

1 Patterns and perceptions of cannabis use with physical activity

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26 **Abstract**

27 Background and Aims: Past research has shown that cannabis use is common among adults in the U.S. In
28 addition, physical activity (PA), such as exercise, is often a component of many American's daily
29 routines. Anecdotal information suggests that a subset of individuals use cannabis in conjunction with
30 PA, but the evidence base is lacking. The purpose of this study was to assess the frequency, methods of
31 ingestion, strain types, and timing (before, during or after) of cannabis use in combination with PA. We
32 also sought to better understand the types of PA that cannabis is being used with and reasons why
33 individuals may use cannabis with PA.

34 Methods and Results: A brief survey was developed and was administered online to community residents
35 (N = 105) who reported use of cannabis with PA. Analysis of survey responses revealed that participants
36 were using cannabis in combination with a wide range of physical activities. While cannabis use was
37 reported before, during, and after PA, the majority of participants (92%) reported use of cannabis before
38 PA. Most participants (77%) believed that the use of cannabis products with their PA had a positive effect
39 on their performance. The strain of cannabis used with PA was dependent on timing of cannabis use
40 before, during, or after PA. Although participants reported a range of reasons for using cannabis before,
41 during, or after PA, pain management was the only reason reported across all time periods.

42 Conclusions: Findings from this study suggest that there is a sub-community of physically active
43 individuals using cannabis with their PA, many who believe that cannabis use has a positive effect on
44 their performance.

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52 **Introduction**

53 Cannabis products, also commonly referred to as marijuana, are derived from the flower, stems
54 and leaves of the hemp plant. In 2016, almost 9% of the U.S. adult population reported cannabis use
55 within the past month, making cannabis the most commonly used illicit drug in the U.S. (1). Beginning in
56 2012 States within the U.S. began to legalize the recreational use of cannabis products. Currently,
57 cannabis products are recreationally available for legal consumption in Alaska, California, Colorado,
58 Maine, Massachusetts, Nevada, Oregon, Vermont, Washington and Washington D.C.

59 Phytocannabinoids, the active components in cannabis, mimic the effects of the endogenous
60 cannabinoids in the body (2). Delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD) are the two
61 most abundant phytocannabinoids present in cannabis products, and have received the most attention
62 from the scientific community. However, THC and CBD are just two of more than 100 known
63 phytocannabinoids (3) and the effects of these compounds have yet to be fully elucidated. Products of the
64 cannabis plant can further be described by their cultivar, or strain, and are often separated into two
65 general categories: *Cannabis Indica* and *Cannabis Sativa* (4), with varying hybrids of the two strains.
66 Among medical cannabis users, common reasons for the use of *Cannabis Indica* include pain
67 management and as an aid in sedation and sleep, while *Cannabis Sativa* users often prefer this strain for
68 its perceived induction of euphoria and energy enhancement (5). Although exploration of the medicinal
69 and psychoactive effects of cannabis products is still in its infancy, interest related to cannabis use on
70 physical activity (PA) is also emerging.

71 Within the U.S., just over half (51.7%) of adults over the age of 18 years met the federal PA
72 guidelines of at least 150-minutes of moderate or 75-minutes of vigorous activity per week (6). Currently,
73 although there is minimal research describing how and why the physically active general population is
74 using cannabis with PA, there have been several studies investigating cannabis use and athletic
75 populations. Among male and female Division 1 National Collegiate Athletic Association (NCAA)
76 athletes surveyed about their personal use of cannabis, 36.8% reported use within the past year (7).
77 Thirty-eight percent of the athletes reporting cannabis use within past year reported using on average once

78 per month, with male athletes more likely to report use when compared to their female counterparts (7). A
79 more recent study found that athletes are more likely to use cannabis if they are male, Caucasian, or using
80 performance enhancing drugs (8). The increasing availability of cannabis products for recreational use,
81 combined with the growing number of U.S. adults who are physically active, and reports of athletes using
82 cannabis may have contributed to a growing interest in the use of cannabis in combination with PA. More
83 than 40 years ago, both moderate and heavy cannabis users were found to be less active the day after
84 heavy cannabis use, however, it was speculated that the findings may have been associated with social
85 reasons rather than pharmacological effects (9).

86 New evidence is emerging that the euphoric effects experienced during exercise, also termed as
87 “runner’s high,” may be the result of the actions of endogenous cannabinoid release during exercise rather
88 than endorphins (10). The G-protein coupled cannabinoid 1 receptors (CB1) in the brain have been
89 observed to be closely linked to opioid receptors, and the dopaminergic reward pathways suggesting
90 endogenous cannabinoid release with PA could be a major reason why regular exercise is perceived as
91 highly rewarding (11, 12). It is possible that using cannabis products high in CB1 agonists, such as THC
92 (13), could increase associated pleasure/reward already observed with regular exercise and increase
93 motivation to partake in PA. Conversely, delayed-onset muscle soreness (DOMS) is often associated with
94 muscle damage resulting from acute inflammation from strenuous exercise (14). Pain associated with
95 DOMS may even result in exercise avoidance (15). -New evidence suggests that cannabinoids like THC
96 and CBD are associated with pain reduction (16) and may have anti-inflammatory effects through their
97 repressive effects on immune tissue (17). As a result, the use of cannabis may be a tempting option to
98 reduce exercise-induced pain and inflammation. Yet, there is little evidence in human populations on how
99 cannabis use combined with PA affects motivation to partake in exercise as well as how cannabis use
100 affects recovery from exercise.

101 The primary goal of this exploratory study is to describe cannabis use as it relates to PA. More
102 specifically, this study examines the frequency, method and timing (before, during or after) of cannabis
103 use in combination with PA. Secondary goals include characterizing cannabis use as it relates to modes of

104 PA and strain use and the examination of characteristics (e.g., age, gender) associated with participants'
105 cannabis use in conjunction with PA. Finally, we aim to better understand reasons that participants use
106 cannabis with PA.

107 **Methods**

108 **Participants and Procedures**

109 From October to December 2017, 140 adults between the ages of 18 to 66 years across the U.S.
110 were surveyed about their cannabis use habits in combination with their PA. Recruitment of participants
111 was conducted online through social media (e.g., Facebook and Snapchat) and through snowballing and
112 flyers posted in the local area for convenience sampling. A link and/or QR code took participants to a
113 Qualtrics survey titled Cannabis Use and PA Questionnaire (CUPAQ), which they completed online.
114 Recruitment materials specifically sought participants who use cannabis and cannabis products in relation
115 to their exercise and PA habits. Participation was anonymous and took approximately 10 minutes. No
116 external incentive was given for survey completion. This study was approved by the Institutional Review
117 Board at the University of Northern Colorado.

118 **Survey Design and Administration**

119 Initial contact in Qualtrics provided participants with a brief overview of the purpose of the study,
120 emphasized that participation would remain anonymous, and noted the time required for participation (10
121 minutes). Participants were asked to complete an informed consent and confirm their age (18 or older)
122 and residence in the U.S. prior to continuing. The survey consisted of 39 questions which were divided
123 into three main sections. The first section consisted of 9 questions designed to gather general cannabis use
124 habits of participants (i.e., frequency and duration of use), as well as age, gender, minutes of PA
125 completed each week, and U.S. state of current residence. Section 2 included 18 questions focused on
126 participants' cannabis use habits as it pertained to their PA (before, during, or after PA). The frequency of
127 cannabis use associated with PA over the last year and most recent episode of use were also assessed.
128 Skip logic was programmed into Qualtrics so that participants who did not report cannabis use at one or
129 more of the PA time points (before, during, or after) did not receive those questions. When cannabis was

130 used before, during, and/or after PA, participants were asked to select the most common method of
131 ingestion (e.g., smoking using a joint, inhaling via a vaporizer) and the strain (i.e., indica, sativa, or
132 indica/sativa hybrid) if known. Participants were also asked to indicate the specific activities (e.g., weight
133 lifting, kayaking) where cannabis was used before, during, and after PA. Lastly, an open-ended question
134 assessed reasons for using cannabis before, during, and after PA. The third and final section of the survey
135 consisted of 12 questions aimed at describing the amount and percentage of THC and CBD consumed.
136 Using skip logic, questions were further divided into three categories based on participant self-reported
137 primary form of cannabis use, including flower or bud, concentrates (i.e., oils, wax, shatter, dabs), and
138 edibles. In assessing the quantity of the flower or bud, a visual aid and terminology were adapted from the
139 Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU) (18).

140 **Statistical Analysis**

141 A total of 140 survey responses were obtained at the conclusion of the study. Three participants
142 failed to complete informed consent and 32 participants reported never using cannabis in combination
143 with their physical activities. These participants were removed from the dataset and a total of 105
144 participants were included in data analyses. All analyses were conducted using SPSS version 24 (IBM
145 Corp.; Armonk, NY) and data are reported as frequency, percent or mean \pm standard deviation. We
146 present descriptive statistics to summarize the background characteristics of the sample and to examine
147 participants' use of cannabis before, during or after PA. To assess whether a range of demographic
148 characteristics (e.g., age, gender) were associated with participants' cannabis use during PA, we used a
149 series of chi square analyses. Significance was $p \leq 0.05$. Lastly, open-ended questions related to the
150 reasons for using cannabis before, during, or after PA were examined through a content-analysis which
151 allowed for the categorization of responses from each question into six or seven different themes.
152 Responses for each of the three questions were coded independently by two coders into each of the theme
153 categories. Agreement on these classifications was reached prior to listing a response under a specific
154 theme category (prior to agreement, interrater reliability [k] = .80 – 1.00). The frequency of responses
155 was calculated and reported for each theme.

156 **Results**

157 *Background Characteristics and Cannabis Use.*

158 Participants (53% male) ranged from 18-66 years of age ($M = 31.4 \pm 11.2$ years) and lived in a
159 total of 21 states across the U.S. The majority of participants were from Colorado ($n=59$), California
160 ($n=9$), Louisiana ($n=7$) and Nebraska ($n=5$). Participants reported an average of 74.5 ± 111.5 months in
161 duration of regular cannabis use. Ongoing cannabis use frequency revealed that 1.9% used less than once
162 per month, 6.7% reported using between 1-3 times per month, 22.9% reported using between 1-6 times
163 per week, and 68.6% reported using cannabis products on a daily basis.

164 *Physical Activity and Cannabis Use*

165 Survey participants reported engaging in an average of 399.87 ± 543.82 minutes of PA
166 throughout a typical week. The average age of participants when they first reported using cannabis with
167 PA was 23 ± 8 years. When asked how frequently they used cannabis products in combination with PA,
168 63.8% of the participants reported using cannabis products in combination with PA within the past week.
169 When asked to report their frequency of cannabis use in combination with PA, 9.5% used cannabis in
170 combination with PA less than once a month, 12.4% used between 1-3 times per month, 41.0% reported
171 using cannabis 1-6 times per week with PA, and 37.2% reported using at least one time or more per day in
172 combination with their PA. Some participants who reported using cannabis with PA multiple times per
173 day used before and after exercise, or used before exercise on two separate exercise bouts within the same
174 day. The majority of participants (78.1%) reported using cannabis products in combination with PA at
175 least once per week.

176 Participants also reported the method and quantity of cannabis used most frequently with PA.
177 Methods/forms of cannabis consumption were grouped into four general categories: inhalation of
178 flower/bud, edible, concentrate (dabbing), and other. The majority (80.0%) of participants reported that
179 their primary method of cannabis use with PA was by inhalation of flower/bud. Methods of inhalation
180 from most to least common are as follows: hand pipe ($n=23$), vaporizer ($n=22$), bong ($n=18$), joint ($n=11$)
181 and blunt ($n=6$). Only 11.4% of participants reported primarily using concentrates with PA, 5.7% used

182 edibles, and 2.9% other (topical/salves, capsules and fresh non-decarboxylated). Flower/bud forms were
 183 most frequently (n=80) reported when cannabis was used in conjunction with PA. Using the visual aid
 184 from the DFAQ-CU, participants who reported flower/bud as their primary form of use with PA
 185 personally used an average of 0.44 ± 0.45 grams of flower/bud before PA, 0.54 ± 0.49 grams of
 186 flower/bud during PA, and 0.78 ± 0.86 grams of flower/bud after PA.

187 *Timing of Cannabis Use with PA*

188 When asked when they had used cannabis in conjunction with PA, 92% (n=97) of participants
 189 reported having used cannabis within one hour before beginning PA, 21% (n=22) reported having used
 190 cannabis during their PA, and 73% (n=77) reported having used cannabis within one hour after PA. Fifty-
 191 three percent (n=56) reported using most often before PA, 4.8% (n=5) reported using most often during
 192 PA, and 41.9% (n=44) reported using most frequently within one hour after completing their PA. A total
 193 of 23.8% of participants reported using cannabis only before PA, while 48.6% reported using before and
 194 after PA, followed by 18.1% reporting using before, during and after. Only 6.7%, 1.9% and 1.0% reported
 195 using only after, before and during, and only during respectively. The frequency of participant primary
 196 method of cannabis use before, during and after PA is presented in Table 1. Over three-fourths of
 197 participants who used cannabis either before, during, or after before PA reported their primary method of
 198 use was through inhalation. Smaller numbers used edibles or concentrates.

199 Table 1. Primary Method of Consumption Used Before, During and After Physical Activity

Category	Method	Frequency Before n (% of total)	Frequency During n (% of total)	Frequency After n (% of total)
Inhalation (flower/bud)	Joint	12 (11.4%)	15 (29.4)	13 (13.8%)
	Blunt	7 (6.8%)	4 (7.8%)	7 (7.4%)
	Hand pipe	25 (24.3%)	11 (21.6%)	20 (21.3%)
	Bong	21 (20.4%)	1 (2.0%)	17 (18.1%)
	Vaporizer	20 (19.4%)	12 (23.5%)	14 (14.9%)
Edible	Edible	5 (4.9%)	3 (5.9%)	2 (2.1%)
Concentrate	Dabbing	11 (10.7%)	4 (7.8%)	14 (14.9)
Other	Other*	2 (1.9%)	1 (2.0%)	7 (7.5%)

200 Frequencies are reported in combination with the percentage of the total number of valid responses (Total
 201 (n)). *Other forms of use included but were not limited to: topical/salves, capsules, and fresh non-
 202 decarboxylated.

203 The cannabis strain used most by participants before, during, and after PA is depicted in Table 2.
204 Sativa and hybrid strains were most commonly used before PA, with hybrid and sativa strains most often
205 used during PA, and indica and hybrid strains most commonly used after PA.

206 Table 2. Cannabis Strain Participants Had Used Before, During and After PA

Strain	Before n (% of total)	During n (% of total)	After n (% of total)
Indica	20 (13.4%)	8 (9.6%)	57 (38.0%)
Sativa	68 (45.6%)	32 (38.6%)	32 (21.3%)
Hybrid	54 (36.2%)	37 (44.6%)	55 (36.7%)
Didn't Know	7 (4.7%)	6 (7.2%)	6 (4.0%)

207 Participants reported the strain(s) that they had used before, during and after PA.

208 *Perception of Cannabis Use on Athletic Performance*

209 When participants were asked to report whether cannabis use with PA had a positive, negative, or
210 no effect on their performance, 81 (77%) respondents reported they felt using cannabis in combination
211 with their PA had a positive effect on their performance. A smaller number (n=21; 20%) reported that
212 they felt cannabis use had no effect of their PA performance, and only 3 (3%) respondents felt cannabis
213 use with their PA had a negative effect on their performance.

214 *Reported Physical Activities with Cannabis Use*

215 Participants described using cannabis in association with both indoor and outdoor activities, as
216 well as team and individual PA. Participants reported using cannabis before (Figure 1a), during (Figure
217 1b) and after (Figure 1c) a variety of PA. When participants used cannabis within 1 hour before PA,
218 hiking (n=69), running (n=54), yoga (n=47), cycling (n=46), and resistance training (n=44) were the most
219 commonly reported. The most frequent activities reported where cannabis was used during PA were:
220 hiking (n=38), golf (n=19), yoga (n=16) and skiing/snowboarding (n=16). The most popular activities that
221 participants reported using cannabis within 1-hour after completion of the activity were: hiking (n=51),
222 running (n=49), resistance training (n=47) and cycling (n=39).

223 *Demographic Characteristics associated with Marijuana Use and Performance*

224 Chi-Square analysis revealed a significant difference between younger (≤ 27 years of age; $n = 53$)
225 and older (≥ 28 years of age; $n = 52$) cannabis users with respect to their primary method of cannabis use
226 with PA ($p = 0.02$). Older users favored more traditional methods of consumption via inhalation (i.e.
227 joint, bong, pipe, vaporizer, and blunt), while younger users were more likely to use concentrates
228 (dabbing). Younger users started using cannabis with PA at an earlier age (19.3 ± 2.9 years) when
229 compared to older users (26.5 ± 10.5 years; $p = 0.02$). With respect to perceptions of cannabis use on
230 performance, older users were more likely to report feeling that cannabis use had a positive effect on their
231 PA performance. In contrast, younger users were more likely to report feeling that cannabis use had no
232 effect on performance ($p = 0.03$). There were no significant differences between younger and older users
233 with respect to the timing of cannabis use with PA (before, during, after; $p = 0.44$) or the frequency of
234 cannabis use with PA ($p = 0.74$).

235 *Participant Reasons for using Cannabis with PA*

236 Three separate open-ended questions asked participants to describe the reasons for using cannabis
237 before, during, or after PA. Coded responses can be found in Table 3. Only participants who reported
238 cannabis use during one or more of these times were provided with the respective open-ended questions.
239 The three most common reasons for using cannabis before PA were: pain relief ($n=25$), to improve focus
240 or get in the zone ($n=25$) and to calm the mind and/or body or to relax ($n=25$). The most popular reasons
241 for using cannabis during PA was to increase/restore energy, push harder, or use as a break ($n=12$).
242 Participants also described using cannabis during PA to improve their enjoyment of an activity and for
243 pain management/relief ($n=11$). The overwhelming majority of responses for reasons of cannabis use
244 after PA were related to relaxation ($n=52$) and to decrease pain or soreness ($n=25$), with minor reasons
245 including appetite stimulation, and aid in sleep and recovery (Table 3). The only category that was present
246 as a reason for cannabis use in all three times (before, during and after PA) was pain relief/management.

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251 Table 3: Categorized Reasons of Cannabis Use Before, During and After PA

Reasons for Using Cannabis Before PA	Frequency (n)
Pain management/relief	25
Improve focus, get in the flow, or “get in the zone”	25
Improve enjoyment of activity	19
Enhance performance, decrease fatigue, or to push harder	16
Improve motivation and state of mind	18
Calm mind and body; relaxation	25
Other	18
Reasons for Using Cannabis During PA	Frequency (n)
Improve enjoyment of activity	11
Improve focus, get back in or stay in the zone	7
Pain management/relief	11
Increase/restore energy, push harder, or to use during a break	12
Maintain the high	4
Other	11
Reasons for Using Cannabis After PA	Frequency (n)
Relaxation	52
Stimulate/increase appetite	7
Pain management/relief	25
Aid in sleep	6
Aid in recovery	9
Other	18

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253 Discussion

254 The present study aimed to describe how and why physically active individuals are using
 255 cannabis in combination with PA. Not only are individuals using cannabis in combination with PA, but
 256 individuals are using cannabis products before (within 1-hour of starting PA), during, and after PA
 257 (within 1-hour of cessation of PA). Studies assessing cannabis use in elite athletes have found that
 258 individuals who were male, Caucasian, and played hockey were most likely to report cannabis use (7, 8).
 259 However, there is little data exploring the characteristics of cannabis use in recreationally physically
 260 active individuals. The present study found that cannabis use with PA was reported equally among males
 261 and females and across a wide range of activities in recreationally physically active individuals. With a
 262 self-reported range of 25-3600 minutes of PA per week, 73 of the 105 participants met the national
 263 weekly physically activity requirements. Hiking was reported as the most prominent activity to use
 264 cannabis with before, during, and after PA. Further observation suggests that the timing of cannabis use is

265 heavily dependent on the specific PA. Running, cycling, and resistance training were the 3rd, 4th, and 5th
266 most frequently reported with cannabis use prior to activity, and were the 2nd, 3rd, and 4th most frequently
267 reported activities to use cannabis after. However, reported frequency of cannabis use during running,
268 cycling, and resistance training dropped to 6th, 7th and 8th respectively. The most popular reported
269 activities to use cannabis during PA were: hiking, golf, skiing/snowboarding, and yoga. Together, these
270 results suggest that the timing of cannabis use with physical activity is heavily dependent on mode of PA.

271 The majority of participants were under the impression that cannabis use in combination with PA
272 had a positive effect on their PA performance, while only 3% felt that using cannabis had a negative
273 effect on PA performance. The perception of improved performance with cannabis use may be purely
274 subjective. The most recent studies which examined this question were conducted 40 years ago and
275 demonstrated that acute use of cannabis containing THC increased resting heart rate (19, 20), systolic and
276 diastolic blood pressure (20) as well as reduced time to exhaustion during a cycling bout (21). Yet, no
277 acute effects of THC administration were reported with respect to oxygen uptake or ventilation during
278 submaximal exercise (19). Unfortunately, the concentration of THC in the cannabis used in these studies
279 is no longer reflective of current cannabis products available on the market today, as THC content in
280 cannabis has been steadily increasing over the past several decades (22).

281 While evidence is lacking related to assessing the effects of acute consumption of cannabis on
282 exercise performance, a recent study explored the effects of chronic cannabis use on exercise
283 performance. In this study, participants were assessed for pulmonary, cardiovascular, anaerobic and
284 strength while at least 12-hours removed from last use of cannabis. When compared to a non-cannabis
285 using control group this cross-sectional study found that there were no differences with respect to
286 pulmonary, cardiovascular, anaerobic, or strength performance (23). However, findings from the present
287 study revealed that a large portion of participants believed that cannabis use had a positive effect on their
288 performance. More research is needed to fully elucidate if the acute use of cannabis is actually effects
289 performance.

290 Previous research has shown that adults aged 18-25 have the highest reported percentage of
291 cannabis use (1), with 20.8% reporting use at least once within the past month (1). While the current
292 study did not assess cannabis use rates among age groups of physically active adults, an age-based
293 analysis was done to assess if individuals 18-27 years of age had different perceptions and methods of use
294 compared to adults over 28 years of age. Chi-square analysis revealed that adults ages 18-27 were
295 significantly more likely to report using concentrates as their primary form of cannabis and began using
296 cannabis with PA at a significantly younger age (i.e., 7 years earlier). However, adults over the age of 28
297 were significantly more likely to report feeling that cannabis use had a positive effect on their
298 performance compared to adults aged 18-27. Emerging research shows that use of concentrates via
299 dabbing may be associated with greater negative consequences, tolerance, and withdrawal compared to
300 flower use (24). We did not assess negative consequences related to participants' cannabis use, but future
301 research should explore whether those using cannabis with their PA are more likely to have problems
302 related to their use and if they are more likely to use cannabis with PA for specific reasons (e.g., pain
303 management).

304 Results from this study revealed that 92% of survey participants reported cannabis use within 1-
305 hour of beginning PA, suggesting that more research to ascertain the effects of acute cannabis use on PA
306 performance may be necessary. Conversely, the perceived performance enhancing effect of cannabis on
307 PA performance could be related to the reduced perception of pain. When asked an open-ended question
308 as to why participants used cannabis before, during, and after PA, pain management/relief was the only
309 reason to be reported across all time points. Pain management was the most common reason for cannabis
310 use before PA, and the second most common reason for use during and after PA. This pain control theme
311 is supported by a recent study which found that pain was the most commonly reported reason for seeking
312 use among medicinal cannabis users (25, 26) with those seeking pain relief preferring *Cannabis Indica* (5,
313 27). Products derived from *Cannabis Indica* are typically lower in THC and contain higher quantities of
314 CBD, reducing the perceived psychoactive effects while still maintaining high pain suppressive effects.
315 Mechanistically cannabinoids modify synaptic transduction in the central nervous system and the

316 periphery. THC and CBD are agonists of the two primary cannabinoid receptors, CB1 and CB2 (2), with
317 CB1 being highly expressed in the central nervous system (28) and CB2 more abundant in the periphery
318 (29). These cannabinoids act on CB1 and CB2 receptors expressed on the pre-and post-synaptic
319 membrane blocking calcium influx, and blocking synaptic vesicle release (30). Activation of these
320 receptors blocks synaptic signal transduction and has even been implicated in long-term depotentiation
321 (31). This mechanism provides a suitable explanation as to why cannabis is used for exercise-associated
322 pain reduction. Interestingly, individuals using cannabis for pain mediation have been found to be at
323 lower risk of development of cannabis use disorders (27).

324 In conjunction with pain management, the most common reasons reported for cannabis use prior
325 to PA were related to improved focus and to calm or relax the mind and body. This was unexpected, as
326 *Cannabis Sativa* was the most frequently reported strain used prior to PA, which is typically associated
327 with feelings of euphoria and energy enhancement (5). After PA, using cannabis for relaxation was
328 reported more frequently than any other response. Given the reported perceived effects of *Cannabis*
329 *Indica* related to sedation and pain management (5), it was expected that this strain may be used
330 predominately post-exercise. This was supported in this study with only 13% and 10% of participants
331 reporting the use of *Cannabis Indica* before and during exercise, respectively. *Cannabis Indica*
332 predominant strains were the most frequently used strain following PA at 38%. This practice could be
333 influenced by perceptions of the effects of *Cannabis Indica* that are popular in the cannabis community.

334 The method and form of cannabis appears to differ based on the time when cannabis is used in
335 relation to PA. Most participants reported consuming cannabis through traditional inhalation methods
336 regardless of PA time point. Yet, the distribution of individual inhalation methods at each of those time
337 points did vary. Before PA, cannabis consumed with a hand pipe was the primary method of use by nearly
338 a quarter of participants. Comparatively, 30% reported using a joint and 23% described using a vaporizer
339 during PA. Primary flower/bud inhalation methods then shifted back to predominant hand pipe and bong
340 use following completion of PA.

341 Although this study provides new information on why physically active individuals are using
342 cannabis products with their PA, it does have a number of limitations. The study was cross-sectional and
343 conducted as an online survey. There are limitations associated with self-report data, even though online
344 and in-person administration of surveys has been shown to yield similar results (32). Reported weekly
345 minutes of PA varied dramatically, with a range of 25 to 3600 minutes of physical activity per week. In
346 an effort to allow participants to report any type of physical activity, participants were not asked if they
347 were physically active for recreational reasons, or if their PA was a part of a structured exercise regimen.
348 Although this approach allows for more broad interpretation of physical activity, it should be considered a
349 limitation and future work should further examine this question. In addition, the present study did not
350 explore if participants experienced any negative side effects due to their cannabis use, such as those
351 associated with Cannabis Use Disorder. Future studies exploring the use of cannabis with exercise may
352 want to discern whether individuals are consuming *ad libitum* and happen to be physically active vs. those
353 who are intentionally using cannabis in conjunction with structured exercise.

354 In summary, this study provides novel insight into cannabis use among individuals that reported
355 using cannabis in combination with their physical activity. This study revealed that the most common
356 time to use cannabis in combination with PA was within 1-hour of starting PA, with the majority of
357 individuals reporting use through traditional inhalation methods. The majority of participants reported
358 feeling that the use of cannabis with PA had a positive effect on PA performance. Reasons for cannabis
359 use with PA were heavily dependent on timing of cannabis use in relation to that activity with pain
360 management as the only common reason reported at before, during, and after time points. Finally, results
361 from this study indicate that timing, method of use and strain of cannabis use were commonly considered
362 when cannabis was used in conjunction with PA.

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Figure 1. Frequency of Cannabis Use Before (1a.), During (1b.), and After (1c.) Physical Activities

