis may influence mindful states during physical activity. The link between cannabis use and mindfulness is nuanced, with much of the existing literature examining mindfulness as a factor related to cannabis use and a potential intervention for reduction (Folivi et al., 2025; Lin et al., 2021; Lorenzetti et al., 2025; Shurtleff, 2018), rather than cannabis use as a potential influence on mindful experiences. Research and anecdotal reports suggest that cannabis might temporarily enhance aspects of mindfulness, such as present-moment focus and sensory awareness (Murray & Srinivasa-Desikan, 2022). This claim has been better substantiated in the literature exploring cannabis use and mindfulness in the context of physical activity. As stated previously, in research where motivations to combine cannabis with physical activity were studied, the most frequently reported reasons included improving focus, enhancing the mind-body-spirit connection, staying “in the zone”, and enhancing body awareness (Ogle et al., 2022; Stallsmith et al., 2024). Each of these reasons reflect core aspects of mindfulness. When combined with activities like yoga or mindful walking, cannabis may help individuals focus more fully on body movements, breathing, and the environment, creating a richer, more immersive experience. For example, a study by Daniels and colleagues (2023) found that participants experienced significantly greater state mindfulness and a stronger sense of mystical experience during a cannabis and yoga session compared to the control. This suggests that combining cannabis with a structured, mindful activity like yoga or walking can elevate certain cognitive and experiential states. With a mindful approach, individuals may find physical activity more immersive and

satisfying, which could support long-term engagement with physical activity. Of course, this may not be the case when cannabis is combined with more vigorous activity like running, in which individuals tend to report greater dissociation during cannabis runs compared to non-cannabis runs (Gibson & Bryan, 2023). However, for lower intensity activities like walking, there is reason to believe cannabis may increase and/or facilitate mindfulness. The present study explored this possibility.

Affect

The literature on physical activity and affect consistently highlights the positive impact physical activity has on emotional well-being (Fox, 1999; Mahindru et al., 2023; Trajković et al., 2023). Numerous studies have shown that physical activity can significantly reduce negative emotional states and increase positive affect, resulting in feelings of pleasure, satisfaction, and contentment (Harvey et al., 2018; Reed & Buck, 2009; Reed & Ones, 2006). This positive affective response is often immediate, with benefits felt during and after physical activity, and may contribute to improved long-term mental health (Rebar et al., 2015). Research has demonstrated that positive affect felt during physical activity, which may increase enjoyment and satisfaction, can enhance motivation, reduce perceived barriers to staying active, and subsequently increase future physical activity (Brand & Ekkekakis, 2018; Rhodes & Kates, 2015; Williams et al., 2012).

The Endocannabinoid System and Affective Responses to Physical Activity

Research suggests that cannabis, affect, and physical activity may intersect through the endocannabinoid system (ECS). The ECS is an extensive neuromodulatory network (Lu & Mackie, 2021), with receptors widely distributed throughout the brain and body (Skaper & Di Marzo, 2012). These receptors interact with both exogenous cannabinoids, such as

tetrahydrocannabinol (THC) from the cannabis plant, and internal cannabinoids, known as endocannabinoids, produced naturally within the body (Lu & Mackie, 2016). The ECS is thought to help regulate mood, reward, and motivation (Fattore et al., 2010; Lu & Mackie, 2021; Zanettini et al., 2011). Early experimental research found that 45 minutes of moderate intensity exercise increased circulating plasma levels of endogenous cannabinoids compared to sedentary controls (Sparling et al., 2003). More recent work suggests that these endocannabinoids may contribute to the “runner’s high”, or the euphoric, anxiolytic, analgesic, and sedative effects following intense exercise (Dietrich & McDaniel, 2004), which was historically attributed primarily to endorphins (Boecker et al., 2008). Supporting this view, opioid blockade does not appear to prevent subjective effects of the runner’s high (Fuss et al., 2015; Siebers et al., 2021), which suggests that exercise-induced positive experiences may be better explained by endocannabinoids, rather than opioids alone (Siebers et al., 2026). Because both cannabis and physical activity engage the ECS, this system may help explain why some individuals combine cannabis with physical activity to increase enjoyment, motivation, recovery, or other subjective experiences (Lisano et al., 2018; Ogle et al., 2022; Stallsmith et al., 2024; YorkWilliams et al., 2019).

This concept is substantiated through numerous studies on cannabis and physical activity that show cannabis is associated with enjoyment of physical activity (Gibson et al., 2023; Gibson & Bryan, 2023; Ogle et al., 2022; Stallsmith et al., 2024; YorkWilliams et al., 2019). In my recent daily diary study on cannabis use and physical activity, there was a significant within-person association between positive affect and physical activity participation on any given day (Stallsmith et al., 2024). Cannabis exercise sessions have also been shown to produce significantly greater positive affect when compared to non-cannabis exercise sessions (Gibson et

al., 2023; Gibson & Bryan, 2023). Cannabis, which seems to foster enjoyment and positive affect during physical activity, may be a powerful driver for physical activity adherence, as people tend to engage in physical activities that they reliably find pleasurable. For that reason, it is critical to study the relation between cannabis, physical activity, and affect in a population of individuals who are insufficiently active, as this could offer insight into whether cannabis may support adherence to physical activity, particularly among those who struggle to find enjoyment in, or motivation for, physical activity.

Collectively, this literature suggests that affective responses may be an important mechanism linking cannabis use with physical activity engagement. If cannabis enhances positive affect during activity, it may make physical activity feel more rewarding and thereby support future engagement. However, these effects are unlikely to occur uniformly across all individuals. Therefore, it is important to consider individual differences that may shape whether cannabis enhances, has no effect on, or worsens the physical activity experience.

Individual Differences Relevant to Cannabis and Physical Activity

It is also important to recognize that cannabis-influenced experiential factors may vary across individuals (Atakan, 2012; Okey & Meier, 2020), conceivably influencing their impact on physical activity and related outcomes. For example, for some insufficiently active individuals, cannabis use could potentially worsen inactivity, heightening their susceptibility to related health issues. Conversely, for others, cannabis use might help to overcome psychological barriers to physical activity, thereby increasing physical activity engagement. The disparity between these two outcomes may be due to individual differences such as personality factors, psychological functioning, attitudes, health behaviors, and cannabis use habits amongst other factors.

Among these factors, perceived benefits and barriers to physical activity may play a particularly important role. Individuals who perceive greater barriers are less likely to engage in and maintain physical activity, whereas those who perceive greater benefits are more likely to initiate and sustain such behaviors (S. A. Brown, 2005; Gjestvang et al., 2020; Stutts, 2002). In the context of cannabis use, these perceptions may be especially relevant, as cannabis may alter perceived barriers such as lack of enjoyment, negative affect, and perceived exertion, potentially shifting individuals' perceptions of physical activity.

In reference to personality traits, meta-analyses have found that those high in neuroticism are prone to sedentary behavior and problematic cannabis use for coping with negative emotions (Allen et al., 2017; Winters et al., 2022). This may mean that for those high in neuroticism, cannabis could reinforce emotional and physical disengagement rather than physical activity. Similarly, low conscientiousness has been associated with both increased sedentary behavior and problematic cannabis use (Allen et al., 2017; Winters et al., 2022). Those lower in conscientiousness may struggle with motivation and maintaining goals, making long-term engagement in physical activity difficult. Cannabis use could exacerbate these tendencies, making it even more challenging to get active. Conversely, high openness has been shown to be positively associated with cannabis use, but not sedentary behavior (Allen et al., 2017; Winters et al., 2022). Individuals high in openness may be more inclined to experiment with combining cannabis and physical activity for a new experience, potentially increasing their enjoyment. Additionally, sensation-seeking and impulsivity-related traits have been linked to cannabis use (Satinder & Black, 1984; Trocki et al., 2009; Waddell et al., 2023) and engagement in stimulating or rewarding experiences (DeYoung & Rueter, 2010; Zuckerman, 1990), suggesting that individuals higher in these traits may be more inclined to combine cannabis with physical

activity. These traits may also influence how individuals initiate and maintain physical activity, particularly in novel or altered contexts, such as the conditions assigned in this study.

In addition to personality, psychological functioning could contribute to differing outcomes when combining cannabis with physical activity. For example, those experiencing mood disruptions, such as anxiety or depression, may rely on cannabis to cope with stress, or to alleviate symptoms like amotivation or anhedonia (Glodosky & Cuttler, 2020; Ouellette et al., 2023; Walsh et al., 2017). However, this is not a uniform effect. For some individuals with anxiety, cannabis, especially high-THC cannabis, may exacerbate anxiety and paranoia (Sharpe et al., 2020), perhaps negatively impacting the experience and subsequent engagement in physical activity. Importantly, these effects may not only vary across individuals but may also depend on how cannabis use, and the type of cannabis used, intersects with other affect-regulating behaviors, such as physical activity. Lisano et al. (2026) found that among individuals with mild or greater anxiety, cannabis-associated reductions in negative affect differed by both physical activity level and cannabis product type, with THC-dominant products showing the least reduction in negative affect (Lisano et al., 2026). Finally, varied expectancies around the effect of combining cannabis with physical activity may meaningfully change outcomes. For example, it is believed that anticipated effects of cannabis (i.e., expectancies) influence one's decision to use and subsequent use patterns and behaviors (Anthenien et al., 2021; Kristjansson et al., 2012). Therefore, it can be extrapolated that baseline expectancies for combining cannabis with physical activity, whether positive or negative, might influence one's experience.

Taken together, these findings suggest that individual differences may help explain why people have divergent experiences when combining cannabis with physical activities. To date, no known studies have identified which individuals are most likely to engage in physical activity

with cannabis use and experience positive effects, as opposed to those who are less likely to do so or who may experience diminished or adverse outcomes. It is vital to gain a better understanding of the qualities and characteristics that may predispose someone to experience harms or benefits from cannabis use so that informed recommendations can be made for specific individuals to increase their physical activity. Given prior research indicating that cannabis may increase enjoyment, concentration, and the mind/body connection when paired with physical activity (Gibson et al., 2023; Gibson & Bryan, 2023; Ogle et al., 2022; Stallsmith et al., 2024), it was hypothesized that cannabis could serve as an intervention for at least some subset of insufficiently active individuals by enhancing the subjective exercise experience (e.g., through increasing enjoyment, mindfulness, motivation, etc.), thereby potentially facilitating greater physical activity engagement. The study further examined individual differences to identify for whom such experiential enhancements may be most evident.

Study Aims and Hypotheses

The purpose of this study was to investigate relations between self-reported ratings of perceived exertion (RPE), mindfulness, and emotional responses (i.e., affect and enjoyment) to physical activity in the context of cannabis use among individuals who use cannabis regularly and are not physically active. The study implemented a remote, longitudinal design to capture naturalistic behaviors and enhance ecological validity. Using a within-subjects design, the study compared participants' experience of going for a walk after acute, self-administered, *ad libitum* use of legal-market flower cannabis to their experience going for a walk without using cannabis. Primary analyses focused on within-person differences in pre- to post-walk perceived exertion, positive affect, and enjoyment.

Regression models were used to examine whether more positive affective experiences during the cannabis walk were associated with stronger intentions to combine cannabis with physical activity in the future, as well as greater intentions to engage in physical activity following the walk. Exploratory analyses further examined whether these intentions predicted physical activity behavior reported at a follow-up assessment while accounting for baseline physical activity levels. In addition, the study aimed to evaluate whether individual difference variables, including demographic, personality, and psychological factors predicted differences in enjoyment between cannabis and non-cannabis walks.

By examining the subjective experience of light to moderate physical activity, such as walking, among insufficiently active individuals who use cannabis, this study sought to determine whether cannabis use may enhance the affective experience of physical activity, and to identify for whom combining cannabis with physical activity may be most enjoyable and motivating.

Aims and Hypotheses

Aim 1. Assessed participants' self-reported ratings of perceived exertion (RPE), mindfulness, and emotional responses (i.e., affect, enjoyment) following each walk condition. Using a within-subjects design, the effects of engaging in a walk without cannabis and a walk following acute, self-administered, ad libitum use of commercially available, legal-market cannabis of participants' choosing were compared.

Hypothesis 1a-c. Participants were expected to report a) lower ratings of perceived exertion (RPE), b) greater mindfulness, and c) greater feelings of positive affect and enjoyment, following a walk with cannabis compared to a walk without cannabis.

Aim 2. Assessed participants' experience using cannabis during a walk and examined associations with intentions to use cannabis during future physical activity. Specifically, this aim investigated whether positive affective experiences during the cannabis walk predicted stronger intentions to combine cannabis with physical activity in the future and stronger intentions to engage in physical activity. In addition, this aim examined whether greater intentions to combine cannabis with physical activity were associated with higher levels of physical activity reported at follow-up. A within-subjects design was used to compare immediate post-cannabis-walk experiences to subsequent intentions and follow-up physical activity behavior.

Hypothesis 2a-b. Participant ratings of how positive they found the experience of using cannabis during their walk would predict a) stronger intentions to combine cannabis with physical activity in the future and b) stronger intentions to engage in physical activity in the future.

Hypothesis 2c. Greater reported intentions to combine cannabis with physical activity would be associated with greater physical activity engagement at one-month follow-up assessment.

Aim 3. Characterized individual differences associated with responding more favorably to the cannabis walk (i.e., greater enjoyment during the cannabis walk relative to the non-cannabis walk). Specifically, this exploratory aim examined whether demographic characteristics, personality, and psychological functioning measured differentiated participants who experienced greater enjoyment during the cannabis walk from those who did not.

It was hypothesized that individual differences would emerge between participants who experienced greater enjoyment during the cannabis walk compared to the non-cannabis walk and those who did not, such that:

Hypothesis 3a. Demographic characteristics would be associated with differences in enjoyment between cannabis and non-cannabis walks.

Hypothesis 3b. Personality traits would be associated with differences in enjoyment between cannabis and non-cannabis walks.

Hypothesis 3c. Psychological factors (e.g., cannabis-exercise expectancies, emotion regulation difficulties, psychological distress, exercise attitudes, cannabis use severity) would be associated with differences in enjoyment between cannabis and non-cannabis walks.

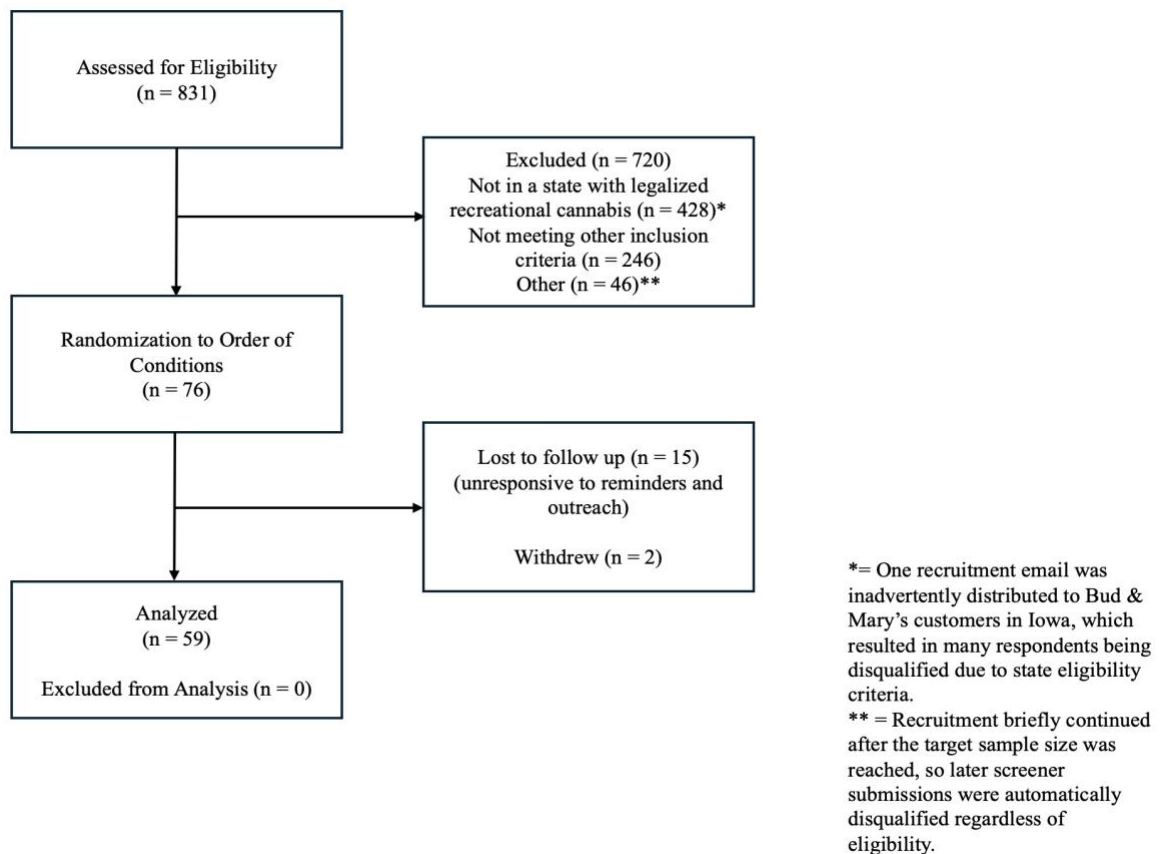
CHAPTER 2: METHOD

Participants

Participants aged 21-65 who lived in U.S. states where recreational cannabis use is legal were recruited for the present study. The minimum participation age of 21 was set in accordance with age restrictions for purchasing and consuming legal-market cannabis. Participants were recruited if they endorsed low physical activity levels (i.e., engaged in moderate to vigorous physical activity less than 90 minutes per week), as determined by a self-report questionnaire within the eligibility survey. Participants were required to have used cannabis while engaging in physical activity (e.g., walking, yardwork, playing frisbee, yoga, bicycling) at least once in their lifetime, and to have reported no negative effects from doing so. Per the criteria set forth by Gibson & Bryan (2023), “no negative effects” was defined as having experienced no physical injuries or psychological distress as a result of combining cannabis and activity. Participants in this study were required to be willing to complete a 2-mile outdoor walk both with and without using flower cannabis prior to initiating the walk. Participants were required to have access to a smartphone and to agree to download and use the Map My Walk application during the walks. Participants who provided consent supplied sociodemographic information and completed surveys related to the study’s objectives. Individuals with medical conditions that increased the risk of complications during exercise, as self-reported by participants through the PAR-Q and You questionnaire, were excluded. Detailed inclusion and exclusion criteria are provided in Appendix A.

A priori power analysis using G*Power 3.1 software (Faul, 2009) was conducted to identify the minimum sample size needed to achieve statistical power of 0.80 with an alpha level of 0.05. Given that the study included multiple analytic approaches across aims, including

Figure 1
CONSORT Diagram



repeated-measures models and regression-based analyses, the sample size estimation was based on the most conservative power estimate requiring the largest number of participants. Therefore, the sample determination was based on a linear regression model with two predictors and a small to moderate effect size ($f = 0.20$), which yielded a needed sample size of 52 participants. Although fewer participants were needed for the primary within-subjects analyses, this strategy ensured sufficient power for both within-subject and between-person regression analyses, which

allowed the detection of meaningful effects across all study aims. 76 participants were consented and enrolled into the study. Of these, 59 participants completed all study procedures and were retained in the final analytic sample. Notably, all participants who completed the first walk also completed the second walk and follow-up assessment. This allowed the study to have an achieved power of 0.86 for regression-based analyses and 0.96 for repeated-measures models. See Figure 1 for a visual representation of participant progress through the study.

Procedure

Participants were recruited via social media (e.g., Reddit, Instagram), posted flyers, targeted email blasts sent by Bud & Mary's Cannabis Brand to customers in states with legalized recreational cannabis laws, and Craigslist ads to complete an online eligibility survey powered through REDCap. Recruitment and data collection occurred from July 2025 – January 2026. Before completing the prescreening portion of the study, participants were provided with study information and consent details. The full text of this information is included in Appendix B.

Once participants completed the prescreening online via REDcap, study staff manually reviewed their responses to determine eligibility. Ineligible participants were notified via email. When a participant was eligible, the study staff contacted them via telephone and explained the study and read over consent. Telephone conversations to describe study procedures and consent participants took approximately 20 minutes to complete. During the phone call, the study staff explained the study procedure in detail and resultant compensation for completing all parts of the study. Participants were informed that participation was voluntary and that they were free to withdraw consent and discontinue participation at any time without penalty.

The study was conducted entirely virtually and included four components: a baseline survey (divided into Part I and Part II to reduce participant burden and allow for breaks), pre-

and post-walk questionnaires for each walk (cannabis and non-cannabis conditions), and a follow-up survey administered one month after completion of the second walking condition. Participants were told they could earn up to \$85 for participating in the study, which included \$15 for completing the baseline survey, \$25 for the combined pre- and post-walk survey in each condition, and \$20 for completing the online follow-up survey. If individuals wanted to join the study after discussion of study procedures, the study staff consented them and provided instructions for downloading the Map My Walk mobile application onto their smartphone. Afterward, participants were informed of their randomly assigned walking condition order. Randomization was completed using a random number generator, with an even number corresponding to cannabis then non-cannabis walk (Order A), and an odd number corresponding to non-cannabis then cannabis walk (Order B). See Figure 2 for further details. After the call concluded, participants received an email with a link to the online baseline survey on REDCap. The two-part baseline questionnaire included questions on demographics, health behaviors, psychological well-being and substance use history and patterns. Details of the baseline measures can be found in Appendix B. Participants were asked to complete both parts of the baseline survey within 48 hours.

Once participants completed the baseline surveys, they were emailed instructions for their first assigned walk condition, along with pre- and post- walk questionnaire links. Each participant completed two 2-mile walks in their neighborhood or surrounding area: one following *ad libitum* flower cannabis use, and one without flower cannabis use. Participants were asked to refrain from any cannabis use for 24 hours before each intended walk, regardless of condition to minimize residual effects of prior cannabis use across walking conditions. For the cannabis walk, participants used cannabis immediately before beginning the walk and then completed the

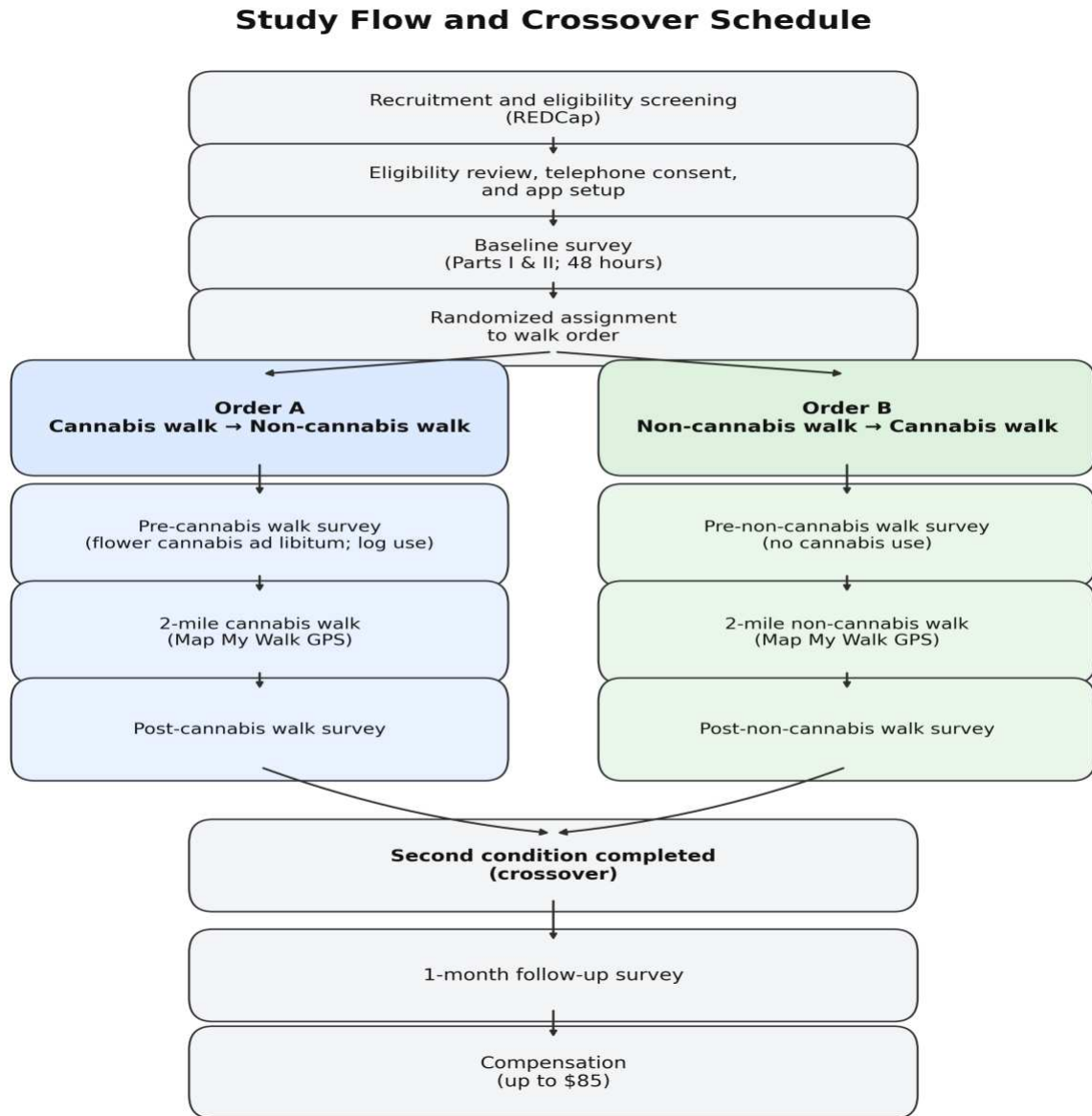
cannabis consumption questionnaire before starting the walk. Separate emails were sent for each condition, and each email contained instructions and questionnaires for a single walk only (cannabis or non-cannabis), in the order in which participants were randomized. Participants were instructed to complete each walk and corresponding surveys within one week of receiving the email. Participants were asked to keep conditions as similar as possible across walks (e.g., time of day), and each walk was logged using the Map My Walk application, a GPS-based activity tracker.

Participants were sent a daily reminder via text or email (depending on preference) until completion of the walk and surveys, or for a maximum of 7 days, whichever occurred first. Forty-eight hours after completing the initial set of questionnaires and accompanying walk, participants received another email with instructions to complete their second walk within one week, with the same instructions outlined above. In the cannabis-walk email, participants were instructed to use a flower cannabis product of their choosing *ad-libitum* only directly before beginning the walk. In the pre-walk survey, they then reported the amount used and method of consumption and uploaded a photo of the product packaging.

One month after participants completed the second of the two walks, they were emailed a follow-up survey that collected information on recent physical activity, psychological well-being, substance use patterns, motivation and, if applicable, current experiences combining cannabis with physical activity.

Figure 2

Study Participation Flow



Note. Procedural overview of the study. Participants were randomly counterbalanced to walking condition in a crossover design to control for order effects and increase experimental efficiency. Image generated using the prompt "Refine my study flow diagram to improve clarity, add Order A and B crossover, change compensation to \$85, and use rounded rectangles instead of ovals" by ChatGPT (March 2026 version), OpenAI, 2026 (<https://chatgpt.com>).

Measures

All items and measures can be found in Appendix B.

Eligibility Screening

The PAR-Q and You. The PAR-Q and You (Shephard, 1988) is a 7-item measure used to screen for health risks prior to exercise. Participants indicate yes or no to questions about conditions like heart issues, joint pain, and chronic illnesses. For this study, participants were only included if they respond "no" to all 7 questions, indicating that it was generally safe for them to proceed with a study on physical activity.

Baseline and 1-month Follow-Up Measures

Baseline Only Measures

Demographic Characteristics. Participants answered questions regarding age, sex assigned at birth, gender identity, ethnicity, race, socioeconomic factors and social history. A detailed breakdown of these variables across the sample is provided in Table 1.

Daily Session, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU). The DFAQ-CU is a 39-item questionnaire assessing aspects of cannabis use, including frequency, age of onset, and quantity consumed. Authors Cuttler and Spradlin created the DFAQ-CU as a robust tool, and the factors have demonstrated good reliability, with Cronbach's alpha coefficients ranging from 0.69 for daily sessions to 0.95 for frequency (Cuttler & Spradlin, 2017). Additionally, these factors show strong convergent, predictive, and discriminant validity in comparison with other cannabis use measures.

Cannabis Use Disorder Identification Test Revised (CUDIT-R). The CUDIT-R (Adamson et al., 2010) is an 8-item measure used to identify problematic cannabis use and

potential cannabis use disorders. The CUDIT-R has demonstrated high sensitivity (91%) and specificity (90%) in prior work. In the present sample, the CUDIT-R total score demonstrated acceptable internal consistency ($\alpha = 0.69$).

Marijuana Withdrawal Checklist (MWC). The MWC (Budney et al., 1999, 2003) was used to assess withdrawal symptoms from cannabis cessation. Consistent with prior work, the 15-item version of the MWC (Budney et al., 2003) administered to this sample demonstrated good internal consistency ($\alpha = 0.86$).

Ten Item Personality Inventory (TIPI). The TIPI (Gosling et al., 2003) is a 10-item measure used to assess the Big 5 personality traits (i.e., openness, conscientiousness, extraversion, agreeableness, and neuroticism). Each item was rated on a 7-point scale ranging from “Disagree strongly” to “agree strongly.” Consistent with TIPI scoring, two-item subscales were calculated for each trait. In the present sample, inter-item correlations ranged from 0.07 to 0.53.

Short UPPS-P Impulsive Behavior Scale (SUPPS-P). The SUPPS-P (Lynam, 2013) is a 20-item measure developed to assess five key factors of impulsivity (i.e., negative urgency, lack of premeditation, lack of perseverance, sensation seeking, positive urgency). It is a shortened version of the full scale UPPS-P. In the present sample, internal consistence was acceptable to good across subscales: negative urgency ($\alpha = 0.83$), lack of perseverance ($\alpha = 0.73$), lack of premeditation ($\alpha = 0.84$), sensation seeking ($\alpha = 0.70$), and positive urgency ($\alpha = 0.73$).

Sensation Seeking Personality Trait Scale (SSPT). The SSPT (Conner, 2022) is a 10-item measure developed to assess Experience Seeking (ES) and Risk Seeking (RS). Each factor contains 5 items, and each item is rated on a scale from 1 (strongly disagree) to 5 (strongly

agree). In the present sample, internal consistency was good for risk seeking ($\alpha = 0.83$) and acceptable for experience seeking ($\alpha = 0.70$).

Difficulty in Emotion Regulation Scale Short Form (DERS-SF). The DERS-SF (Kaufman et al., 2016) is an 18-item measure used to evaluate individuals' emotional regulation capacities. There are six domains of emotional regulation difficulties, and in each domain there are questions rated on a 5-point scale from “almost never” to “almost always,” with higher scores representing greater difficulties with emotional regulation. In the present sample, DERS-SF demonstrated high internal consistency ($\alpha = 0.91$).

The Depression, Anxiety, and Stress Scale (DASS-21). The DASS-21 is a brief, 21-item self-report questionnaire designed to measure levels of depression, anxiety, and stress. Each of the three subscales consists of 7 items, with responses rated on a 4-point scale from 0 (“did not apply to me at all”) to 3 (“applied to me very much or most of the time”); (Lovibond & Lovibond, 1995). In the present sample, the internal consistency was good for depression subscale ($\alpha = 0.90$), and stress subscale ($\alpha = 0.87$), lower for the anxiety subscale ($\alpha = 0.64$) and excellent for the total score ($\alpha = 0.92$).

Baseline and 1-Month Follow-Up

The SF-12 Health Survey. The SF-12 is a 12-item questionnaire designed to assess both physical and mental health, generating two primary scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). In previous studies, the measure demonstrated good reliability and was validated against the longer SF-36 (Ware et al., 1996). In the present study, PCS and MCS scores were calculated at baseline and 1-month follow-up using the standard scoring algorithm from the original publication and Cronbach’s alpha was not calculated because these are weighted component scores.

Exercise Benefits/Barriers Scale (EBBS). The EBBS is a 43-item measure of perceived barriers (e.g., “It costs too much to exercise.”) and perceived benefits (e.g., “I have improved feelings of well-being from exercise.”) to exercise (Sechrist et al., 1987). In the present sample, the internal consistency for the EBBS total score at baseline was high ($\alpha = 0.92$) and at one-month follow up ($\alpha = 0.91$). Internal consistency was also high for the benefits subscale at baseline ($\alpha = 0.94$ and follow-up ($\alpha = 0.92$), and acceptable for the barriers subscale at baseline ($\alpha = 0.78$) and follow-up ($\alpha = 0.79$).

The Physical Activity Enjoyment Scale - Short Version (PACES-S). The PACES-S is a shortened, 4-item measure created to evaluate enjoyment and emotional responses related to physical activity (C. Chen et al., 2021). In the present sample, the PACES-S demonstrated good internal consistency at baseline ($\alpha = 0.89$) and follow-up ($\alpha = 0.90$).

Cannabis and Exercise Expectancies Questionnaire. The Cannabis and Exercise Expectancies Questionnaire is a measure of reinforcement expectancies with regard to the use of cannabis with exercise developed by researchers within the CUChange Lab at the University of Colorado, Boulder. It was adapted from the Alcohol Expectancy Questionnaire (S. A. Brown et al., 1987). The original questionnaire had 7 questions. To evaluate psychometric properties, a confirmatory factor analysis was performed, and 5 items were retained for the scale. In the present study, the 5-item measure demonstrated acceptable internal consistency at baseline ($\alpha = 0.77$) and follow-up ($\alpha = 0.70$).

Modified Godin Leisure-Time Exercise Questionnaire (GLTEQ). The GLTEQ (Godin & Shephard, 1985) is a self-report tool measuring leisure-time physical activity. The measure asks individuals to report number of times (of 15 minutes or more) they have engaged in strenuous, moderate, and mild exercise over the past week during free time. This measure has

demonstrated concurrent validity through associations with objective fitness indicators and acceptable test-retest reliability for the total leisure activity score ($r = 0.74$) (Godin & Shephard, 1985). The measure has also been validated for use in many research populations including those with multiple sclerosis and ADHD, among others (Alotaibi et al., 2024; Motl et al., 2018). For this study, the GLTEQ was modified to ask participants the total minutes per week spent in each exercise intensity category, as well as the number of separate exercise sessions completed in each category.

(Follow-Up Only) Cannabis and Exercise Questionnaire. The Cannabis and Exercise Questionnaire is a 7-item measure developed by researchers within the CUChange Lab at the University of Colorado, Boulder. It was designed to evaluate how often participants use cannabis while engaging in exercise and to explore their motivations for doing so. Measures were combined with preexisting survey questions used in previous research (Ogle et al., 2022; Stallsmith et al., 2024), such as questions assessing the types of physical activities participants engaged in while using cannabis, as well as a new item assessing perceived differences in cannabis effects when used during physical activity compared to sedentary use. Together, these items were used to create a novel questionnaire consisting of 16 total items. The questionnaire included a mix of multiple choice, dichotomous (yes/no) options, and open-ended responses.

Pre-Walk and Post-Walk Measures (Non-cannabis and Cannabis conditions)

The Physical Activity Affect Scale (PAAS). The PAAS (Lox et al., 2000) is a 12-item measure used to evaluate emotional responses to physical activity. It includes four dimensions: positive affect, negative affect, fatigue, and tranquility. In the present sample, internal consistency across the PAAS subscale for positive affect, the only component used for analyses, was good (α 's = 0.81 - 0.83).

Fatigue. Fatigue was assessed using a single, adapted, Likert-type item (Temel et al., 2006). The measure prompts participants “How would you rate your fatigue on a scale of 0 to 10 with 0 being 'no fatigue' and 10 being the 'worst possible fatigue'?”

Feeling Scale (FS). This measure (Hardy & Rejeski, 1989) is a single-item, bipolar scale designed to measure the subjective experience of pleasure or displeasure during physical activity. The measure prompts participants to answer “How do you feel right now? (before or after exercise)” on an 11-point scale from very good (5) to very bad (-5).

Felt Arousal Scale (FAS). The FAS (Svebak & Murgatroyd, 1985) is a single-item measure used to assess the perceived level of physiological arousal during or after an activity. The measure prompts participants to “Estimate here how aroused you actually feel. Do this by moving the slider. "Arousal" here means how "worked-up" you feel. You might experience high arousal in one of a variety of ways, for example as excitement or anxiety or anger. Low arousal might also be experienced by you in one of a number of different ways, for example as relaxation or boredom or calmness” on a 6-point scale from low arousal (1) to high arousal (6).

State Mindfulness Scale (SMS). The SMS (Tanay & Bernstein, 2013) is a 21-item measure developed to assess temporary mindfulness, focusing on bodily sensations (6 items) and mental events (15 items). In the present sample, internal consistency was excellent across pre- and post-walk assessments in the cannabis and non-cannabis conditions (α 's = 0.93 - 0.95).

Post-Walk Only

The Physical Activity Enjoyment Scale - (PACES). The PACES is an 18-item measure created to evaluate enjoyment and emotional responses related to physical activity on a 7-point bipolar scale (Kendzierski & DeCarlo, 1991). (Latorre Roman et al., 2014; Motl et al., 2001; Murrock et al., 2016). In the present sample, the PACES demonstrated excellent internal

consistency following both the cannabis walk ($\alpha = 0.92$) and the non-cannabis walk ($\alpha = 0.95$)

Modified Borg RPE (CR10 Scale). The CR10 Scale (G. A. Borg, 1982) is a shortened (single-item) version of the Borg scale. The CR10 scale ranges from 0 (no exertion, at rest) to 10 (maximum effort, highest possible). The CR10 Scale is commonly used in walking interventions and has demonstrated test-retest reliability and validity as a measure of exercise intensity, even lower intensity physical activity in prior work (G. Borg, 1998; M. J. Chen et al., 2002; Shariat et al., 2018). To simplify participant responding, the original ratings were collapsed into 7 ordinal exertion categories: 0 = 0, No exertion (at rest), 1 = 1, Very light; 2 = 2 to 3, Light; 3 = 4 to 5, Moderate (somewhat hard); 4 = 6 to 7, High (vigorous); 5 = 8 to 9, Very hard; 6 = 10, Maximum effort (highest possible).

Attentional Focus. This scale (Gillman & Bryan, 2016) is a single-item measure used to assess attentional focus during exercise, using a 10-point scale. This scale asks participants to rate their focus from "internal" (focusing on bodily sensations or personal experiences) to "external" (distracted or focusing on external elements like surroundings or entertainment).

Intentions for Future Physical Activity. This is a three-item measure on perceived behavioral control to measure intentions to exercise (A. D. Bryan & Rocheleau, 2002). Participants rated each item on a 7-point Likert scale from 1 (Strongly Disagree) to 7 (Strongly Agree). In the present sample, internal consistency was modest following both the cannabis walk ($\alpha = 0.61$) and the non-cannabis walk ($\alpha = 0.58$). Given that shorter scale length and smaller samples can result in a misleadingly low alpha (Xiao et al., 2024), inter-item correlations (IIC) were calculated and suggested reasonable item homogeneity (Piedmont, 2024), r 's = 0.32 – 0.34.

Objective Reports of Physical Activity. After completing walks, participants were asked to submit a screenshot of their tracked walk from the Map My Walk application, which

included time spent walking, route, distance traveled, pace, and heart rate if they are wearing an activity tracking device (e.g., Apple Watch, Garmin, etc.). Applications such as this have been shown to be effective for activity tracking (Benson et al., 2015).

Additional Measures Administered at Only Pre- and Post-Walk with Cannabis Sessions

Pre-Walk Only

Cannabis Consumption Measure. This is a collection of objective measures related to participant's cannabis use prior to going on their two-mile walk. Participants were asked to report amount of cannabis used in grams or milligrams (pictures were provided to aid in estimation of amount), route of administration, and time of consumption (both start and end time). Participants were asked to upload a photo of dispensary packaging and report cannabinoid content from the product label.

Pre- and Post-Walk

Drug Effects Questionnaire (DEQ). The DEQ (de Wit & Phillips, 2012) is a 5-item measure used to assess subjective responses to drugs, including both positive and negative strength and desirability of effects. The DEQ has demonstrated good discriminant validity, as evidenced by the items distinguishing between active drug and placebo responses, and good construct, convergent, and criterion validity across substances (Morean et al., 2013). In the present sample, the DEQ demonstrated moderate internal consistency for the pre-cannabis walk questionnaire ($\alpha = 0.621$) and post-cannabis walk questionnaire ($\alpha = 0.58$).

Post-Walk Only

Subjective Reports of Combining Cannabis with Physical Activity. This measure assessed participants' subjective experiences walking with cannabis and their future intentions to combine cannabis with physical activity. It also included an item assessing whether participants

perceived the effects of cannabis to differ when used during physical activity compared to sedentary use. For the full set of post-cannabis walk subjective experience items, see Appendix B.

Data Analysis Plan

Data Handling and Preparation

All analyses were conducted using version 2026.01.2-418 of R Studio (Posit team, 2025). Missing data were evaluated before conducting hypothesis tests. Unplanned missing data across study variables was low, ranging from 0% to 3.39%. A substantial portion of missingness was due to planned branching logic preventing participants from viewing items that were not relevant based on earlier responses. Prior to hypothesis testing, patterns of missing data were examined. Cases were classified as structurally missing rather than missing due to nonresponse. For analyses involving true missing data, listwise deletion was utilized. This approach was deemed appropriate and unlikely to bias parameter estimates because missing data were limited and no systematic differences were observed between participants with and without complete data (Allison, 2009; Little & Rubin, 2019).

Analysis 1. For this aim, post-walk differences in perceived exertion, enjoyment, and affective outcomes between the cannabis and non-cannabis walking conditions were examined using paired-sample tests when assumptions for this type of analysis were met and Wilcoxon signed-rank tests when they were not. Separate mixed-effect models were also used to evaluate changes in mindfulness and positive affect from pre- to post- walk across condition.

To test Hypothesis 1a, which predicted significantly lower RPE following the cannabis walk than the non-cannabis walk, post-walk RPE scores were compared using a Wilcoxon signed-rank test. This nonparametric within-subjects test was selected because participants completed both walking conditions and the distribution of RPE difference scores violated the

normality assumption required for a paired-samples t-test. Because RPE was measured using an adapted version of the Borg CR10 (G. A. Borg, 1982) with seven ordinal exertion categories, the Wilcoxon signed-rank test was also appropriate for comparing paired ordinal ratings across conditions.

To test Hypothesis 1b, which predicted mindfulness would be significantly higher following a walk with cannabis compared to one without, the hypothesis was first tested using a paired-samples t-test comparing post-walk mindfulness ratings across the cannabis and non-cannabis conditions. Mindfulness was measured as a summed score from the State Mindfulness Scale (Tanay & Bernstein, 2013) with higher scores indicating greater mindfulness. To further evaluate mindfulness across pre- and post-walk, a linear mixed-effects model was conducted with condition, time, and condition x time interaction as predictors. This model assessed both average differences in mindfulness across condition and time, as well as whether changes in mindfulness from pre- to post-walk differed between the cannabis and non-cannabis conditions. Random intercepts were estimated for participants, and baseline physical activity, cannabis-exercise expectancies, and conscientiousness were initially evaluated as covariates. Cannabis-exercise expectancies were retained in the final model; others were excluded due to limited contribution to model fit and parsimony.

To test Hypothesis 1c, which stated that positive affect and enjoyment would be significantly greater following a walk with cannabis compared to one without, post-walk condition differences were evaluated separately for positive affect and enjoyment. Positive affect was measured by an average score on the PAAS (Lox et al., 2000). The positive affect difference scores met assumptions of normality, therefore a paired-samples t-test was conducted to compare post-walk positive affect ratings between the cannabis and non-cannabis conditions. Positive

affect was also examined using a mixed-effect model with condition, time, and condition by time as predictors. Random intercepts were estimated for participants. This model assessed whether positive affect differed by condition, changed from pre- to post-walk, and whether changes over time differed between cannabis and non-cannabis conditions. Enjoyment was measured via the Physical Activity Enjoyment Scale (Kendzierski & DeCarlo, 1991) through a sum score and only assessed post-walk, was tested through a within-subject post-walk comparison. Difference scores violated assumptions of normality; therefore a Wilcoxon signed-rank test was conducted to compare post-walk enjoyment scores between the cannabis and non-cannabis conditions.

Analysis 2. For this aim, participants' cannabis-walk experiences and their relations to intentions and subsequent physical activity behavior were examined using linear regression models, and one multiple linear regression model.

To test Hypothesis 2a, which stated that higher positive affect following the cannabis-walk would predict significantly greater future intentions to combine cannabis with physical activity, linear regression was used with the positive affect as the predictor and future intentions as the outcome. Positive affect was treated as a continuous predictor. Future intentions were measured using a 5-point Likert-type item and treated as approximately continuous for this analysis. The item was reverse coded so that higher scores reflected stronger future intentions. This model evaluated whether participants who reported greater positive affect following the cannabis walk also reported stronger intentions to use cannabis with physical activity in the future.

To test Hypothesis 2b, which stated that higher positive affect following the cannabis-walk would predict significantly greater intentions for physical activity immediately following the walk, utilized another linear regression model. Positive affect was the continuous predictor,

and reported intentions to engage in physical activity in the future was calculated as a mean score from the intentions questionnaire (A. D. Bryan & Rocheleau, 2002) and treated as a continuous outcome. This model evaluated greater positive affect following the cannabis walk was associated with stronger intentions to engage in future physical activity.

To test Hypothesis 2c, which stated that greater intentions to combine cannabis with physical activity would be associated with significantly higher physical activity engagement at follow-up, a multiple linear regression was conducted. Intentions to combine cannabis with physical activity in the future was the predictor, and follow-up physical activity engagement was the outcome. Intentions to engage in physical activity in the future was calculated as a mean score from the intentions (A. D. Bryan & Rocheleau, 2002) and treated as approximately continuous for this analysis. Physical activity at follow up was measured using total minutes of physical activity from the Godin Leisure-Time Exercise questionnaire (Godin & Shephard, 1985) and treated as a continuous outcome. Baseline physical activity, also measured as total Godin minutes, was included as a covariate. This model evaluated whether stronger intentions to combine cannabis with physical activity predicted greater physical activity engagement at follow-up after accounting for baseline physical activity.

An exploratory analysis was added to this hypothesis to examine changes in mild, moderate, and vigorous activity from baseline to 1-month follow-up. Physical activity was measured as minutes reported on the Godin Leisure Time Exercise Questionnaire (Godin & Shephard, 1985). Change scores were calculated for physical activity at each intensity level, and separate linear regression models were conducted predicting changes in mild, moderate, and vigorous activity from intentions, controlling for baseline physical activity at the corresponding intensity level. These models evaluated whether stronger intentions to combine cannabis with

physical activity predicted greater physical activity engagement at each intensity level at follow-up after accounting for baseline physical activity.

Analysis 3. For this aim, individual differences including demographics, personality factors, and psychological factors, were used as predictors of differences in enjoyment between the cannabis and non-cannabis walks. For each participant, an enjoyment difference score was calculated by subtracting the non-cannabis walk enjoyment from the cannabis-walk enjoyment rating, which was measured using the PACES (Kendzierski & DeCarlo, 1991). Higher scores indicated greater enjoyment during the cannabis walk relative to the non-cannabis walk. Linear regression models were used to test whether individual difference variables were associated with this enjoyment difference score.

Hypothesis 3a was tested using linear regression models. Given the absence of prior data to inform the expected direction of the association, this hypothesis was evaluated using a non-directional approach. The enjoyment difference score was the continuous outcome. Age and gender, measured during the baseline survey, were examined as demographic predictors. Age was treated as a continuous predictor, and gender was treated as a categorical predictor. In the initial model, both age and gender were included as predictors. A final model was then tested with gender as the only predictor. These models evaluated whether demographic characteristics were associated with differences in enjoyment between the cannabis and non-cannabis walks.

Hypothesis 3b was tested using linear regression models. Given the absence of prior data to inform the expected direction of the association, this hypothesis was evaluated using a non-directional approach. The enjoyment difference score was the continuous outcome. Theoretically relevant personality variables were examined as predictors, including experience seeking, risk taking, positive urgency, negative urgency, sensation seeking, and openness. Experience seeking

and risk taking were examined using the Sensation Seeking Personality Trait Scale (Conner, 2022), impulsivity related items were measured using the Short UPPS-P Impulsive Behavior Scale (Lynam, 2013) and openness was measured using the Ten Item Personality Inventory (Gosling et al., 2003). All personality predictors were treated as continuous predictors. In the initial model, all predictors were included, then removed sequentially based on model results. The final model included openness as the only predictor. These models evaluated whether personality characteristics were associated with differences in enjoyment between the cannabis and non-cannabis walks.

Hypothesis 3c was tested using linear regression models. Given the absence of prior data to inform the expected direction of the association, this hypothesis was evaluated using a non-directional approach. The enjoyment difference score was the continuous outcome.

Psychological variables including cannabis-exercise expectancies, emotion regulation difficulties, psychological distress, exercise attitudes, and cannabis use were examined as predictors. Cannabis-exercise expectancies were measured by an average on the Cannabis and Exercise Expectancies Questionnaire. Emotion regulation difficulties were measured by a total score on the DERS-SF (Kaufman et al., 2016). Psychological distress was measured by the DASS total score (Lovibond & Lovibond, 1995). Exercise attitudes were measured by a total score on the Exercise Benefits and Barriers Scale (Sechrist et al., 1987), with higher ratings indicating more positive perceptions of exercise. Cannabis use severity was measured from the total score on CUDIT-R (Adamson et al., 2010). All predictors were treated as continuous. In the initial model, all predictors were included, then removed sequentially based on model results. The final model included cannabis-exercise expectancies and exercise attitudes as predictors.

These models evaluated whether psychological characteristics were associated with differences in enjoyment between the cannabis and non-cannabis walks.

CHAPTER 4: RESULTS

Descriptive Statistics

76 individuals met inclusion criteria, were recruited, and completed the consent portion of this study. Of those recruited, 59 completed the baseline survey, pre- and post-cannabis walk condition, pre- and post-non-cannabis walk condition, and 1-month follow-up survey. This resulted in a final sample of 59 participants (male = 31, female = 27, intersex = 1). Table 1 presents the demographic and baseline characteristics for the 59 participants in the final sample. Participants average age was 39.78 years ($SD = 10.16$; range = 21-59). The majority of the sample identified as non-Hispanic (78.0%) and White (79.7%). Participants were generally highly educated, with 45.8% holding a bachelor's degree or higher. The majority (68.4%) were employed full time. At baseline, participants reported regular cannabis use with most using weekly or more frequently (98.3%), with a mean CUDIT-R score of 11.85 ($SD = 5.31$). On the SF-12, participants had a mean Physical Component Score of 33.58 ($SD = 5.96$) and a mean Mental Component Score of 52.69 ($SD = 7.10$), suggesting relatively poorer physical health functioning compared to a normative sample but average to somewhat above-average mental health functioning compared to a normative sample. Participants reported engaging in an average of 144.66 ($SD = 200.46$) minutes of mild-intensity exercise, 78.56 ($SD = 85.08$) minutes of moderate-intensity exercise, and 31.78 ($SD = 46.75$) minutes of vigorous-intensity exercise per week.

Table 1*Participant demographics and baseline characteristics.*

	Overall N = 59
<i>Demographics</i>	
Age	39.78 (10.2)
Sex	
Female	27 (45.8%)
Male	31 (52.5%)
Intersex	1 (1.7%)
Gender	
Woman	25 (42.4%)
Man	32 (54.2%)
Non-binary	1 (1.7%)
Prefer not to respond	1 (1.7%)
Ethnicity	
Not Hispanic or Latin/a/o/x/e	46 (78.0%)
Hispanic or Latin/a/o/x/e	3 (5.1%)
Another	8 (13.6%)
Do not wish to respond	2 (3.4%)
Race	
Black or African American	6 (10.2%)
White	47 (79.7%)
Another	2 (3.4%)
Do not wish to respond	3 (5.1%)
Two or more races	1 (1.7%)
Education	
High school diploma or GED	5 (8.5%)
Some college	11 (18.6%)
Associate degree / Technical certification	16 (27.1%)
Bachelor's degree	22 (37.3%)
Master's degree	4 (6.8%)
Doctoral degree	1 (1.7%)
Employment Status	
Unemployed / Disabled / Retired / Other	7 (12.3%)
Part-time employed (<30 hrs/week)	4 (7.0%)
Full-time employed (≥30 hrs/week)	39 (68.4%)
Full-time student	3 (5.3%)
Homemaker / Stay-at-home parent	4 (7.0%)

Table 1*Participant demographics and baseline characteristics.*

	Overall N = 59
Income	
\$0 - \$9,999	3 (5.1%)
\$10,000 - \$19,999	3 (5.1%)
\$20,000 - \$29,999	5 (8.5%)
\$30,000 - \$39,000	4 (6.8%)
\$40,000 - \$49,000	3 (5.1%)
\$50,000 - \$59,000	5 (8.5%)
Over \$60,000	36 (61.0%)
<i>Baseline Characteristics</i>	
Cannabis Frequency	
2-3 times a month	1 (1.7%)
Once a week	2 (3.4%)
Twice a week	4 (6.8%)
3-4 times a week	9 (15.3%)
5-6 times a week	9 (15.3%)
Once a day	10 (16.9%)
More than once a day	24 (40.7%)
Cannabis Use Disorder Score	11.85 (5.31)
SF-12 Physical Component Score	33.58 (5.96)
SF-12 Mental Component Score	52.69 (7.10)
Mild Exercise Minutes/Wk	144.66 (200.5)
Moderate Exercise Minutes/Wk	78.56 (85.1)
Vigorous Exercise Minutes/Wk	31.78 (46.8)

Note. Mean (SD) or n (%). Percentages for categorical variables are based on nonmissing responses for that variable.

Effects of Cannabis on Subjective Walking Experience

Walk orders were randomly assigned and counterbalanced between participants. Participants were instructed to complete their pre-walk surveys directly before the started their walk, then complete their post-walk surveys immediately after they completed their walk. Data (e.g., duration, pace, distance, etc.) were collected for cannabis and non-cannabis walks via Map My Walk application screenshots of completed walks. Of the 59 captured non-cannabis-walks, six screenshots were incorrectly captured and uploaded, and therefore excluded because final distance, duration, and pace values were not available. Descriptive analyses therefore included 53 completed walks. Among the 53 completed walks, mean distance was 2.04 miles ($SD = 0.22$; range = 1.12–2.69 miles). Median time to complete a walk was 42 minutes 57 seconds (range = 25:24–2:06:19). Median walking pace was 20 minutes 57 seconds per mile (range = 15:26–60:09 min/mi). Of the 59 captured cannabis-walks, two screenshots were incorrectly captured and uploaded, and therefore excluded because final distance, duration, and pace values were not available. Descriptive analyses therefore included 57 completed walks. Among the 57 completed walks, mean distance was 2.07 miles ($SD = 0.11$; range = 1.79–2.42 miles). Median time to complete a walk was 44 minutes 43 seconds (range = 32:57–2:18:21). Median walking pace was 21 minutes 38 seconds per mile (range = 16:13–68:09 min/mi). With regards to the consumption method in the cannabis-walk condition, joints were the most commonly reported method of flower consumption ($n = 18$, 30.5%), followed by pipes ($n = 16$, 27.1%), pre-rolls ($n = 8$, 13.6%), vaporizers ($n = 7$, 11.9%), bongs ($n = 5$, 8.5%), and other methods ($n = 4$, 6.8%). One participant (1.7%) had missing data for this section. 52 participants reported the amount of flower used, which was on average 0.60 grams ($SD = 0.43$; median = 0.50; range = 0.02–2.00). 57 participants reported the percentage THC in their products, and mean THC concentration was

27.0% ($SD = 10.2$; median = 25.2%; range = 10%–85%). Finally, 53 participants reported the percentage of CBD in their products, and mean CBD concentration was 0.33% ($SD = 1.23$; median = 0%; range = 0%–8%).

Descriptive statistics were calculated for all primary study variables including RPE, mindfulness, affect, and enjoyment across cannabis and non-cannabis conditions. Correlations among variables for Aim 1 and Aim 2 can be found in Table 2 below. Data were examined for missingness, outliers, and distributional properties. All values were determined to be plausible and retained. Assumptions of normality were evaluated using Shapiro-Wilk test on difference scores (cannabis minus non-cannabis). Variables that met normality assumptions were analyzed using parametric tests (paired sample t -tests), and non-normally distributed variables were analyzed using nonparametric tests (Wilcoxon signed-rank tests).

Covariates were initially selected based on theoretical relevance and included baseline physical activity, cannabis-exercise expectancies, and personality traits. Non-significant covariates were removed in a stepwise fashion to improve model parsimony, resulting in a final model that retained cannabis-exercise expectancies as the only significant covariate.

Perceived Exertion (RPE)

Given that perceived exertion difference scores violated assumptions of normality based on Shapiro-Wilk testing, a Wilcoxon signed-rank test was conducted. The Wilcoxon signed-rank test indicated that there was no significant difference in perceived exertion between the cannabis and non-cannabis conditions, $V = 196.00$, $z = 0.19$, $p = 0.86$, $r = 0.02$, representing a negligible effect. Perceived exertion was scored using a modified, single-item scale with seven ordinal categories ranging from 0 (no exertion) to 6 (maximal effort). The median score on exertion in the cannabis condition was 2.00, identical to 2.00 on the non-cannabis condition, representing

light exertion. Observed ratings ranged from 1 (very light) to 4 (high, vigorous), in both the cannabis and non-cannabis condition.

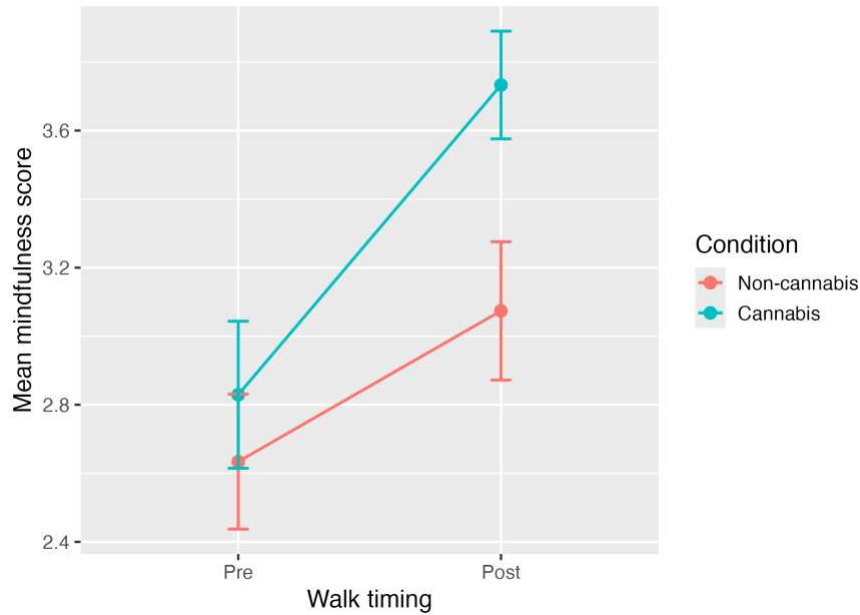
Mindfulness

Given that mindfulness difference scores met assumptions of normality, a paired-samples *t*-test was conducted. It indicated that mindfulness was significantly higher following the cannabis walk compared to the non-cannabis walk, $t(58) = 6.24, p < 0.001, d = 0.81$, representing a large effect. Participants reported greater mindfulness in the cannabis condition ($M = 3.73, SD = 0.81$) compared to the non-cannabis condition ($M = 3.07, SD = 0.79$).

To further examine changes across time and condition, a linear mixed-effects model was conducted. There was not a significant main effect of condition. There was a significant main effect of time ($B = 0.45, SE = 0.11, p < 0.001$), indicating that mindfulness increased from pre- to post-walk across conditions. Results also revealed a significant condition by time interaction ($B = 0.46, SE = 0.15, p < 0.01$), indicating that increases in mindfulness from pre- to post-walk were significantly greater in the cannabis condition compared to the non-cannabis condition. Cannabis-exercise expectancies were also a significant predictor of mindfulness ($p < 0.01$).

Figure 3

Condition by Time Interaction for Mindfulness



Positive Affect

Given that positive affect difference scores were normally distributed, a paired-samples t -test was conducted, which indicated that positive affect was significantly higher following the cannabis walk compared to the non-cannabis walk, $t(58) = 4.03, p < 0.001, d = 0.52$, representing a medium effect. Participants reported greater positive affect in the cannabis condition ($M = 2.35, SD = 0.99$) compared to the non-cannabis condition ($M = 1.83, SD = 0.94$).

A linear mixed-effects model revealed significant main effects of condition ($B = 0.35, SE = 0.11, p < 0.01$) and time ($B = 0.54, SE = 0.11, p < 0.001$), indicating higher overall positive affect in the cannabis condition and increases from pre- to post-walk. The condition by time interaction was not significant ($p = 0.30$).

Enjoyment

The analytic sample for analyses involving enjoyment difference scores was reduced due to missing data. Two participants were missing enjoyment ratings for one condition, precluding a difference score being calculated, resulting in an $n = 57$. Given that enjoyment difference scores

violated assumptions of normality based on Shapiro-Wilk testing, a Wilcoxon signed-rank test was conducted and indicated that enjoyment was significantly higher following the cannabis walk compared to the non-cannabis walk, $V = 1456.50$, $z = 5.37$, $p < 0.001$, $r = 0.71$, representing a large effect. Enjoyment scores were summed from an 18-item, 7-point Likert scale survey, resulting in a total possible score from 18 to 126, with higher numbers indicating greater enjoyment. The median score for enjoyment in the cannabis condition was 104.00 compared to 91.00 in the non-cannabis condition.

Table 2*Descriptive Statistics and Correlations Among Aim 1 and Aim 2 Study Variables*

Variable	n	M	SD	1	2	3	4	5	6	7	8
1. Enjoyment difference score	59	0.82	1.05	—							
2. RPE difference score	59	0.02	0.75	-.026 (.85)	—						
3. Mindfulness difference score	59	0.66	0.81	.250 (.06)	-.031 (.81)	—					
4. Positive-affect difference score	59	0.52	0.99	.605*** ($<.001$)	-.070 (.60)	.073 (.58)	—				
5. Post-cannabis-walk positive affect	59	2.35	0.78	.162 (.22)	.117 (.38)	-.092 (.49)	.377** (.003)	—			
6. Post-cannabis-walk intention to combine cannabis with PA again	58	4.48	0.80	.266* (.04)	-.166 (.21)	-.106 (.43)	.417** (.001)	.344** (.008)	—		
7. Post-cannabis-walk future PA motivation/intention	59	5.10	1.00	.177 (.18)	.223 (.09)	.020 (.88)	.134 (.31)	.443*** ($<.001$)	.162 (.22)	—	
8. Follow-up physical activity (minutes/week)	59	263.46	184.20	.054 (.68)	-.131 (.33)	.162 (.22)	.147 (.27)	.012 (.93)	.174 (.19)	-.055 (.68)	—

Note. Difference scores were calculated as cannabis-condition scores minus non-cannabis-condition scores. Positive values for enjoyment, mindfulness, and positive affect indicate higher scores in the cannabis condition. Asterisks denote two-tailed statistical significance, * $p < .05$, ** $p < .01$, *** $p < .001$.

Cannabis Walk Experiences, Intentions, and Physical Activity

Positive Affect Predicting Cannabis Related Intentions

To test whether positive experiences after the cannabis walk would be associated with greater intentions to combine cannabis with physical activity in the future, a linear regression model was conducted. There was a significant effect of positive affect on intentions to combine cannabis with physical activity ($B = 0.39$, $SE = 0.13$, $t(56) = 3.13$, $p < 0.01$), such that greater positive affect after the cannabis walk was significantly associated with stronger intentions to use cannabis prior to physical activity in the future. The model explained 14.9% of the variance in intentions ($R^2 = 0.15$), indicating a small-to-moderate effect. Although residuals were non-normal based on Shapiro-Wilk testing, linear regression is generally robust to moderate violations of residual normality (Knief & Forstmeier, 2021) and visual inspection of residual diagnostics did not reveal serious violations of regression assumptions, therefore results from linear regression analyses were retained.

Positive Affect Predicting Intentions for Future Physical Activity

To test whether positive cannabis-walk experiences would be associated with greater intentions for physical activity immediately following the walk, a linear regression was conducted, and the model met all regression assumptions. There was a significant effect of positive affect on intentions for future physical activity ($B = 0.60$, $SE = 0.15$, $t(57) = 4.02$, $p < 0.001$), such that greater positive affect after the cannabis walk was associated with stronger intentions to engage in physical activity following the experience. The model accounted for 22.1% of variance in intentions ($R^2 = 0.22$), indicating a moderate effect.

Intentions Predicting Physical Activity Behavior

To test whether greater intentions to combine cannabis with physical activity would be significantly associated with higher levels of physical activity overall at follow-up, a multiple linear regression was conducted controlling for baseline physical activity. At 1-month follow-up, participants reported a mean of 263.46 minutes of total physical activity per week ($SD = 184.20$, range: 22 – 960). The overall model was not statistically significant, $F(2, 55) = 2.68, p = 0.08$, and accounted for 8.9% of the variance in follow-up physical activity ($R^2 = 0.09$), indicating a small effect. There was not a significant effect of intentions to combine cannabis with physical activity on one month follow-up physical activity ($B = 26.18, SE = 29.93, t(55) = 0.88, p = 0.39$). However, baseline physical activity was a significant predictor of follow-up physical activity ($B = 0.22, SE = 0.10, t(55) = 2.24, p = 0.03$), such that participants with higher baseline activity levels reported higher levels of physical activity at follow-up. Residuals were non-normal based on Shapiro-Wilk testing, though linear regression is generally robust to moderate violations of residual normality (Knief & Forstmeier, 2021). One non-plausible value was identified (Cook's $D > 1$) and winsorized by reducing it to one unit greater than the next highest observed value, then the model was rerun. Intentions remained a nonsignificant predictor of follow-up physical activity ($B = 27.78, SE = 29.31, t(55) = 0.95, p = 0.35$). Therefore, this result was retained but should be interpreted with caution.

Exploratory Analyses of Physical Activity Intensity

An exploratory analysis was added to test whether greater intentions to combine cannabis with physical activity would be significantly associated with higher levels of mild, moderate, and/or vigorous activity at follow-up while controlling for baseline physical activity at the corresponding intensity level, using multiple linear regression. At 1-month follow-up,

participants reported a mean of 123.0 minutes of mild physical activity per week ($SD = 108$, range: 0 - 500). For moderate activity, participants reported a mean of 92.1 minutes per week ($SD = 76.6$, range: 0 - 360). For vigorous activity, participants reported a mean of 48.8 minutes per week ($SD = 61.0$, range: 0 – 240). Intentions did not significantly predict changes in mild activity ($B = 20.54$, $p = 0.23$), moderate activity ($B = 9.72$, $p = 0.45$), or vigorous activity ($B = 0.59$, $p = 0.95$). Residuals were non-normal based on Shapiro-Wilk testing, though linear regression is generally robust to moderate violations of residual normality (Knief & Forstmeier, 2021). Two non-plausible values were identified (Cook's $D > 1$), one within mild activity and one within moderate activity. These values were winsorized by reducing them to one unit greater than the next highest observed value, then the model was rerun. Intentions remained nonsignificant predictors of mild activity change ($B = 20.60$, $p = 0.208$), moderate activity change ($B = 11.7$, $p = 0.358$), and vigorous activity change ($B = 0.59$, $p = 0.950$). Exploratory analyses were robust to winsorization of highly influential physical activity values.

Individual Difference Predictors of Cannabis-Related Enjoyment

A comprehensive table, including correlations among variables for Aim 3 can be found in Table 3 below.

Demographic Predictors

A linear regression model examined whether age and gender predicted differences in enjoyment between cannabis and non-cannabis walks. The full model was not statistically significant, $F(4, 52) = 0.23, p = .921$, and accounted for 1.7% of the variance in enjoyment difference scores ($R^2 = 0.02$), indicating a negligible effect. Neither age nor gender significantly predicted enjoyment differences (p 's > 0.48). Overall, demographic variables did not meaningfully explain variability in cannabis-related enjoyment. Post-hoc power analysis indicated that with $N = 57$ and $\alpha = 0.05$, the study had 80% power to detect effects of approximately Cohen's $f^2 \geq .23$. Thus, for this model, smaller effects may not have been detectable with this sample size.

Personality Predictors

A linear regression model examined whether personality traits predicted enjoyment differences. Personality variables were selected based on theoretical relevance to reward sensitivity and exercise-related experiences, as well as statistical significance. The initial full model included sensation seeking, impulsivity-related variables, and openness as predictors and was not significant, $F(6, 50) = 0.71, p = 0.64, R^2 = 0.08$, indicating a small effect.

Stepwise model trimming based on statistical significance ($p < 0.10 - 0.15$) was conducted, and the final model retained only openness. This model approached significance $F(1, 55) = 2.98, p = 0.090, R^2 = 0.05$, indicating a small effect. Openness was negatively associated with enjoyment differences ($B = -0.390, SE = 0.23, t(55) = -1.73, p = 0.090$), such that

individuals higher in openness showed slightly smaller differences in enjoyment between cannabis and non-cannabis walks. This effect did not reach statistical significance, however it may indicate a modest trend whereby individuals higher in openness experience relatively similar enjoyment across conditions. Although residuals deviated from normality based on Shapiro-Wilk testing, linear regression is generally robust to moderate violations of this assumption (Knief & Forstmeier, 2021), and results were therefore retained.

Psychological Predictors

A linear regression model examined whether cannabis-exercise expectancies, emotion regulation difficulties, psychological distress, exercise attitudes, and cannabis use severity predicted enjoyment differences. The full model was significant, $F(5, 51) = 3.90, p = 0.005$, explaining 27.7% of the variance in enjoyment differences ($R^2 = 0.28$), indicating a moderate-to-large effect. After stepwise trimming based on statistical significance ($p > 0.10 - 0.15$), the final model retained cannabis-exercise expectancies and exercise attitudes as significant predictors and remained significant, $F(2, 54) = 7.96, p < 0.001$, explaining 22.8% of the variance ($R^2 = 0.23$), indicating a moderate effect.

Cannabis-exercise expectancies were positively associated with enjoyment differences ($B = 11.52, SE = 3.36, t(54) = 3.43, p = 0.001$), such that individuals with stronger positive expectancies about combining cannabis with physical activity experienced greater increases in enjoyment during cannabis walks compared to non-cannabis walks.

Exercise attitudes were negatively associated with enjoyment differences ($B = -0.34, SE = 0.16, t(54) = -2.15, p = 0.036$), indicating that individuals with more positive attitudes towards exercise exhibited smaller differences in enjoyment between condition. Although residuals deviated from normality based on Shapiro-Wilk testing, linear regression is generally robust to

moderate violations of this assumption (Knief & Forstmeier, 2021), and results were therefore retained.

Table 3*Descriptive Statistics and Correlations Among Aim 3 Individual-Difference Variables*

Variable	n	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Enjoyment difference score	59	0.82	1.05	—																	
2. Age (years)	59	39.78	10.16	.090 (.50)	—																
3. TIPI Extraversion	59	4.17	1.53	-.175 (.18)	.260 (.05)	—															
4. TIPI Agreeableness	59	5.14	1.17	.102 (.44)	.058 (.67)	-.101 (.44)	—														
5. TIPI Conscientiousness	59	5.31	1.26	-.168 (.20)	.073 (.58)	.045 (.74)	.150 (.26)	—													
6. TIPI Emotional stability	59	4.63	1.43	-.085 (.52)	.288 (.03)	-.077 (.56)	.422 ($<.001$)	.216 (.10)	—												
7. TIPI Openness	59	5.58	1.08	-.161 (.22)	-.080 (.55)	.282 (.03)	.127 (.34)	.128 (.34)	.148 (.26)	—											
8. SSPT Experience seeking	59	4.00	0.56	-.142 (.28)	-.016 (.91)	.262 (.05)	.032 (.81)	.280 (.03)	.160 (.23)	.431 ($<.001$)	—										
9. SSPT Risk seeking	59	2.24	0.75	-.215 (.10)	-.054 (.68)	.393 (.002)	-.287 (.03)	-.272 (.04)	-.151 (.25)	.144 (.28)	.322 (.01)	—									
10. SUPPS-P Negative urgency	59	2.09	0.75	.008 (.95)	-.086 (.52)	.272 (.04)	-.334 (.01)	-.295 (.02)	-.421 ($<.001$)	-.175 (.18)	-.078 (.56)	.485 ($<.001$)	—								
11. SUPPS-P Lack of perseverance	59	1.83	0.57	.067 (.61)	-.179 (.17)	-.102 (.44)	-.068 (.61)	-.386 (.003)	-.151 (.25)	-.127 (.34)	-.255 (.05)	.112 (.40)	-.084 (.53)	—							

Variable	n	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
12. SUPPS-P Lack of premeditation	59	1.73	0.58	-.148 (.26)	-.021 (.88)	.284 (.03)	-.317 (.01)	-.378 (.003)	-.277 (.03)	-.086 (.52)	.043 (.75)	.342 (.01)	.299 (.02)	.203 (.12)	—						
13. SUPPS-P Sensation seeking	59	2.66	0.75	-.119 (.39)	-.062 (.64)	.294 (.02)	-.001 (.99)	-.024 (.85)	.189 (.15)	.429 ($<.001$)	.556 ($<.001$)	.606 ($<.001$)	.029 (.83)	.079 (.55)	.144 (.28)	—					
14. SUPPS-P Positive urgency	59	1.59	0.53	-.019 (.89)	-.007 (.96)	.123 (.35)	-.370 (.004)	-.348 (.007)	-.291 (.03)	-.107 (.42)	.106 (.43)	.533 ($<.001$)	.476 ($<.001$)	-.018 (.89)	.312 (.02)	.081 (.54)	—				
15. DERS-SF score	59	35.69	11.56	-.065 (.63)	-.406 (.001)	.019 (.87)	-.342 (.008)	-.312 (.02)	-.577 ($<.001$)	-.188 (.16)	-.055 (.68)	.306 (.02)	.602 ($<.001$)	.146 (.27)	.236 (.07)	-.015 (.91)	.352 (.006)	—			
16. Depression	59	6.98	7.74	-.105 (.43)	-.347 (.007)	-.114 (.40)	-.272 (.04)	-.304 (.02)	-.547 ($<.001$)	-.228 (.08)	-.118 (.37)	.225 (.09)	.468 ($<.001$)	.301 (.02)	.291 (.03)	-.015 (.91)	.270 (.04)	.727 ($<.001$)	—		
17. Anxiety	59	5.92	5.23	.075 (.57)	-.243 (.06)	-.230 (.08)	-.279 (.03)	-.068 (.61)	-.437 ($<.001$)	-.164 (.21)	-.212 (.11)	.049 (.71)	.315 (.02)	-.120 (.37)	.062 (.64)	-.149 (.26)	.182 (.17)	.399 (.002)	.402 (.002)	—	
18. Stress	59	9.88	8.30	-.173 (.19)	-.327 (.01)	.029 (.83)	-.308 (.02)	-.181 (.17)	-.587 ($<.001$)	-.094 (.48)	-.075 (.58)	.332 (.01)	.489 ($<.001$)	.035 (.79)	.345 (.008)	.042 (.75)	.247 (.06)	.578 ($<.001$)	.716 ($<.001$)	.536 ($<.001$)	—

Note. The enjoyment difference score was calculated as cannabis-condition enjoyment minus non-cannabis-condition enjoyment; positive values indicate greater enjoyment in the cannabis condition.

CHAPTER 5: DISCUSSION

Cannabis holds a complex and frequently contested role in physical activity. Perhaps surprisingly, individuals seem to be combining cannabis with their physical activity at notable rates (Lisano et al., 2018; Ogle et al., 2022; YorkWilliams et al., 2019). While exact rates of co-occurrence are unknown, preliminary results from survey data reveal that more than 80% of individuals in states with legalized recreational cannabis use cannabis concurrently with exercise (YorkWilliams et al., 2019). It is evident from the literature that cannabis does not reliably enhance exercise performance (Kramer et al., 2020), therefore researchers have turned their attention to the subjective effects of combining cannabis with exercise as a possible explanation for the high rate of combining these behaviors.

For example, among those who use cannabis regularly, cannabis use prior to exercise has been associated with greater positive affect, reduced negative affect, increased tranquility and greater enjoyment in cannabis-exercise conditions compared to non-cannabis-exercise conditions, in the absence of a statistically significant effect on performance (Gibson et al., 2023; Gibson & Bryan, 2023). These subjective experiences are important because positive affective responses to physical activity are strongly linked to future physical activity engagement (Henderson & Ainsworth, 2002; Millstein et al., 2020; Pasco et al., 2011). However, much of this work has been conducted among individuals who are already active. For example, existing exercise-intervention studies examining cannabis and physical activity have largely included physically active samples rather than insufficiently active adults. Although not all studies explicitly recruited physically active participants, available sample characteristics suggest that existing cannabis-exercise intervention studies have largely included active individuals. Cheung

et al. (2024) recruited participants from community and club-level cycling and rowing teams (Cheung et al., 2024), while Gibson and colleagues (Gibson et al., 2023; Gibson & Bryan, 2023) reported sample characteristics of participants who exceeded the minimum recommendation of 150 minutes of moderate-to-vigorous physical activity per week (CDC, 2025). Thus, existing intervention work may better reflect the experience of physically active individuals and be less generalizable to insufficiently active adults. Moreover, these studies assigned participants to intense exercise, like maximal effort on a cycle ergometer (Cheung et al., 2024), or running (Gibson et al., 2023; Gibson & Bryan, 2023), a high-impact form of exercise that is more physically demanding and may carry a greater risk of injury than lower-impact activities (Medical Associates of Northwest Arkansas, 2021). In addition, because these studies involved highly active individuals, participants may have been more likely to derive positive experiences from physical activity and perceive fewer barriers to engagement. Together, these factors limit the extent to which prior findings generalize to less active populations. Insufficiently active populations are particularly relevant to study because nearly half of U.S. adults do not currently meet minimum recommendations for physical activity (CDC, 2025), and they may respond differently to physical activity interventions than highly active samples. Therefore, it remains unclear whether cannabis use prior to low-impact physical activity, such as walking, produces similarly positive subjective experiences among individuals who are insufficiently active.

The present study aimed to fill this gap in the literature by investigating the relationship between cannabis and physical activity among adults who regularly use cannabis but did not meet minimum recommendations for physical activity, a group that may stand to benefit from strategies to increase physical activity engagement. The study utilized a naturalistic design, which allowed participants to walk outdoors in their own neighborhoods or surrounding areas, a

form of physical activity that was accessible, familiar, and may more closely reflect the types of physical activity that insufficiently active individuals engage in outside of a research setting. Additionally, walking, and activity outdoors, are both highly reported in the literature on combining cannabis with physical activity (Ogle et al., 2022; YorkWilliams et al., 2019), making the present study's focus on outdoor walking especially relevant to how individuals may actually combine these behaviors in everyday life. Specifically, subjective outcomes such as perceived exertion, affect, mindfulness, and enjoyment were examined to determine whether positive subjective experiences would also emerge in this understudied population. The study also explored individual difference factors that may predict who may derive the greatest benefit from combining cannabis with physical activity. The randomized, within-subjects, crossover design allowed cannabis and non-cannabis walk experiences to be compared within the same individuals, reducing between-person variability (Liu, 2010) and strengthening the ability to detect condition-related differences in subjective walking experiences. Overall, the study demonstrated that cannabis use was associated with a more positive walking experience, characterized by greater levels of mindfulness, more positive affect, and greater enjoyment, without increasing perceived exertion. However, while positive acute experiences were associated with exercise intentions, this did not translate to actual changes in physical activity behavior at the one-month follow-up.

Notably, ratings of perceived exertion (RPE) did not differ between the cannabis and non-cannabis walks. This finding is divergent from the study hypothesis that cannabis use may *lower* ratings of perceived exertion due to its perceived medicinal properties (Hoch et al., 2025) which could potentially reduce discomfort during physical activity (Gillman et al., 2015). However, the present result adds to the existing evidence that shows cannabis does not reliably

reduce RPE (Cheung et al., 2024; Gibson & Bryan, 2023). This pattern has now appeared across both active and insufficiently active adults, and a range of exercise modalities including running, cycle ergometer, and walking. In contrast, one study has reported that cannabis *increased* ratings of perceived exertion between cannabis and non-cannabis runs (Gibson et al., 2023). Together, these findings suggest that cannabis may be neutral, or even unfavorable to RPE, despite theoretical and medicinal reasons to expect otherwise (Atwood & Mackie, 2010; Gillman et al., 2015; Hoch et al., 2025; Martin et al., 2021).

The absence of differences in RPE between the cannabis and non-cannabis walks suggests that the positive affective responses to physical activity captured by this study were not simply attributable to differences in perceived exertion (i.e., the cannabis walk was not more enjoyable simply because it felt easier). It is important to note that in this study participants were allowed to self-pace their walks, which may help explain why RPE was low in both conditions. It is also important to note that RPE scales were originally developed as a proxy to heart rate during physical activity (G. Borg, 1962). Importantly, THC-containing cannabis products can increase heart rate (Page et al., 2020), which may have influenced some participant's RPE more than the walk itself. This possibility should be considered, and controlled for, in future studies on cannabis and physical activity where RPE is assessed. Regardless, low ratings of perceived exertion during the walks were plausible, as walking may require relatively little effort and may not produce a substantial increase in heart rate (Flairty & Scheadler, 2020). The median RPE rating in both conditions was 2.00 on a modified, 0-6 ordinal response scale, indicating light exertion. This clustering of ratings towards the lower end of the scale may be representative of a floor effect (Garin, 2024), making it harder to detect the effect cannabis had on RPE during the walk. However, research suggests that self-paced physical activity may support continued

engagement and positive experiences not necessarily by reducing perceived exertion, but by allowing individuals to regulate their intensity in ways that make physical activity more tolerable, promote positive affective responses during physical activity, and support future physical activity behavior (Williams et al., 2016). Given that differences between cannabis and non-cannabis walks were not explained by perceived exertion, affective responses offer another mechanism through which cannabis may influence the walking experience.

Consistent with study hypotheses, mindfulness was significantly higher following the walk with cannabis compared to the walk without cannabis. The present study also revealed a significant condition-by-time effect, such that mindfulness increased more from pre- to post-walk in the cannabis condition than in the non-cannabis condition. It is important to note that compared to walking inside, walking outside, as was done for this study, has been shown to increase levels of mental restoration and result in a higher-level meditative state (Bailey et al., 2018) which may in part explain the mindfulness benefits. Cannabis appears to have amplified that expected increase in mindfulness. This may be explained by the preliminary finding that acute cannabis use increases mindfulness (Murray & Srinivasa-Desikan, 2022), potentially through its effects on sensory focus and perceptual changes (Zaytseva et al., 2019), including altered perceptions of time and bodily sensation. These effects may heighten present-moment awareness, as well as internal sensations or environmental cues, providing one possible mechanism through which cannabis is thought to increase mindfulness.

An alternative explanation for the increased mindfulness in the cannabis condition is that walking after cannabis use was a novel experience for most individuals in the study. This novelty may have drawn participants' attention to distinct sensory, bodily, or environmental aspects of the walk, which could have contributed to greater mindfulness scores. In addition, cannabis-

exercise expectancies significantly predicted mindfulness, suggesting that participants who expected cannabis to enhance the experience of physical activity may have been more likely to report greater mindfulness during the cannabis-walk condition. Regardless of the specific mechanisms, this finding is meaningful because mindfulness-based approaches have been suggested to support physical activity engagement and adherence (Schneider et al., 2019). Therefore, interventions or experiences that increase mindful awareness during physical activity may make it more rewarding and sustainable.

Positive affect may also help contextualize the mindfulness finding. In the present study, positive affect was significantly higher following the cannabis walk compared to the non-cannabis walk, in line with previous research (Gibson et al., 2023; Gibson & Bryan, 2023). There was no significant condition-by-time interaction, suggesting that both walks may have improved affect, however, positive affect was higher overall in the cannabis condition. This result supports the idea that cannabis may enhance the emotional experience of physical activity among insufficiently active individuals engaging in low-intensity exercise activities.

Relatedly, enjoyment was high in both conditions but was significantly higher following the cannabis walk compared to the non-cannabis walk. Again, outdoor walks, compared to indoor walks, have been linked to increased enjoyment and intention for future outdoor walks (Focht, 2009). In addition, self-paced physical activity may be more likely to produce positive feelings than activity that is too difficult (Williams et al., 2016). Thus, the non-cannabis walk itself may have been enjoyable because it was outdoors, low-intensity, and self-paced. However, the higher observed enjoyment observed in the cannabis condition suggests that cannabis may have further enhanced the positive qualities of the walking experience.

This interpretation is consistent with daily diary and survey data showing that individuals combine cannabis with physical activity in an effort to increase enjoyment (Ogle et al., 2022; Stallsmith et al., 2024; YorkWilliams et al., 2019). It is also consistent with prior experimental and naturalistic studies showing greater enjoyment during cannabis-exercise bouts compared to non-cannabis exercise bouts in the context of running (Gibson et al., 2023; Gibson & Bryan, 2023). The present study extends this work by showing a similar pattern during self-paced walking among insufficiently active individuals. This extension is notable because lower-intensity activity is less likely to produce the traditional “runner’s high” on its own. Newer research suggests that endocannabinoids, rather than endogenous opioids, may contribute to the pleasurable state commonly referred to as the “runner’s high” (Siebers et al., 2021, 2022). Therefore, exogenous cannabinoids, such as those from flower cannabis used for this study, may plausibly enhance feelings of pleasure or enjoyment during physical activity regardless of exercise intensity, although this was not directly tested in the present study (Williams et al., 2016).

Taken together, these results suggest that cannabis may enhance the subjective experience of walking. Mindfulness, positive affect, and enjoyment were all shown to be higher in the cannabis condition compared to the non-cannabis condition, while perceived exertion was similar across conditions. This pattern suggests that cannabis may influence the emotional and attentional aspects of physical activity rather than changing how hard the activity actually feels. Our other primary question was whether these positive subjective effects of cannabis can be leveraged to increase engagement in exercise among insufficiently active individuals.

Along these lines, exercise intentions are a critical outcome in the physical activity literature (He et al., 2022), as they are considered strong predictors of future behavior, according

to many well-established theoretical frameworks such as the Theory of Planned Behavior (Ajzen, 1991). A central premise of this study was that cannabis may enhance some aspects of the physical activity experience and thereby promote increased engagement in physical activity. Thus, the present study tested whether positive affect during the cannabis walk was associated with both intentions, and actual exercise behavior one month later. Greater positive affect during the cannabis walk was significantly associated with both stronger intentions (assessed immediately post-walk) to use cannabis before physical activity in the future and stronger intentions to engage in physical activity more broadly. These finding suggests that the pleasant affective experience of the cannabis walk may have been motivationally relevant for both cannabis-related physical activity intentions and general physical activity intentions. However, because positive affective responses during exercise and generally associated with stronger intentions (Kwan & Bryan, 2010; Parschau et al., 2014; Rhodes & Kates, 2015) it is unclear whether these associations reflect a cannabis-specific motivational process or the broader influence of positive experiences during physical activity.

These findings are also relevant in light of common assumptions about cannabis use and motivation. Stereotypically, cannabis use is associated with low motivation and apathy, with some support in the literature (Pacheco-Colón et al., 2018). However, the relationship between cannabis and motivation appears to be more nuanced. In the limited literature, acute cannabis use may temporarily reduce effort-based motivation, but there appears to be no meaningful difference in motivation between those who use cannabis regularly and those who do not (Skumlien et al., 2024). The present findings complicate this stereotype by suggesting that, at least in the context of a pleasurable walking experience, cannabis use was not incompatible with physical activity intentions. This result is important because intentions are a critical first step

toward physical activity behavior change, and cannabis-associated walking experiences may help shape these intentions. This may be especially relevant for insufficiently active individuals who already use cannabis regularly, as the present finding suggests that pairing existing cannabis-use behavior with low-intensity physical activity may be associated with stronger intentions to be active.

While the result of increased intentions in the present study appears promising, intentions do not always equate to behavior due to many factors (Rhodes et al., 2022) known as the intention-behavior gap (Feil et al., 2023). The intention-behavior gap is particularly relevant to physical activity, where nearly half of individuals with positive exercise intentions fail to act on them (Feil et al., 2023; Rhodes & de Bruijn, 2013) potentially because intentions do not address the self-regulatory, motivational, and practical demands required to initiate and sustain behavior change (Faries & Dudgeon, 2019). Indeed, in the present study, intentions to combine cannabis and physical activity did not significantly predict overall quantity of physical activity at one-month follow-up, meaning physical activity behavior did not actually change, despite self-reported intentions. This suggests that positive intentions alone may not be sufficient to produce behavior change. Neither the overall quantity, nor quality, measured as intensity, of physical activity increased at one-month follow up. Baseline physical activity was the only significant predictor of subsequent physical activity, suggesting that existing physical activity patterns are more stable predictors than intentions formed after a one-time walk experience. Health-related habit formation may take about two months or more depending on individual differences (Singh et al., 2024), which may mean the follow-up timing for the current study was not enough time to detect meaningful changes in physical activity behavior. In addition, although a single cannabis-walk may have produced a positive experience and increased immediate intentions, one walk

may not have been sufficient to produce sustained behavior change. Repeated cannabis-walk sessions may be necessary for participants to integrate physical activity into their routines and become accustomed to combining the two behaviors, a strategy sometimes referred to as habit stacking. Habit stacking, define as pairing a new habit with an existing one (Ara, 2025), may be particularly relevant for this participant population, who already use cannabis regularly but are insufficiently active, as it builds on an existing behavior rather than requiring the adoption of two entirely new behaviors.

Another goal of the current study was to begin to identify individuals for whom cannabis could be particularly beneficial when combined with physical activity, an area that appears to be novel in the literature. Demographic variables including age and gender did not explain differences between levels of enjoyment during the cannabis-walk and non-cannabis walk. Further, personality variables (e.g., sensation seeking, impulsivity, and openness) did not significantly predict differences in enjoyment between the cannabis and non-cannabis walks either. However, given the study's sample size, it may not have been powered to detect smaller effects. Cannabis-exercise expectancies, on the other hand, were found to positively predict enjoyment differences, meaning that more positive expectations about the effect cannabis would have on exercise (i.e., in domains of exercise performance, enjoyment, motivation, ability to focus, and recovery) resulted in greater increases in enjoyment from pre- to post-cannabis walks compared to non-cannabis walks. This finding aligns with the broader outcome expectancy literature, which suggests that beliefs about the likely consequences of behavior may shape how the behavior is experienced (Fasbender, 2020). It also aligns with what has been shown in previous studies, that cannabis-exercise intentions (attitudes) moderate the effect of cannabis on enjoyment, affective valence, and runner's high effects (Gibson & Bryan, 2023). This study

expanded the result to those who were insufficiently active, and those who expected cannabis to enhance their walk may have been more likely to experience the walk as enjoyable.

Alternatively, this effect may be attributable to expectancy effects more broadly (Rosenthal, 2000).

Conversely, positive exercise attitudes generally were negatively associated with enjoyment differences, indicating that individuals with more positive attitudes towards exercise exhibited smaller differences in enjoyment between condition. This may be because those who already have favorable perceptions and attitudes towards physical activity may experience enjoyment during a walk, regardless of condition. Therefore, cannabis would not provide any positive subjective experience above and beyond that which they already derive from physical activity.

Limitations and Future Directions

This study is not without limitations. To begin, the final analytic sample included 59 participants. Although this sample was sufficient for the planned primary analyses, it may have resulted in limited power to detect small effects, especially in regression models examining individual difference predictors. Further, participants were mostly white (79.7%), non-Hispanic (78.0%), well-educated (45.8% holding a bachelor's degree or higher), and employed full time (68.4%), thus findings may not generalize to more diverse populations. Although participants were recruited on the basis of being insufficiently active (i.e., reported less than 90 minutes of moderate-vigorous physical activity per week), reported baseline physical activity in the final sample was relatively high, especially for mild activity. Therefore, this sample may not exactly reflect a sedentary population. Future work should use more stringent recruitment criteria (e.g., lower reported mild, moderate and vigorous physical activity) and screening procedures in order

to recruit a sample whose characteristics could generalize to sedentary populations. The most popular recruitment method for these participants was through cannabis-related subreddits and email blasts from Bud & Mary's cannabis company, which may have skewed the sample towards individuals with more favorable views of cannabis. Further, the eligibility criterion required participants to have previously combined cannabis with physical activity without experiencing injury or psychological distress. As a result, the sample was clearly familiar with combining the two behaviors and, given the relatively high rate of mild activity and cannabis use, participants may have done so numerous times previously. However, the frequency of combining cannabis use with physical activity was not directly assessed at baseline. Thus, the sample may not have been entirely naïve to combining the two behaviors. Altogether, these recruitment criteria may have introduced self-selection bias (Elston, 2021) and limited the extent to which findings generalize to those who use cannabis with less favorable or more mixed experiences combining cannabis with physical activity. To address these limitations, future research should recruit larger and more demographically diverse samples and rely on diversified recruitment strategies. Despite these limitations, the virtual, low-burden protocol implemented in this study may be useful for future naturalistic studies on cannabis and physical activity. The approach captured experiences from participants in multiple states with legalized recreational cannabis rather than limiting the sample to one geographic region.

Although the naturalistic design of this study is a strength in terms of increasing ecological validity, it also has limitations. Because we did not standardize the strain, THC/CBD potency, dose, and method of flower consumption, it is not possible to determine which aspects of the cannabis use may have contributed to findings. Future studies may therefore benefit from more experimental control over the products, potencies, doses, and consumption methods

participants use. For example, specific cannabis products, such as edibles, should be studied, as they are commonly cited as being combined with physical activity (Lisano et al., 2018; Ogle et al., 2022; YorkWilliams et al., 2019). This type of experimental manipulation may become more feasible if the cannabis scheduling landscape changes, providing clarity for both researchers and individuals who use cannabis (U.S. Department of Justice, 2026).

Another limitation comes from the fact that self-report data were collected both before and after walk interventions, which may have introduced expectancy effects, recall bias, or social desirability bias (Harris & Rosenthal, 1985; Sedgwick, 2012; Van de Mortel, 2008). Specifically, expectancy effects were likely present in this study, given that cannabis-exercise expectancies significantly predicted some outcomes, suggesting that participants' beliefs about combining the two behaviors may have influenced their reported experiences. Moreover, even though participants were asked to keep conditions between the two walks as similar as possible, it is possible that contextual factors such as weather, time of day, social engagement, or even having their dog along may have introduced confounding factors.

The present study found that cannabis was associated with more positive acute walking experiences, and that positive affect during the cannabis walk was associated with stronger intentions to combine cannabis with physical activity and stronger intentions for future physical activity. However, intentions did not significantly predict physical activity behavior at one-month follow-up. As outlined in the discussion, there may be many factors that explain this intention-behavior gap, but methodologically, the study may have benefitted from a longer follow-up period or repeated follow-up assessments. Additionally, while this study used a smartphone-based physical activity tracking app during the walking interventions, future studies may benefit from using an objective physical activity measurement during the follow-up period.

Viable options include accelerometry or smartphone-based activity tracking, which could help reduce overestimated self-reports of physical activity, which is common in the field (Steene-Johannessen et al., 2016). Finally, the present study did not directly assess safety outcomes such as impairment, injury, or balance. Although walking is generally low-impact and lower-risk, future studies should assess both beneficial and adverse outcomes before making prescriptive claims about combining cannabis with walking. All of the methodological improvements listed above would help clarify for whom, under what conditions, and with what level of risk cannabis may be associated with more positive physical activity experiences.

Implications and Conclusion

The present study has important implications for research on cannabis and physical activity broadly, as well as for adults who use cannabis and do not meet minimum physical activity recommendations. The present study reveals that positive subjective experiences resulting from cannabis use are not exclusively for habitual exercisers engaging in moderate-to-vigorous activity but rather extend to insufficiently active individuals doing lower-intensity physical activity as well. This finding may be particularly relevant for adults who use cannabis regularly but do not meet the current minimum physical activity recommendations.

However, these findings should be interpreted cautiously. Cannabis use is not without risk, and can impair coordination, attention, decision-making, and reaction time (Brooks-Russell et al., 2024; Crean et al., 2011) all of which are relevant to safe participation in physical activity. Studies show that some people do have adverse experiences when combining cannabis with physical activity (Ogle et al., 2022; YorkWilliams et al., 2019), though the rate seems to be quite low compared to those who have a neutral or positive experience. Moreover, impairment from cannabis may increase safety concerns for some forms of physical activity, particularly those

involving higher intensity or complex coordination, or those that require driving to the activity, as cannabis should never be used when operating a vehicle. Thus, these findings should *not* be interpreted as a recommendation to use cannabis before exercise. Rather, the findings suggest that adults who already use cannabis regularly and choose to combine that behavior with low-impact, lower-risk physical activity, such as neighborhood walking, may experience affective and experiential benefits. These findings suggest that cannabis use may not be exclusively a barrier to health behavior change, as it has often been viewed (Sorkhou et al., 2021; Volkow et al., 2016). Rather, there may be value in meeting individuals who use cannabis where they are and considering the potential benefits that could arise when an existing behavior (cannabis use) is paired with a healthful behavior such as physical activity.

In conclusion, as research on cannabis and physical activity continues to grow, studies that address specific gaps in the literature including inclusion of insufficiently active participants, low-intensity, accessible forms of exercise, and longer-term, more rigorous designs are needed to clarify how cannabis may relate to physical activity experiences and behavior. In the present study, for those who were insufficiently active, a walk with cannabis appeared to increase mindfulness, positive affect, and enjoyment more than a non-cannabis walk, with no change to perceived exertion between conditions. Consistent with prior research, (Kwan & Bryan, 2010; Parschau et al., 2014; Rhodes & Kates, 2015), positive affect during the cannabis-walk was associated with stronger intentions to pair cannabis with exercise and with greater exercise intentions generally. Together, these findings suggest that cannabis may enhance the acute subjective experience of self-paced walking for some individuals, particularly those with positive cannabis-physical activity expectancies.

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APPENDICES

Appendix A: Inclusion/Exclusion Criteria

Inclusion Criteria:

1. Between the ages of 21 and 65.
2. Are a resident of a U.S. state with legalized recreational cannabis.
3. Must use flower cannabis at least once per week.
4. Have access to a smartphone (IOS or Android).
5. Willing and able to download the Map My Walk mobile application onto their smartphone .
6. Have used cannabis while engaging in physical activity (e.g., walking, playing frisbee, yardwork) at least once in their lives with NO negative effects. No negative effects is defined as having experienced no physical injuries or psychological distress as a result of combining cannabis and exercise.
7. Willing to walk outside in both conditions (i.e., cannabis-walk and non-cannabis walk) for 2 miles during each walk.
8. Participants must currently have low physical activity levels, meaning they currently engage in less than 90 minutes of moderate to vigorous physical activity per week.
9. Can safely engage in 2-mile walk (determined by answering "no" to all question on the PAR-Q and You), AND have a safe place to walk near their home.
10. Must endorse knowledge of the procedure(s) for obtaining cannabis from a legal dispensary.
11. Females must NOT be pregnant, breastfeeding nor will they be actively trying to get pregnant during the entire duration of their involvement in the study
12. Capable of refraining from cannabis use for 24 hours.

Exclusion criteria:

1. Have a history of cardiac or respiratory disease
2. Are receiving treatment for a heart condition or high blood pressure
3. Experience chest pains during and/or not during physical activity
4. Have received a diagnosis of bipolar disorder or a diagnosis of psychotic spectrum disorder (e.g. schizophrenia)
5. Does not have a location nearby (i.e., cannot drive to a park or other location) where they can walk 2 miles consistently.

- (If yes) During the time you used cannabis while engaging in physical activity, did you experience any negative effects (physical injuries, psychological distress, etc.)? (Yes/No)
(RA: if yes, subject is ineligible)

LEGAL STATE CRITERIA

- What state do you currently live in? _____ (fill in the blank)
(RA: if subject lists a state OTHER than the following (states with legalized recreational cannabis laws), subject is ineligible:

- ☐ Alaska
- ☐ Arizona
- ☐ California
- ☐ Colorado
- ☐ Connecticut
- ☐ Delaware
- ☐ Illinois
- ☐ Maine
- ☐ Maryland
- ☐ Massachusetts
- ☐ Michigan
- ☐ Minnesota
- ☐ Missouri
- ☐ Montana
- ☐ Nevada
- ☐ New Jersey
- ☐ New Mexico
- ☐ New York
- ☐ Ohio
- ☐ Oregon
- ☐ Rhode Island
- ☐ Vermont
- ☐ Virginia
- ☐ Washington
- D.C.)

- Are you knowledgeable about the procedures for obtaining cannabis from a legal dispensary? (Yes/No) *(If no, subject is ineligible)*

STUDY PROCEDURE CRITERIA

- Do you have access to a smartphone (iOS or Android)? (Yes/No)
- Are you willing and able to download the Map My Walk mobile application onto your smartphone? (Yes/No) *(If no, subject is ineligible)*

- This study requires you to walk outside near your home (i.e., cannot drive to a park or other location) continuously. Do you have a safe place to walk (2 miles) that is close to your home? *(If no, subject is ineligible)*
- Are you willing to walk for 2 miles continuously for each walk? (Yes/No) *(If no, subject is ineligible)*
- This study requires you to walk in two different conditions – a walk without cannabis, and a walk immediately after consuming cannabis. Are you willing to walk in both conditions? (Yes/No) *(If no, subject is ineligible)*
- Are you capable of refraining from cannabis use for 24 hours before each walking session? (Yes/No) *(If no, subject is ineligible)*

INDIVIDUALS ASSIGNED FEMALE AT BIRTH ONLY

- Are you currently pregnant? _____ (yes/no) *(RA: if yes, subject is ineligible)*
- Are you currently breastfeeding? _____ (yes/no) *(RA: if yes, subject is ineligible)*
- Are you currently trying to become pregnant? _____ (yes/no) *(RA: if yes, subject is ineligible)*

MENTAL HEALTH CRITERIA

- Have you ever been diagnosed with bipolar disorder or a psychotic spectrum disorder (e.g., schizophrenia)? (Yes/No) *(RA: if yes, subject is ineligible)*

“LOW PHYSICAL ACTIVITY” CRITERIA

- How many minutes of moderate to vigorous activity do you usually get per week?
(Examples and definitions of moderate to vigorous physical activity – Moderate: exercise activities that would be considered “5” or “6” out of 10 on a scale of 0 (no effort at all) – 10 (“maximal effort”). Examples include brisk walking, light jogging, or riding your bike on mostly level ground. Vigorous: exercise activities that would be considered a “7 or above” on a scale of 0 (no effort at all) – 10 (“maximal effort”). Examples include running, swimming laps, hiking up hills, and interval training (e.g., crossfit, HIIT classes). *(RA: If subject engages in moderate to vigorous physical activity MORE THAN OR EQUAL TO 90 minutes per week subject is ineligible).*
 - 0-29 minutes per week
 - 30-59 minutes per week
 - 60-89 minutes per week
 - 90-119 minutes per week
 - 120+ minutes per week

THE PAR-0 AND YOU CRITERIA

(RA: If subjects answer “yes” to any of the following questions, subject is ineligible)

Physical Activity Readiness Questionnaire (PAR-Q) and You

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly:

YES	NO		
☐	☐	1.	Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
☐	☐	2.	Do you feel pain in your chest when you do physical activity?
☐	☐	3.	In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4.	Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5.	Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6.	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7.	Do you know of <u>any other reason</u> why you should not do physical activity?

If you answered:	YES to one or more questions
	Talk to your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES. - You may be able to do any activity you want – as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice. - Find out which community programs are safe and helpful for you.
	NO to all questions
If you answered NO honestly to <u>all</u> PAR-Q questions, you can be reasonably sure that you can: - Start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go. - Take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.	Delay becoming much more active: - If you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or - If you are or may be pregnant – talk to your doctor before you start becoming more active. Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed use of the PAR-Q: Reprinted from ACSM's Health/Fitness Facility Standards and Guidelines, 1997 by American College of Sports Medicine

Baseline and 1-month Follow-Up Measures

(Baseline-Only) Demographic Characteristics.

What is your age in years?

What was the sex assigned to you at birth?

- Male
- Female
- Intersex
- Another
- Do not wish to respond

How do you define your gender identity? Choose all that apply.

- Agender
- Androgynous
- Cis man
- Cis woman
- Demiboy
- Demigirl
- Gender fluid
- Non-binary
- Gender non-conforming
- Genderless
- Genderqueer
- Man
- Third gender
- Trans man
- Trans woman
- Transgender
- Transperson
- Two spirit
- Woman
- Another
- Do not wish to respond

What is the highest level of education that you have completed? Please select one option.

- Less than high school
- High-school diploma or GED
- Some college
- Associates degree or Technical Certification
- Bachelor's degree

- Master's degree
- Doctoral degree

Are you employed?

- Full-time employed, work 30 or more hours per week
- Part-time, work less than 30 hours per week
- Unemployed, disabled, retired, other
- Full-time student
- Homemaker/stay at home parent

What is your present household income range in the past year? Choose one:

- \$0–\$9,999
- \$10,000–\$19,999
- \$20,000–\$29,999
- \$30,000–\$39,000
- \$40,000–\$49,000
- \$50,000–\$59,000
- Over \$60,000

How do you define your ethnicity? Choose one:

- Hispanic or Latina/o/x/e
- Not Hispanic or Latina/o/x/e
- Another
- Do not wish to respond

How do you define your race? Choose all that apply.

- American Indian or Alaskan Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White
- Another
- Do not wish to respond

If you selected “another” to any category above, please describe.

(Baseline-Only) Daily Session, Frequency, Age of Onset, and Quantity of Cannabis Use

Inventory (DFAQ-CU)

Instructions: Please read each of the following questions and mark the response alternative that best describes your use of cannabis. *Note that the term cannabis is being used to refer to marijuana, cannabis concentrates, and cannabis-infused edibles.*

1. Have you ever used cannabis?

0 = No

1 = Yes

**If response = 0 then skip to end of questionnaire*

2. Which of the following best captures when you last used cannabis?

1 = over a year ago

7 = last week

2 = 9 – 12 months ago

8 = this week

3 = 6 – 9 months ago

9 = yesterday

4 = 3 – 6 months ago

10 = today*

5 = 1 – 3 months ago

11 = I am currently high*

6 = less than 1 month ago

**If response = 10 (today) or 11 (I am currently high) then answer 2b below*

2b. How high are you right now?

0 = I am not at all high

1 = I am a little bit high

2 = I am moderately high

3 = I am very high

4 = I am extremely high

3. Which of the following best captures the average frequency you currently use cannabis?

0 = I do not use cannabis

7 = once a week

1 = less than once a year

8 = twice a week

2 = once a year

9 = 3 – 4 times a week

3 = once every 3-6 months (2-4 times/yr)

10 = 5 – 6 times a week

4 = once every 2 months (6 times/yr)

11 = once a day

5 = once a month (12 times/yr)

12 = more than once a day

6 = 2 – 3 times a month

4. Which of the following best captures how long you have been using cannabis **at this frequency?**

1 = less than 1 month

6 = 1 – 2 years

2 = 1 – 3 months

7 = 2 – 3 years

3 = 3 – 6 months

8 = 3 – 5 years

4 = 6 – 9 months

9 = 5 – 10 years

5 = 9 – 12 months

10 = 10 – 15 years

- 11 = 15 – 20 years
12 = more than 20 years
5. Before the period of time you indicated above, how frequently did you use cannabis?
- | | |
|---|---------------------------|
| 0 = I did not use cannabis | 7 = once a week |
| 1 = less than once a year | 8 = twice a week |
| 2 = once a year | 9 = 3 – 4 times a week |
| 3 = once every 3-6 months (2-4 times/yr.) | 10 = 5 – 6 times a week |
| 4 = once every 2 months (6 times/yr.) | 11 = once a day |
| 5 = once a month | 12 = more than once a day |
| 6 = 2 – 3 times a month | |
6. How many days of the past week did you use cannabis?
- | | |
|------------|------------|
| 0 = 0 days | 4 = 4 days |
| 1 = 1 day | 5 = 5 days |
| 2 = 2 days | 6 = 6 days |
| 3 = 3 days | 7 = 7 days |
7. Approximately how many days of the past month did you use cannabis? _____
8. Which of the following best captures the number of times you have used cannabis in your entire life?
- | | |
|--------------------------------|--|
| 1 = 1 – 5 times in my life | 6 = 501 – 1000 times in my life |
| 2 = 6 – 10 times in my life | 7 = 1001 – 2000 times in my life |
| 3 = 11 – 50 times in my life | 8 = 2001 – 5000 times in my life |
| 4 = 51 – 100 times in my life | 9 = 5001 – 10,000 times in my life |
| 5 = 101 – 500 times in my life | 10 = More than 10,000 times in my life |
9. Which of the following best captures your pattern of cannabis use throughout the week?
- 0 = I do not use cannabis at all
1 = I only use cannabis on weekends
2 = I only use cannabis on weekdays
3 = I use cannabis on weekends and weekdays
10. How many hours after waking up do you typically first use cannabis?
- | | |
|-----------------------------------|---------------------------------|
| 0 = I do not use cannabis at all | 5 = 1 – 3 hours after waking up |
| 1 = 12 – 18 hours after waking up | 6 = within 1 hour of waking up |
| 2 = 9 – 12 hours after waking up | 7 = within ½ hour of waking up |
| 3 = 6 – 9 hours after waking up | 8 = immediately upon waking up |
| 4 = 3 – 6 hours after waking up | |
11. How many times a day, on a typical weekday, do you use cannabis? _____
12. How many times a day, on a typical weekend, do you use cannabis? _____

13. What is the primary method you use to ingest cannabis?

0 = I do not use cannabis

1 = Joints

2 = Blunts (cigar sized joints)

3 = Hand pipe

4 = Bong (water pipe)

5 = Hookah

6 = Vaporizer (e.g., Volcano, Vape pen)

7 = Edibles

8 = Other _____

14. Which of the following other methods to ingest cannabis do you use **regularly** (at least 25% of the time use you cannabis)? [Mark all that apply]

0 = None

1 = Joints

2 = Blunts (cigar sized joints)

3 = Hand pipe

4 = Bong (water pipe)

5 = Hookah

6 = Vaporizer (e.g., Volcano, Vape pen)

7 = Edibles

8 = Other _____

15. What is the primary form of cannabis you use?

0 = None****

A = Marijuana***

B = Concentrates (e.g., Oil, Wax, Shatter, Butane Hash Oil, Dabs)**

C = Edibles*

D = Other _____

16. What other forms of cannabis do you use **regularly** (at least 25% of the time you use cannabis)? [Mark all that apply]

0 = None****

A = Marijuana***

B = Concentrates (e.g., Oil, Wax, Shatter, Butane Hash Oil, Dabs)**

C = Edibles*

D = Other _____

****If response to questions 15 and 16 = 0 (None) then skip to question 29

***If responses to questions 15 or 16 = A (Marijuana) then answer questions 17-21

**If responses to question 15 or 16 = B (Concentrates) then answer questions 22-26

*If responses to question 15 or 16 = C (Edibles) then answer question 27

Note: If you use more than one form of cannabis then complete all of the associated questions listed above.

****If responses to questions 15 or 16 = A (Marijuana) then answer questions 17-21 below.*

Please use the image below to refer to various quantities of marijuana. The image is not to scale; the dollar bill is included to help provide size perspective.



For questions 17 to 19 below, clearly indicate the number of grams of marijuana you use with a number between 0 – 100. Do NOT include other forms of cannabis you may use (such as concentrates). You may use up to 3 decimals to indicate amounts under 1 gram.

Note: $\frac{1}{8}$ of a gram = 0.125 grams, $\frac{1}{4}$ of a gram = 0.25 grams, $\frac{1}{2}$ of a gram = 0.5 grams, $\frac{3}{4}$ of a gram = 0.75 grams. $\frac{1}{8}$ of an ounce = 3.5 grams, $\frac{1}{4}$ of an ounce = 7 grams, $\frac{1}{2}$ ounce = 14 grams, 1 ounce = 28 grams

17. In a typical session, how much marijuana do you personally use? _____

18. On a typical day you use marijuana, how much do you personally use? _____

19. In a typical week you use marijuana, how much marijuana do you personally use? _____

20. On a typical day you use marijuana, how many sessions do you have? _____

21. What is the average THC content of the marijuana you typically use? Leave blank if you do not know.

1 = 0 – 4%

2 = 5 – 9%

3 = 10 – 14%

4 = 15 – 19%

5 = 20 – 24%

6 = 25 – 30%

7 = greater than 30%

***If response to questions 15 or 16 = B (Concentrates) then answer questions 22-26 below*

22. In a typical session you use cannabis concentrates, how many hits do you personally take? ____

23. On a typical day you use cannabis concentrates, how many hits do you personally take? _____

24. How many hits of cannabis concentrates did you personally take yesterday? _____

25. On a typical day you use cannabis concentrates, how many sessions do you have? _____

26. What is the average THC content of the concentrates you typically use? Leave blank if you do not know.

1 = 0 – 9%

2 = 10 – 19%

3 = 20 – 29%

4 = 30 – 39%

5 = 40 – 49%

6 = 50 – 59%

7 = 60 – 69%

8 = 70 – 79%

9 = 80 – 90%

10 = greater than 90%

***If response to questions 15 or 16 = C (Edibles) then answer question 27 below*

27. When you eat edibles how many milligrams of THC do you personally ingest in a typical session? _____

28. What is your current age? _____

29. How many years in total have you used cannabis? _____

30. How old were you when you FIRST tried cannabis? _____

31. Has there been any time in your life when you used cannabis regularly (2 or more times per month for 6 months or longer)?

0 = No

1 = Yes*

**If response = 1 (Yes) then answer questions 31b and 31c below*

31b. How old were you when you FIRST STARTED using cannabis regularly (2 or more

times/month)? _____

31c. Has there been any time in your life when you used cannabis on a daily or near daily basis for 6 months or longer?

0 = No

1 = Yes*

**If response = 1 (Yes) then answer question 31ci below*

31ci. How old were you when you FIRST STARTED using cannabis on a daily or near daily basis? _____

32. Which of the following best captures the average frequency that you used cannabis before the age of 16?

0 = more than once a day

1 = once a day

2 = 5 – 6 times a week

3 = 3 – 4 times a week

4 = twice a week

5 = once a week

6 = 2 – 3 times a month

7 = once a month

8 = once every 2 months (6 times/yr.)

9 = once every 3-6 months (2-4 times/yr.)

10 = once a year

11 = less than once a year

12 = never

33. Do you have a physician's recommendation to use cannabis for medicinal purposes?

0 = No

1 = Yes*

2 = Yes, but I use it for both medicinal and recreational purposes*

**If response = 1 or 2 (Yes) then answer questions 33b and 33c*

33b. Which medical condition(s) do you use cannabis for?

33c. What percentage of the time do you use cannabis for recreational (rather than medicinal) purposes?

(Baseline-Only) Cannabis Use Disorder Identification Test Revised (CUDIT-R)

The Cannabis Use Disorder Identification Test - Revised (CUDIT-R)

Have you used any cannabis over the past six months? Yes _____ No _____

If you answered "Yes" to the previous question, please answer the following questions about your cannabis use. Circle the response that is most correct for you in relation to your cannabis use over the *past six months*.

1. How often do you use cannabis?

Never 0	Monthly or less 1	2-4 times a month 2	2-3 times a week 3	4+ times a week 4
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2. How many hours were you "stoned" on a typical day when you had been using cannabis?

Less than 1 0	1 or 2 1	3 or 4 2	5 or 6 3	7 or more 4
------------------	-------------	-------------	-------------	----------------

3. How often during the past 6 months did you find that you were not able to stop using cannabis once you had started?

Never 0	Less than monthly 1	Monthly 2	Weekly 3	Daily/almost daily 4
------------	------------------------	--------------	-------------	-------------------------

4. How often during the past 6 months did you fail to do what was normally expected from you because of using cannabis?

Never 0	Less than monthly 1	Monthly 2	Weekly 3	Daily or almost daily 4
------------	------------------------	--------------	-------------	----------------------------

5. How often in the past 6 months have you devoted a great deal of your time to getting, using, or recovering from cannabis?

Never 0	Less than monthly 1	Monthly 2	Weekly 3	Daily/almost daily 4
------------	------------------------	--------------	-------------	-------------------------

6. How often in the past 6 months have you had a problem with your memory or concentration after using cannabis?

Never 0	Less than monthly 1	Monthly 2	Weekly 3	Daily or almost daily 4
------------	------------------------	--------------	-------------	----------------------------

7. How often do you use cannabis in situations that could be physically hazardous, such as driving, operating machinery, or caring for children?

Never 0	Less than monthly 1	Monthly 2	Weekly 3	Daily/almost daily 4
------------	------------------------	--------------	-------------	-------------------------

8. Have you ever thought about cutting down, or stopping, your use of cannabis?

Never 0	Yes, but not in the past 6 months 2	Yes, during the past 6 months 4
------------	--	------------------------------------

This questionnaire was designed for self-administration and is scored by adding each of the 8 items:

Question 1-7 are scored on a 0-4 scale
Question 8 is scored 0, 2, or 4

Score: _____

Scores of 8 or more indicate hazardous cannabis use, while scores of 12 or more indicate a possible cannabis use disorder for which further intervention may be required.

(Baseline-Only) Marijuana Withdrawal Checklist (MWC)

Protocol text	<u>Instructions when administered during a period of marijuana use</u>				
	Please indicate whether or not you have experienced these symptoms and rate their severity <u>during the past week.</u>				
	<u>Instructions when administered during a period of marijuana abstinence</u>				
	Please indicate whether or not you have experienced these symptoms and rate their severity <u>the last time you stopped smoking marijuana.</u>				
		none	mild	moderate	severe
	1) Shakiness/tremulousness	0	1	2	3
	2) Depressed mood	0	1	2	3
	3) Decreased appetite	0	1	2	3
	4) Nausea	0	1	2	3
	5) Irritability	0	1	2	3
	6) Sleep difficulty	0	1	2	3
	7) Sweating	0	1	2	3
	8) Craving to smoke marijuana	0	1	2	3
	9) Restlessness	0	1	2	3
	10) Nervousness/anxiety	0	1	2	3
11) Increased aggression	0	1	2	3	
12) Headaches	0	1	2	3	
13) Stomach Pains	0	1	2	3	
14) Strange dreams	0	1	2	3	
15) Increased anger	0	1	2	3	
16) Other (list)					
	0	1	2	3	

	Scoring Procedure and Interpretation A total MWC score is obtained by summing the severity ratings. Budney et al. (2003) also tested a withdrawal discomfort score (WDS), based on summing the 12 following MWC items: 1-3, 5-7, 9-11, and 13-15. Higher scores indicate more severe symptoms associated with marijuana withdrawal.
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(Baseline-Only) Ten Item Personality Inventory (TIPI)

Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

1 = Disagree strongly

2 = Disagree moderately

3 = Disagree a little

4 = Neither agree nor disagree

5 = Agree a little

6 = Agree moderately

7 = Agree strongly

I see myself as:

1. ____ Extraverted, enthusiastic.

2. ____ Critical, quarrelsome.

3. ____ Dependable, self-disciplined.

4. ____ Anxious, easily upset.

5. _____ Open to new experiences, complex.
6. _____ Reserved, quiet.
7. _____ Sympathetic, warm.
8. _____ Disorganized, careless.
9. _____ Calm, emotionally stable.
10. _____ Conventional, uncreative.

Short UPPS-P Impulsive Behavior Scale (SUPPS-P)

Short UPPS-P

Below are a number of statements that describe ways in which people act and think. For each statement, please indicate how much you agree or disagree with the statement. If you **Agree Strongly** circle **1**, if you **Agree Somewhat** circle **2**, if you **Disagree somewhat** circle **3**, and if you **Disagree Strongly** circle **4**. Be sure to indicate your agreement or disagreement for every statement below.

	Agree Strongly	Agree Some	Disagree Some	Disagree Strongly
1. I generally like to see things through to the end.	1	2	3	4
2. My thinking is usually careful and purposeful.	1	2	3	4
3. When I am in great mood, I tend to get into situations that could cause me problems.	1	2	3	4
4. Unfinished tasks really bother me.	1	2	3	4
5. I like to stop and think things over before I do them.	1	2	3	4
6. When I feel bad, I will often do things I later regret in order to make myself feel better now.	1	2	3	4
7. Once I get going on something I hate to stop.	1	2	3	4
8. Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.	1	2	3	4
9. I quite enjoy taking risks.	1	2	3	4
10. I tend to lose control when I am in a great mood.	1	2	3	4
11. I finish what I start.	1	2	3	4
12. I tend to value and follow a rational, "sensible" approach to things.	1	2	3	4
13. When I am upset I often act without thinking.	1	2	3	4
14. I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional.	1	2	3	4
15. When I feel rejected, I will often say things that I later regret.	1	2	3	4
16. I would like to learn to fly an airplane.	1	2	3	4
17. Others are shocked or worried about the things I do when I am feeling very excited.	1	2	3	4
18. I would enjoy the sensation of skiing very fast down a high mountain slope.	1	2	3	4
19. I usually think carefully before doing anything.	1	2	3	4
20. I tend to act without thinking when I am really excited.	1	2	3	4

Sensation Seeking Personality Trait Scale (SSPT)

Table 1: The Sensation Seeking Personality Trait Scale

The following scale consists of a series of statements regarding preference for engaging in new or exciting activities. For each of the following items, you will be asked to indicate how much you agree or disagree with the statement. There are no right or wrong answers and we ask that you respond honestly.

	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
1. I enjoy participating in unsafe activities.	1	2	3	4	5
2. I don't enjoy trying new things.	1	2	3	4	5
3. I think it is important to try as many new things as I can.	1	2	3	4	5
4. I do things even if I know that doing them will get me in trouble.	1	2	3	4	5
5. I love challenging myself with new and interesting tasks.	1	2	3	4	5
6. I think that excitement is more important than safety.	1	2	3	4	5
7. I have the most fun when I am doing risky or dangerous things.	1	2	3	4	5
8. I rarely do things that seem risky.	1	2	3	4	5
9. I like to experience anything and everything I can.	1	2	3	4	5
10. I like to explore new areas.	1	2	3	4	5

Notes: Risk Seeking = 1, 4, 6, 7, 8*, Experience Seeking = 2*, 3, 5, 9, 10, * variables need to be to be reverse coded

Difficulty in Emotion Regulation Scale (DERS-SF)

Difficulties in Emotion Regulation Scale – Short Form (DERS-SF)

Kaufman, Xia, Fosco, Yaptangco, Skidmore, & Crowell (2015)

Please indicate how often the following apply to you.

	Almost Never (0–10%)	Some- times (11–35%)	About Half Of the Time (36–65%)	Most of the Time (66–90%)	Almost Always (91–100%)
1. I pay attention to how I feel	1	2	3	4	5
2. I have no idea how I am feeling	1	2	3	4	5
3. I have difficulty making sense out of my feelings	1	2	3	4	5
4. I care about what I am feeling	1	2	3	4	5
5. I am confused about how I feel	1	2	3	4	5
6. When I'm upset, I acknowledge my emotions	1	2	3	4	5
7. When I'm upset, I become embarrassed for feeling that way	1	2	3	4	5
8. When I'm upset, I have difficulty getting work done	1	2	3	4	5
9. When I'm upset, I become out of control	1	2	3	4	5
10. When I'm upset, I believe that I will end up feeling very depressed	1	2	3	4	5
11. When I'm upset, I have difficulty focusing on other things	1	2	3	4	5
12. When I'm upset, I feel guilty for feeling that way	1	2	3	4	5
13. When I'm upset, I have difficulty concentrating	1	2	3	4	5
14. When I'm upset, I have difficulty controlling my behaviors	1	2	3	4	5
15. When I'm upset, I believe there is nothing I can do to make myself feel better	1	2	3	4	5
16. When I'm upset, I become irritated with myself for feeling that way	1	2	3	4	5
17. When I'm upset, I lose control over my behavior	1	2	3	4	5
18. When I'm upset, it takes me a long time to feel better	1	2	3	4	5

The Depression, Anxiety, and Stress Scale (DASS-21)

DASS21		Name:	Date:
Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement. The rating scale is as follows: 0 Did not apply to me at all 1 Applied to me to some degree, or some of the time 2 Applied to me to a considerable degree or a good part of time 3 Applied to me very much or most of the time			
1 (s)	I found it hard to wind down	0	1 2 3
2 (a)	I was aware of dryness of my mouth	0	1 2 3
3 (d)	I couldn't seem to experience any positive feeling at all	0	1 2 3
4 (a)	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1 2 3
5 (d)	I found it difficult to work up the initiative to do things	0	1 2 3
6 (s)	I tended to over-react to situations	0	1 2 3
7 (a)	I experienced trembling (e.g. in the hands)	0	1 2 3
8 (s)	I felt that I was using a lot of nervous energy	0	1 2 3
9 (a)	I was worried about situations in which I might panic and make a fool of myself	0	1 2 3
10 (d)	I felt that I had nothing to look forward to	0	1 2 3
11 (s)	I found myself getting agitated	0	1 2 3
12 (s)	I found it difficult to relax	0	1 2 3
13 (d)	I felt down-hearted and blue	0	1 2 3
14 (s)	I was intolerant of anything that kept me from getting on with what I was doing	0	1 2 3
15 (a)	I felt I was close to panic	0	1 2 3
16 (d)	I was unable to become enthusiastic about anything	0	1 2 3
17 (d)	I felt I wasn't worth much as a person	0	1 2 3
18 (s)	I felt that I was rather touchy	0	1 2 3
19 (a)	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1 2 3
20 (a)	I felt scared without any good reason	0	1 2 3
21 (d)	I felt that life was meaningless	0	1 2 3

The SF-12 Health Survey

SF-12 Health Survey

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. **Answer each question by choosing just one answer.** If you are unsure how to answer a question, please give the best answer you can.

1. In general, would you say your health is:

☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	YES, limited a lot	YES, limited a little	NO, not limited at all
2. Moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	☐	☐	☐
3. Climbing several flights of stairs.	☐	☐	☐

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	YES	NO
4. Accomplished less than you would like.	☐	☐
5. Were limited in the kind of work or other activities.	☐	☐

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	YES	NO
6. Accomplished less than you would like.	☐	☐
7. Did work or activities less carefully than usual.	☐	☐

8. During the past 4 weeks, how much did pain interfere with your normal work (including work outside the home and housework)?

☐ Not at all ☐ A little bit ☐ Moderately ☐ Quite a bit ☐ Extremely

These questions are about how you have been feeling during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 4 weeks...

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
9. Have you felt calm & peaceful?	☐	☐	☐	☐	☐	☐
10. Did you have a lot of energy?	☐	☐	☐	☐	☐	☐
11. Have you felt down-hearted and blue?	☐	☐	☐	☐	☐	☐

12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

☐ All of the time ☐ Most of the time ☐ Some of the time ☐ A little of the time ☐ None of the time

Exercise Benefits/Benefits Scale

EXERCISE BENEFITS/BARRIERS SCALE

DIRECTIONS: Below are statements that relate to ideas about exercise. Please indicate the degree to which you agree or disagree with the statements by circling SA for strongly agree, A for agree, D for disagree, or SD for strongly disagree.

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. I enjoy exercise.	SA	A	D	SD
2. Exercise decreases feelings of stress and tension for me.	SA	A	D	SD
3. Exercise improves my mental health.	SA	A	D	SD
4. Exercising takes too much of my time.	SA	A	D	SD
5. I will prevent heart attacks by exercising.	SA	A	D	SD
6. Exercise tires me.	SA	A	D	SD
7. Exercise increases my muscle strength.	SA	A	D	SD
8. Exercise gives me a sense of personal accomplishment.	SA	A	D	SD
9. Places for me to exercise are too far away.	SA	A	D	SD
10. Exercising makes me feel relaxed.	SA	A	D	SD
11. Exercising lets me have contact with friends and persons I enjoy.	SA	A	D	SD
12. I am too embarrassed to exercise.	SA	A	D	SD
13. Exercising will keep me from having high blood pressure.	SA	A	D	SD
14. It costs too much to exercise.	SA	A	D	SD
15. Exercising increases my level of physical fitness.	SA	A	D	SD
16. Exercise facilities do not have convenient schedules for me.	SA	A	D	SD
17. My muscle tone is improved with exercise.	SA	A	D	SD
18. Exercising improves functioning of my cardiovascular system.	SA	A	D	SD
19. I am fatigued by exercise.	SA	A	D	SD
20. I have improved feelings of well being from exercise.	SA	A	D	SD
21. My spouse (or significant other) does not encourage exercising.	SA	A	D	SD

(Continued on reverse side)

	Strongly Agree	Agree	Disagree	Strongly Disagree
22. Exercise increases my stamina.	SA	A	D	SD
23. Exercise improves my flexibility.	SA	A	D	SD
24. Exercise takes too much time from family relationships.	SA	A	D	SD
25. My disposition is improved with exercise.	SA	A	D	SD
26. Exercising helps me sleep better at night.	SA	A	D	SD
27. I will live longer if I exercise.	SA	A	D	SD
28. I think people in exercise clothes look funny.	SA	A	D	SD
29. Exercise helps me decrease fatigue.	SA	A	D	SD
30. Exercising is a good way for me to meet new people.	SA	A	D	SD
31. My physical endurance is improved by exercising.	SA	A	D	SD
32. Exercising improves my self-concept.	SA	A	D	SD
33. My family members do not encourage me to exercise.	SA	A	D	SD
34. Exercising increases my mental alertness.	SA	A	D	SD
35. Exercise allows me to carry out normal activities without becoming tired.	SA	A	D	SD
36. Exercise improves the quality of my work.	SA	A	D	SD
37. Exercise takes too much time from my family responsibilities.	SA	A	D	SD
38. Exercise is good entertainment for me.	SA	A	D	SD
39. Exercising increases my acceptance by others.	SA	A	D	SD
40. Exercise is hard work for me.	SA	A	D	SD
41. Exercise improves overall body functioning for me.	SA	A	D	SD
42. There are too few places for me to exercise.	SA	A	D	SD
43. Exercise improves the way my body looks.	SA	A	D	SD

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The Physical Activity Enjoyment Scale – Short Version (PACES-S)

When I am physically active... 1 = “strongly disagree” to 5 = “strongly agree”

I enjoy it

I find it pleasurable

It is very pleasant

It feels good

Cannabis and Exercise Expectancies Questionnaire

What impact do you think cannabis has on the following aspects of your exercise experience?

For each item, please select one of the following options:

- Makes it much worse
- Makes it a little worse
- Doesn’t have any impact
- Makes it a little better
- Makes it much better

Items:

- Exercise Performance
- Enjoyment of Exercise
- Motivation to Exercise
- Ability to focus during exercise
- Discomfort/pain during exercise
- Recovery from exercise

What impact does cannabis have on the perception of time during exercise?

- Makes it go by much slower
- Makes it go by a little slower
- Doesn’t have any impact
- Makes it go by a little faster
- Makes it go by much faster

Modified Godin Leisure-Time Exercise Questionnaire (GLTEQ) (Baseline and Follow-Up)

The next series of questions will ask you about how often you engage in vigorous, moderate, and mild-intensity cardiovascular-type exercise. Exercise intensity is an indication of how hard your body is working during exercise.

Vigorous-Intensity Exercise

Vigorous-intensity exercise activities are those that greatly increase the rate that you are breathing and the amount that you are sweating. Exercise at this level of intensity will cause your heart to beat rapidly and will make it difficult to say more than a few words without pausing for a breath. Vigorous-intensity exercise activities are those that would be rated a "7" or above on a scale of 0 ("no effort at all") to 10 ("maximal effort").

Examples of vigorous activities include:

- Running
- Swimming laps
- Climbing flights of stairs
- Hiking hills
- Interval training, e.g., CrossFit, HIIT classes
- Riding your bike uphill

Total minutes of vigorous intensity exercise per week on average:

Separate vigorous intensity exercise sessions per week on average:

Moderate-Intensity Exercise

Moderate-intensity exercise activities are those that work you hard enough to raise your heart rate and may cause you to break a sweat. One way to tell that you are exercising at a moderate intensity is that you are able to talk, but not sing, the words to your favorite song. Moderate intensity exercise activities are those that would be considered a "5" or "6" out of 10 on a scale of 0 ("no effort at all") to 10 ("maximal effort").

Examples of moderate activities include:

- Brisk walking
- Light jogging
- Trekking on mostly level ground
- Riding your bike on mostly level ground

Total minutes of moderate intensity exercise per week on average:

Separate moderate intensity exercise sessions per week on average:

Mild-Intensity Exercise

Mild-intensity exercise activities are those that work you hard enough to raise your heart rate, but likely do not cause you to break a sweat. During mild intensity exercise, you should be able to talk effortlessly and sing the words to your favorite song. Mild intensity exercise activities are those that would be considered a "3" or a "4" out of 10 on a scale of 0 ("no effort at all") to 10 ("maximal effort").

Examples of mild-intensity activities include:

- Leisure walking
- Light yoga or stretching
- Bowling
- Archery
- Fishing from a riverbank etc.

Total minutes of mild intensity exercise per week on average:

Separate mild intensity exercise sessions per week on average:

Administered at Both Pre-Walk and Post-Walk Sessions (Non-cannabis and Cannabis)

The Physical Activity Affect Scale (PAAS)

APPENDIX					
<i>Instructions: Please use the following scale to indicate the extent to which each word below describes how you feel at this moment in time. Record your responses by circling the appropriate number.</i>					
	<i>Do Not Feel</i>	<i>Feel Slightly</i>	<i>Feel Moderately</i>	<i>Feel Strongly</i>	<i>Feel Very Strongly</i>
1. Upbeat	0	1	2	3	4
2. Calm	0	1	2	3	4
3. Energetic	0	1	2	3	4
4. Tired	0	1	2	3	4
5. Peaceful	0	1	2	3	4
6. Miserable	0	1	2	3	4
7. Worn-out	0	1	2	3	4
8. Relaxed	0	1	2	3	4
9. Fatigued	0	1	2	3	4
10. Discouraged	0	1	2	3	4
11. Enthusiastic	0	1	2	3	4
12. Crummy	0	1	2	3	4

Note. Subscales and corresponding items are as follows: Positive Affect (1, 3, 11); Negative Affect (6, 10, 12); Fatigue (4, 7, 9); Tranquility (2, 5, 8).

Fatigue

“How would you rate your fatigue on a scale of 0 to 10 with 0 being ‘no fatigue’ and 10 being the

‘worst possible fatigue’?”

Feeling Scale (FS)

“How do you feel right now?” (before or after exercise)

+5 = Very good

+4 = Good

+3 = Fairly good

+2 = Quite good

+1 = A little good

0 = Neutral

-1 = A little bad

-2 = Quite bad

-3 = Fairly bad

-4 = Bad

-5 = Very bad

Felt Arousal Scale (FAS)

FELT AROUSAL SCALE

Estimate here how aroused you actually feel. Do this by circling the appropriate number. By “arousal” here is meant how “worked-up” you feel. You might experience high arousal in one of a variety of ways, for example as excitement or anxiety or anger. Low arousal might also be experienced by you in one of a number of different ways, for example as relaxation or boredom or calmness.

6 High Arousal

5

4

3

2

1 Low Arousal

State Mindfulness Scale (SMS)

SMS items

1. I was aware of different emotions that arose in me
2. I tried to pay attention to pleasant and unpleasant sensations.
3. I found some of my experiences interesting
4. I noticed many small details of my experience
5. I felt aware of what was happening inside of me
6. I noticed pleasant and unpleasant emotions
7. I actively explored my experience in the moment
8. I clearly physically felt what was going on in my body
9. I changed my body posture and paid attention to the physical process of moving
10. I felt that I was experiencing the present moment fully
11. I noticed pleasant and unpleasant thoughts
12. I noticed emotions come and go
13. I noticed various sensations caused by my surroundings (e.g., heat, coolness, the wind on my face)
14. I noticed physical sensations come and go
15. I had moments when I felt alert and aware
16. I felt closely connected to the present moment
17. I noticed thoughts come and go
18. I felt in contact with my body
19. I was aware of what was going on in my mind
20. It was interesting to see the patterns of my thinking
21. I noticed some pleasant and unpleasant physical sensations

F

Post-Walk Only

Modified Borg RPE (CR10 Scale)

Modified Borg CR10 RPE scale

The modified Borg CR10 RPE scale measures exertion on a scale of 0 (no exertion or resting) to 10 (pushing yourself to the max). You use your breathing rate or breathlessness to determine your RPE during exercise.

Rating	Perceived Exertion Level
0	No exertion (at rest)
1	Very light
2 to 3	Light
4 to 5	Moderate (somewhat hard)
6 to 7	High (vigorous)
8 to 9	Very hard
10	Maximum effort (highest possible)

Attentional Focus

ATTENTIONAL FOCUS

Please estimate the approximate amount of time that your thoughts were either associative or dissociative during exercise bout.

(“100% Associate/thinking about exercise” to “100% Dissociative/thinking about other things”)

Physical Activity Enjoyment Scale (PACES)

PHYSICAL ACTIVITY ENJOYMENT SCALE (PACES)

Please rate how you feel about the exercise bout you just completed.

* 1 2 3 4 5 6 7		* 1 2 3 4 5 6 7
I enjoy it	I hate it	It's very invigorating
I feel bored	I feel interested	It's not at all invigorating
I dislike it	I like it	I am very frustrated by it
* 1 2 3 4 5 6 7		* 1 2 3 4 5 6 7
I find it pleasurable	I find it unpleasurable	I am not at all frustrated by it
* 1 2 3 4 5 6 7		* 1 2 3 4 5 6 7
I am very absorbed in this activity	I am not at all absorbed in this activity	It's very gratifying
1 2 3 4 5 6 7		* 1 2 3 4 5 6 7
It's no fun at all	It's a lot of fun	It's very exhilarating
* 1 2 3 4 5 6 7		It's not at all stimulating
I find it energizing	I find it tiring	* 1 2 3 4 5 6 7
1 2 3 4 5 6 7		It gives me a strong sense of accomplishment
It makes me depressed	It makes me happy	* 1 2 3 4 5 6 7
* 1 2 3 4 5 6 7		It's very refreshing
It's very pleasant	It's very unpleasant	1 2 3 4 5 6 7
* 1 2 3 4 5 6 7		I felt as though I would rather be doing something else
I feel good physically while doing it	I feel bad physically while doing it	

(cont.)

*Item is reversed scored (i.e., 1=7, 2=6, . . . 6=2, 7=1).

Intentions for Future Physical Activity

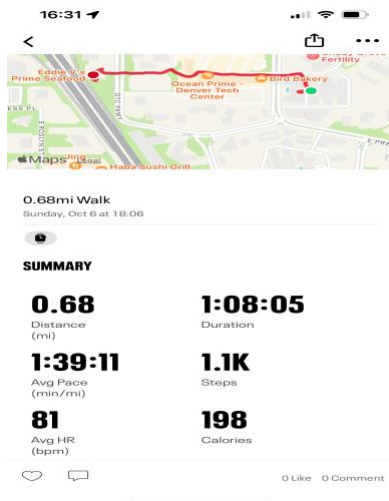
I feel confident that I could do aerobic exercise even if I was very busy. 1 (Strongly Disagree) to 7 (Strongly Agree).

I feel confident that I could do aerobic exercise even if I was feeling tired. 1 (Strongly Disagree) to 7 (Strongly Agree).

I feel confident that I could do aerobic exercise even if none of my friends would do it with me. 1 (Strongly Disagree) to 7 (Strongly Agree).

Objective Reports of Physical Activity

This is an example of data generated from a tracked walk in the Map My Walk application.



Additional Measures Administered at Only Pre-Walk and Post-Walk with Cannabis Sessions

Pre-Walk

Cannabis Consumption Measure.

1. For flower cannabis consumption prior to physical activity
 - i. What did you use to smoke? (bong, joint, pre-roll, pipe, vaporizer,

other).

- ii. If loose flower, how much flower did you use? (Please provide an estimate in grams or milligrams).
 - iii. If pre-roll, how many pre-rolls did you consume?
 - iv. If pre-roll, approximately how much of the pre-roll was consumed (entire, half, other – please specify)
- 2. What type of cannabis did you use? (sativa, indica, hybrid)
 - 3. What cannabis strain did you use? (ex: Blue Dream, Sour Diesel, etc.)
 - 4. Please indicate the THC and CBD percentages of your product, as indicated on product packaging label.
 - 5. What brand of cannabis did you use? (ex: Wana, Stratos, etc.)
 - 6. Please provide a photo of the product packaging label that includes clear product details (ex: Strain, THC and CBD percentages, etc.)
 - 7. Is there any other information on the label you'd like to provide?
 - 8. Please indicate what time you started consuming cannabis and what time you stopped.

Pre- and Post-Walk

Drug Effects Questionnaire (DEQ)

Instructions: This questionnaire asks about how you are feeling after taking the substance that was given to you. Please draw a mark on the line to show how strongly you are feeling each of the following effects **right now**. You can mark anywhere on the line, but please draw a vertical line (one that goes straight up and down).

Let's look at an example first.

EXAMPLE: Do you feel dizzy right now?

If you do not feel dizzy, draw a line at NOT AT ALL. If you feel very dizzy, draw a line at EXTREMELY. If you feel somewhere in between, you can draw a mark anywhere along the line between NOT AT ALL and EXTREMELY to indicate how dizzy you are. For example, if you feel a little dizzy, you might draw a line that looks something like the example below.

NOT AT ALL |-----| EXTREMELY

1. Do you FEEL a drug effect right now?

NOT AT ALL |-----| EXTREMELY
 |-----|

2. Are you HIGH right now?

NOT AT ALL |-----| EXTREMELY
 |-----|

3. Do you DISLIKE any of the effects you are feeling right now?

NOT AT ALL |-----| EXTREMELY
 |-----|

4. Do you LIKE any of the effects you are feeling right now?

NOT AT ALL |-----| EXTREMELY
 |-----|

5. Would you like MORE of the drug you took, right now?

NOT AT ALL |-----| EXTREMELY
 |-----|

Post-Walk

Subjective Reports of Combining Cannabis with Physical Activity

1. Based on this experience, how likely are you to use cannabis again before physical activity in the near future?
 - Very likely
 - Somewhat likely
 - Neutral
 - Somewhat unlikely
 - Very unlikely
2. Were the effects you felt from cannabis during your walk different from when you use cannabis at home (or in another sedentary situation)?
 - Yes, the walk enhanced the drug effects I experienced from cannabis
 - Yes, the walk blunted the drug effects I experienced from cannabis
 - No, the walk did not change the drug effects I experienced from cannabis
 - Other (please explain)
3. Is there anything else you would like to share about your experience combining cannabis with physical activity?
 - Yes (please specify): _____

- No

Follow-Up Only

Cannabis and Exercise Questionnaire

1. Over the last month, were you physically active?
 - a. If yes - Over the last month, during the time that you spent engaging in physical activity, were you under the influence of cannabis or experiencing any effects from using cannabis earlier in the day?
 - i. If yes – how many times in the last month did you use cannabis before/during physical activity
 - ii. Over the last month, please indicate what cannabis you used before/during physical activity (flower, edibles, concentrates/dabs, tinctures, topicals)
 - iii. Why did you decide to use cannabis in conjunction with physical activity (check all that apply)?
 1. As ritualistic medicine
 2. Distraction from exercise
 3. Helps me focus/concentrate
 4. To be more observant/aware
 5. To be less observant/aware
 6. Improve flexibility
 7. Enhance physical performance
 8. Increase energy

9. Enhances mind/body/spirit connection
10. Enhances body awareness
11. Decreases body awareness
12. To be more conscious of my breath during exercise
13. Keeps me in the zone
14. To decrease my sense of time during exercise
15. To decrease inflammation
16. As a reward for exercising
17. To improve creativity during exercise
18. To decrease self-consciousness
19. To manage social anxiety
20. To relieve muscle tension
21. To manage pain in order to tolerate exercise
22. Improve patience from frustration
23. My friends do it/we do it together
24. As a neuroprotectant
25. Delays onset of muscle soreness
26. Recovery for pain
27. Helps me enjoy the exercise experience
28. Helps sleep
29. To regulate my breathing
30. To regulate my heart rate
31. Other

- iv. (If flower/concentrate) If you used cannabis flower, concentrate, or tinctures, what would you say is the average THC content (%) you used before/during physical activity?
- v. (If flower/concentrate) If you used cannabis flower, concentrate, or tinctures, what would you say is the average CBD content (%) you used before/during physical activity?
- vi. (If edibles) If you used edibles, what would you say is the average THC content (mg) you used before/during physical activity?
- vii. (If edibles) If you used edibles, what would you say is the average CBD content (mg) you used before/during physical activity?
- b. If yes – Over the past month, did you use cannabis within two hours AFTER engaging in physical activity?
 - i. If yes – how many times in the last month did you use cannabis within 2 hours after physical activity?
 - ii. Over the last month, please indicate what cannabis you used within 2 hours after physical activity (flower, edibles, concentrates/dabs, tinctures, topicals)
 - iii. Why did you decide to use cannabis in conjunction with physical activity (check all that apply)?
 - 1. As ritualistic medicine
 - 2. Distraction from exercise
 - 3. Helps me focus/concentrate
 - 4. To be more observant/aware

5. To be less observant/aware
6. Improve flexibility
7. Enhance physical performance
8. Increase energy
9. Enhances mind/body/spirit connection
10. Enhances body awareness
11. Decreases body awareness
12. To be more conscious of my breath during exercise
13. Keeps me in the zone
14. To decrease my sense of time during exercise
15. To decrease inflammation
16. As a reward for exercising
17. To improve creativity during exercise
18. To decrease self-consciousness
19. To manage social anxiety
20. To relieve muscle tension
21. To manage pain in order to tolerate exercise
22. Improve patience from frustration
23. My friends do it/we do it together
24. As a neuroprotectant
25. Delays onset of muscle soreness
26. Recovery for pain
27. Helps me enjoy the exercise experience

28. Helps sleep

29. To regulate my breathing

30. To regulate my heart rate

31. Other

iv. (If flower/concentrate) If you used cannabis flower, concentrate, or tinctures, what would you say is the average THC content (%) you used within 2 hours after physical activity?

v. (If flower/concentrate) If you used cannabis flower, concentrate, or tinctures, what would you say is the average CBD content (%) you used within 2 hours after physical activity?

vi. (If edibles) If you used edibles, what would you say is the average THC content (mg) you used within 2 hours after physical activity?

vii. (If edibles) If you used edibles, what would you say is the average CBD content (mg) you used within 2 hours after physical activity?

c. Please check physical activities you are most likely to use cannabis in conjunction with. Choose all that apply or write in an alternative if it does not appear on the list.

i. 1, Brisk walking or jogging

ii. 2, Running

iii. 3, Yard work (mowing, raking)

iv. 4, Dancing

v. 5, Swimming

vi. 6, Biking/Cycling

- vii. 7, Hiking
 - viii. 8, Weightlifting
 - ix. 9, Yoga
 - x. 10, HIIT
 - xi. 11, Crossfit
 - xii. 12, Pilates
 - xiii. 13, Sports
 - xiv. 14, Other
- d. Were the effects you felt from cannabis during your physical activity different from when you use cannabis at home (or in another sedentary situation)?
- i. Yes, the physical activity enhanced the drug effects I experienced from cannabis
 - ii. Yes, the physical activity blunted the drug effects I experienced from cannabis
 - iii. No, the physical activity did not change the drug effects I experienced from cannabis
 - iv. Other (please explain)