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Quantifying Cannabis: A Field Study of Marijuana Quantity Estimation

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Abstract

The assessment of marijuana use quantity poses unique challenges. These challenges have limited research efforts on quantity assessments. However, quantity estimates are critical to detecting associations between marijuana use and outcomes. We examined accuracy of marijuana users' estimations of quantities of marijuana they prepared to ingest and predictors of both how much was prepared for a single dose and the degree of (in)accuracy of participants' estimates. We recruited a sample of 128 regular-to-heavy marijuana users for a field study wherein they prepared and estimated quantities of marijuana flower in a joint or a bowl as well as marijuana concentrate using a dab tool. The vast majority of participants overestimated the quantity of marijuana that they used in their preparations. We failed to find robust predictors of estimation accuracy. Self-reported quantity estimates are inaccurate which has implications for studying the link between quantity and marijuana use outcomes.

Keywords

marijuana; cannabis; quantity estimation; marijuana industry; heavy marijuana users

The reliability and validity of self-reported substance use has been an issue for decades (e.g., Buchan, Dennis, Tims, & Diamond, 2002; Johnson, 2014; Johnson, & Golub, 2007; NRC, 2001; Williams & Nowatzki, 2005). Two limitations to the reliability and validity of self-report measures are relying on memory (e.g., retrospective recall bias) and social desirability (Carroll, 1995; Del Boca & Darkes, 2003; Johnson, & Golub, 2007). Researchers are working to improve self-report substance use questionnaires in response to these issues, including using timeline follow back interviews (e.g., Robinson, Sobell, Sobell, & Leo, 2014), biological measures of substance use (e.g., metabolites in blood and urine, Wolff & Gossop, 2016), estimates of intoxication (e.g., estimated blood alcohol content, eBAC, Hustad & Carey, 2005), and multiple informant interviews (Fisher et al., 2006). Although

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these methods improve reliability and validity, they do not eliminate all of the inherent flaws in self-reported substance use.

Substance use can be measured on at least two dimensions (a) quantity (e.g., how much of [substance] did you use) and, (b) frequency (e.g., how many times/days in the last [timeframe] did you use) (Day & Robles, 1989; Stockwell et al., 2004). Self-report issues may impact assessments of quantity more than frequency, as it is more difficult to recall exact amounts used versus number of use occasions during a given timeframe, especially considering varying methods of marijuana consumption that impact the relation between the amount of substance consumed and the amount of psychoactive compounds ingested (Chait & Zacny, 1992; Ohlsson et al., 1980). Common consumption methods include smoking flower (the unrefined bud of the marijuana plant) or concentrate (cannabis products refined from flower into a more potent form, such as wax, shatter, resin, use of which is often referred to as dabbing), vaporizing flower or concentrates, eating foods that contain cannabis, and using topical solutions that contain cannabis. There is variability both within and between methods of consumption in the amount of psychoactive compound ingested, or potency, time to intoxication, and degree of intoxication (e.g., 10 milligrams of Tetrahydrocannabinol (THC) in edible form will have a different impact on a person when compared to 10 milligrams of concentrated marijuana) (Williams, 2014).

Lab-based administration studies have been conducted to examine dose effects of marijuana by tightly controlling the amount and potency of marijuana consumed (e.g., Fulton et al., 1987; Haney et al., 2008; Vadhan et al., 2017); although such procedures strengthen to internal validity of these studies, it sacrifices external or ecological validity. Thus, observational and survey studies are also needed to study the dose effects of marijuana to improve the ecological validity of such findings. In order to achieve this goal, we need to understand how participants estimate the quantity of marijuana they use. Multiple research studies have attempted to address this issue by measuring marijuana quantity without measuring actual quantity used. For example, Walden and Earlywine (2008) had participants report number of quarter ounces consumed on average on a monthly basis, failing to identify the amount used per use occasion. Light and colleagues (2014) created quantity estimates by dividing the total amount of marijuana purchased in Colorado, measured in metric tons, by the number of marijuana users in the State. Zeisser and colleagues (2011) defined quantity (i.e., a joint was equal to .5 grams or 10 puffs from a joint or 5 puffs from a bong/pipe) based on qualitative data collected from a small sample of users of medicinal marijuana and then asked all participants to report quantity by the number of joints they smoked. This procedure assumes uniform quantity when there is no evidence that quantity is uniform or even that puff sizes are equivalent. Finally, Ridgeway and Kilmer (2016) used the amount of money paid as an estimator of the average weight, which does not take into account price variance based on quality or potency of the marijuana being purchased (Sevigny, 2013)

There have been some attempts of estimating and the impact of potency on self-reported cannabis use at the individual level. Mariani and colleagues (2011) attempted to get estimates of standard amounts of marijuana used to roll joints, pack bowls, and roll blunts, however, participants used oregano instead of cannabis. It is unclear how density differences between cannabis and oregano might impact these estimations, given that direct comparisons

between the two substances were not reported. In one of the studies conducted by Pol and colleagues (2013), potency of cannabis was estimated by the user with no confirmation testing to determine accuracy of the estimation. Kögel and colleagues (2017) attempted to define standard joint size by collecting a random sample of joints rolled by users. Limitations include a variety of potency, which has been shown to lead to dose titration (Pol et al., 2013, 2014), and the products being measured included tobacco and were a mix between hash and marijuana. Importantly, they did not weigh the joints; rather, they used self-report estimates to determine that the average joint contains 0.25 grams of marijuana. We could find no research examining standard sizes for concentrate doses, even though concentrate usage has increased significantly in the U.S. (Carlini, Garrett, & Harwick, 2017). Together, these studies illustrate the complexity involved in attempting to measure marijuana quantity. Given this complexity, quantity is *not* typically measured. Moreover, there is no gold standard for assessing quantity. This is a serious limitation given that every known psychoactive drug has dose-dependent effects (McCrady & Epstein, 2013).

Given inherent issues with self-report data, many marijuana researchers default to frequency estimates of marijuana use (Walden & Earlywine, 2008), and using this information to classify individuals as daily or near daily users (20 or more days per month, Johnston et al., 2016), which assumes that single instance daily use is comparable to multiple instance daily use. In addition, frequency measurements equate smoking one hit from a joint using flower to several hits of high percentage concentrates (i.e., dabs) (Asbridge et al. 2014). In other words, frequency estimates without quantity or potency information can lack information on the amount of psychoactive compounds ingested (Asbridge, Duff, Marsh, & Erickson, 2014; Pol et al., 2013). This crude assessment of marijuana use is at best obscuring and at worst preventing our ability to detect the associations between marijuana use and important outcomes.

The goal of the present study was to examine regular and heavy marijuana users' ability to estimate quantity (e.g., weight in grams) of both flower and concentrated marijuana to narrow the gap between tightly controlled lab studies and survey-based observational studies. This study sought to provide two important pieces of information: 1) the relative accuracy of marijuana users' estimations of quantities of marijuana, 2) the typical dose (i.e., grams used) for two common types of marijuana products (i.e., flower and concentrates), 3) salient predictors of quantity of marijuana prepared for a single dose, and 4) salient predictors of estimation (in)accuracy.

Method

Participants

Table 1 presents demographic and descriptive information about the sample of 128 regular marijuana users (48% female). The average age of participants was 29.48 (SD = 6.89) with a range from 21.59 to 64.15. The mean age of first use of marijuana was 15.31 (SD = 2.76) with a range of 8 to 26 years. The majority of participants were White (73%) and non-Hispanic (74%). The sample contained recreational users (47%), medical users (13%), and those who indicated they used for both recreational and medical reasons (39%). Additionally, one participant reported using Cannabidiol (CBD) products only.

Approximately 81% of participants reported daily or multiple times per day use of flower and/or concentrated marijuana. Most participants indicated via self-report that they were intoxicated on marijuana at the time of participation (78%). Of those who reported on subjective intoxication, two-thirds rated their intoxication as 5 or less on a scale ranging from 0 “not high at all” to 10 “extremely high”. The goal of the study was to observe regular-to-heavy marijuana users in a natural environment to maximize external validity. As such, we did not have a predetermined sample size in mind and collected data over the course of five cannabis related events. As part of the analytic strategy we conducted post-hoc power analyses described below.

Procedures

Data were collected from 2 types of events held in a private marijuana club in a private space in a large city in the Western United States: 1) one large industry-related product demonstration and workforce appreciation event for individuals who worked as “budtenders” (employees in marijuana dispensaries), marijuana chemists, bud trimmers, wholesale distributors, and other industry professionals (60% of participants) and 2) six non-industry related social events (e.g., 3 yoga classes, 1 happy hour, 2 specialized research events; 40% of participants) with most participants being marijuana users who did not work in the marijuana industry. All events except one of the specialized research events allowed for marijuana consumption during data collection. Because of the observational nature of the study, during use events researchers did not restrict participant activities or use in anyway. All participants were members of the private marijuana club. All events were private and by invitation only. All participants were notified of research opportunities and scheduled for participation by employees of the private club. Researchers did not collect any identifying information from participants. For all events other than the workforce appreciation event, participants were asked at the time of recruitment by club staff to bring their most recent marijuana dispensary purchase with them to the event. Marijuana was provided by outside vendors at the workforce appreciation event. All participants provided informed consent prior to participating via an electronic consent document. For all events except the industry-related product demonstration and workforce appreciation event, participants were compensated for their time and participation with $20 gift cards to a popular online retailer. For the workforce appreciation event, participants were entered into a contest to win one of two $100 gift cards awarded to the participants with the most accurate flower and concentrate estimates to the same online retailer as compensation for their participation. All procedures were approved by the Colorado State University Institutional Review Board.

Data collection consisted of a marijuana quantity estimation task and completion of a battery of measures (measures and materials described below). For the estimation task, participants were asked whether they typically use marijuana in the form of flower or concentrate. Additionally, they were asked how the typically use flower (i.e., in joint-form or in a bowl). Participants were then asked to roll a joint or pack a bowl using marijuana flower they provided depending on their self-reported preferred method. If they reported using concentrates they were also asked to load a dab tool. They were then instructed to place the joint, bowl, or dab tool on a scale and estimate the amount of marijuana product used. They could not see the weight calculated by the scale. Researchers electronically recorded the

estimated and actual amounts used as well as the weight of the paper, bowl, or dab tool. After the quantity estimation task, participants completed the battery of measures.

Measures and Materials

Materials—For the flower quantity estimation task, rolling papers and clean bowls (bowls that had not been smoked out of) were provided by the researchers. Researchers used a scale accurate to .01 of a gram to weigh the quantity of flower used to roll the joint and pack the bowl. Papers and bowls were tared out prior to the quantity estimation task. For the concentrated marijuana quantity estimation task, researchers provided a dab tool (a small device, typically made of metal, to scoop and hold the amount of concentrate that will be used). Researchers used a scale accurate to .001 of a gram to weigh the quantity of concentrated marijuana used to load the dab tool. Dab tools were tared out prior to the quantity estimation task.

Measures—Demographic and descriptive variables included in analyses were age (calculated as current date minus birthdate), sex (0 = female, 1 = male), race (0 = non-white, 1 = white), ethnicity (0 = non-Hispanic, 1 = Hispanic), years of marijuana use (current age minus age of onset of marijuana use), age of onset, frequency of marijuana use by concentrate and flower (measured as days of use per typical week), whether participants were under the influence of marijuana at the time of data collection (0 = no, 1 = yes), reasons for marijuana use (0 = medicinal, both recreational and medicinal, and CBD only, 1 = recreational only), and type of event (0 = non-industry, 1 = industry).

Results

Marijuana Quantities

Table 2 presents descriptive statistics on typical estimated quantity and actual quantity for flower (combined, in bowl, and in joint) and concentrated marijuana.

Actual quantities—For those estimating flower (across bowls and joints), they rolled or packed on average .40 grams (SD = .32 grams) with a range from .01 grams to 1.89 grams. The actual weights for joints was nearly double the actual weights for bowls (M_{joint} = .58, SD_{joint} = .27, $Range_{joint}$ = .08, 1.32; M_{bowl} = .25, SD_{bowl} = .13, $Range_{bowl}$ = .01, .54). For those estimating concentrates, they loaded on average .08 grams (SD = .07 grams) with a range from .01 grams to .34 grams.

Estimated quantities—During the estimating procedure, for those estimating either type of flower, they estimated that they rolled or packed on average .57 grams (SD = .47 grams) with a range from .02 grams to 3.50 grams. The estimated weights for flower used in joints was greater than the estimated weights for flower used in bowls (M_{joint} = .76, SD_{joint} = .60, $Range_{joint}$ = .02, 3.50; M_{bowl} = .41, SD_{bowl} = .24, $Range_{bowl}$ = .02, 1.00). For those estimating concentrates, they estimated that they loaded on average .16 grams (SD = .16 grams) with a range from .002 grams to 1.00 grams onto the dab tool.

Accuracy—Based on paired-samples *t* tests (see Table 2), we found that participants significantly overestimated marijuana quantity in every form (all *p*s < .007), with effect sizes indicating medium-to-large overestimations (.557 < *d*s < .823). The average difference (estimated weight minus actual weight) combining both types of flower preparations was 0.18 grams (SD = .36 grams) with the misestimation ranging from −0.59 to 2.18 grams. A similar pattern of misestimation was found when examining those who estimated amount of flower used in bowls (M_{diff} = .17, SD_{diff} = .22, $Range_{diff}$ = -.26, .95) and those who estimated flower used in joints (M_{diff} = .22, SD_{diff} = .49, $Range_{diff}$ = -.46, 2.18). Of note, there was a wider range of misestimation for flower used in joints compared to bowls, which likely resulted from the overall larger quantities being estimated for flower in joints compared to bowls. The mean misestimation for concentrated marijuana was .09 grams (SD = .16 grams) with a range of -.09 grams to .94 grams.

In terms of proportional difference, the estimates of concentrated marijuana were the most inaccurate (estimated quantity was 113.2% higher than actual quantity) followed by flower in bowls (estimated quantity was 68.3% higher than actual quantity) and flower in joints (estimated quantity was 37.2% higher than actual quantity). Dichotomizing individuals into whether they overestimated or underestimated quantity reveals that most participants overestimated quantity of flower (77%), either in joints (73%) or in bowls (81%), and overestimated the quantity of concentrated marijuana (71%).

Correlates of actual quantities—Spearman's rank correlations were examined to identify correlates of quantity used in the flower preparations (combined, in a joint, or in a bowl) as well as marijuana concentrate. Spearman's correlation uses the rank ordering of responses to provide an estimate of the strength and direction of the monotonic relationship between two continuous random variables. Post-hoc power analysis revealed that our sample size of *N* = 128 provides power = .93 to detect "low" correlations (Mukaka, 2012). In contrast to Pearson's *r* correlation, it is also appropriate for ordinal data and is robust to outliers. As shown in Table 3, we found that males used significantly more marijuana flower in their preparations than females (ρ= .259), an effect driven by their tendency to prepare larger joints (ρ = .463). Individuals who reported being a recreational user only (compared to individuals who endorsed being a medical user, both a recreational and marijuana user, or a CBD only user) used significantly more marijuana flower generally, significantly more flower in a joint, marginally more flower in a bowl, and significantly more concentrate (.348 < ρs < .587). Compared to individuals not employed in the cannabis industry, individuals employed in the cannabis industry also used significantly more flower in a joint, in a bowl, and more concentrate (.267 < ρs < .412).

Correlates of estimation inaccuracy—Spearman's rank correlations were also examined to identify correlates of overall estimation inaccuracy across the flower preparations (combined, in a joint, or in a bowl) as well as marijuana concentrate. For each preparation, we calculated the absolute difference between actual weights and estimated weights to create outcomes of estimation inaccuracy (i.e., smaller values indicate more accurate estimates, larger values indicate less accurate estimates). To our surprise (see Table 4), user characteristics were largely not significantly correlated with estimation inaccuracy

with the only significant association being between Hispanic ethnicity and marijuana concentrate estimation inaccuracy. We did find that flower estimation inaccuracy was significantly positively related to concentrate estimation inaccuracy ($\rho = .305$, $p = .047$) and flower in a bowl estimation inaccuracy was significantly positively related to concentrate estimation inaccuracy ($\rho = .541$, $p = .002$); however, flower in a joint estimation inaccuracy was not significantly associated with concentrate estimation inaccuracy ($\rho = .005$, $P = .986$). Thus, to some extent, individuals who were more inaccurate on estimating quantity in one preparation were also inaccurate on estimating quantity in another preparation.

Discussion

In an effort to narrow the gap between internally valid lab studies and externally valid observational studies, the present study examined how accurate regular-to-heavy marijuana users are in estimating the quantity of marijuana they typically prepare for use. We selected three preparations: rolling marijuana flower in a joint, packing marijuana flower in a bowl, and loading marijuana concentrates onto a dabbing tool. Even in this sample of regular-to-heavy users, we found consistent overestimations (19–29% underestimated) of marijuana quantity regardless of whether they were preparing flower or concentrate, regardless of industry status. In packing a bowl, participants on average estimated marijuana quantity to be 168.3% of the actual quantity. In rolling a joint, participants on average estimated marijuana quantity to be 137.2% of the actual quantity. Lastly, in loading marijuana concentrates, participants on average estimated marijuana quantity to be 213.2% of the actual quantity. Overestimates were proportionally larger for smaller preparations of marijuana relative to larger preparations. Thus, single occasion marijuana use estimates are likely differentially overestimated depending on the type of preparation.

We also found modest-to-substantial correlations between quantity estimates and actual quantity across preparations ($.273 < rs < .661$). When participants prepared larger amounts of marijuana, they provided higher estimates of quantity. Thus, self-reported estimates of quantity are useful for rank-ordering individuals by amount of marijuana prepared. Supportive of this notion, a recent study found that a self-reported measure of marijuana use quantity had a very small raw correlation ($r = .078$) with experiencing marijuana-related negative consequences, but demonstrated a more substantial Spearman rank correlation ($\rho = .398$) (Pearson et al., 2018).

Current practice is to collect frequency, not quantity data, which fails to take into account heterogeneity among daily users and does not allow for rank ordering of users based on quantity used in a single day. Moreover, even frequency measures that assess number of times used per day do not obtain accurate estimates of the amount of marijuana being used per use occasion. Even with multiple use per day assessments, it is not possible to rank order individuals by amount of psychoactive compounds ingested. Proper rank ordering is only possible with quantity estimates. There is value in collecting frequency data, however, without assessing quantity, important information regarding intensity of use is missing. We recommend that researchers include both quantity and frequency measures.

Another contribution of this study was determining the amount of marijuana used in common preparations of marijuana by regular-to-heavy users in Colorado. We found that regular-to-heavy users on average prepared about .58 grams of marijuana in a joint, which is similar to a joint-to-weight conversion formula used by Zeisser et al. (2011), but is more than double the amount of marijuana per joint identified by Kögel et al. (2017). We also found that users tended to prepare a bowl with about .25 grams of marijuana and a concentrate dab weighing about .08 grams. Interestingly, men, recreational users and industry workers, on average used more marijuana in their preparations (see Table 3). Given that these are preliminary and exploratory findings replication is necessary in order to understand the meaningfulness of these differences.

Estimation accuracy was not better among individuals who worked in the cannabis industry when compared to non-industry participants. Considering that industry workers regularly handle and weigh marijuana, findings suggest that even those with practice estimating quantity are prone to misestimation. Additional research is needed to develop procedures that can improve estimation of marijuana quantity. On average there were no significant differences between strictly recreational users and those who used at least partially for medical reasons. The one exception was that strictly recreational users provided worse estimates for flower rolled into joints (see Table 4).

The present study examined the accuracy estimation of marijuana quantity in grams. However, there are other issues that limit the accuracy of self-reported marijuana use. For example, most self-report measures assess use patterns over a large time window (e.g., past 30 days), resulting in known retrospective recall biases when estimating substance use even in small time windows (Ekholm, 2004; Gmel & Daeppen, 2007), and social desirability biases can lead to inaccurate reporting (Carroll, 1995; Del Boca & Darkes, 2003; Johnson, & Golub, 2007).

In the current study, marijuana quantity was measured in grams. There are other ways of having participants report on quantity used including dollar amounts spent on marijuana, length of time to consume a particular purchased amount (e.g., an $1/8^{th}$ ounce lasts 1-week), or attempts to create a standard unit of marijuana used (e.g., estimate the number of .5 oz. joints consumed per occasion). All of these methods have limitations. Despite the ongoing challenges of measuring marijuana quantity, the legalization of marijuana and increased regulation of its production may improve researchers' ability to standardize quantity estimation. For example, the accurate labeling of marijuana (e.g., % THC content and weight) will likely improve individuals' ability to report more precisely how much marijuana they consume (Parnes, Bravo, Conner, & Pearson, 2017).

The procedures used in this study are likely too cumbersome to be implemented in all research settings. However, as an alternative to the standard laboratory procedure of administering controlled doses, researchers could allow participants to self-administer THC. We suggest a variant of our procedure wherein participants pack, roll, or load their typical quantity of marijuana and the researcher weighs it prior to consumption and participation in clinical trials. This would increase the external validity of laboratory-based studies by allowing for natural variability of marijuana use. In addition, future observational and survey

studies can use the current procedure and/or the current findings to assess or statistically control for the degree of misestimation across various preparations of marijuana.

We learned some valuable lessons while designing and implementing this study. First, the size of rolling papers, bowls, and dab tools limited the range of possible quantities prepared. Estimations of quantity will inevitably vary by size of the device being used. Unless increased standardization of devices occurs, when assessing quantity, researchers may also want to assess the size of the devices that a participant uses. Second, as part of the field study, we observed an important factor that we did not previously consider: how finely the participant broke up or ground the flower impacted the amount they could fit into the device. Researchers should consider asking participants to what degree they break up their marijuana flower. A third lesson learned was that participants often reported complex patterns of use both within and across use days. For example, some participants reported using edibles during the day to "take the edge off," smoking flower in the evening in social settings, and then returning home to dab concentrates before going to sleep, while other people reported using exclusively concentrates, and yet others indicated the importance of contextual variables in determining what type and how much marijuana they would use. In other words, for context-driven users, quantity, type, and pattern of marijuana use vary day-to-day based on the responsibilities, roles, who they are with, among many other things. Frequency estimates cannot take into account this amount of variability. Although quantity will not capture this variability, it can serve as a proxy for the amount of psychoactive compounds ingested. Future research might include an open-ended assessment allowing participants to self-report patterns of use to improve both frequency and quantity estimations.

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Table 1

Demographic and Descriptive Information

	N	%
Industry Event		
Non-Industry Event	51	40%
Industry Event	77	60%
Sex		
Male	66	52%
Female	62	48%
Race		
White	90	70%
African American	7	5%
American Indian/Alaska Native	2	2%
Multiracial	9	7%
No Response	20	16%
Ethnicity		
Hispanic	20	18%
Non-Hispanic	94	72%
Marijuana User Status		
Recreational	36	47%
Medical	10	13%
Recreational & Medical	30	39%
CBD only	1	1%
High Now		
Yes	100	79%
No	27	21%
	M (SD)	**Range**
Age	29.48 (6.89)	21.59–64.15
Age of First Marijuana Use	15.31 (2.76)	8–26

Note: Age was calculated by subtracting date of birth from date of data collection in days and converting to age in years.

Table 2

Comparing Estimated and Actual Weights of Marijuana Used in the Quantity Estimation Task

	Actual Weight (in grams)	Estimated Weight (in grams)	Absolute Difference (in grams)	*n*	*r* (*p*-value)	*t* (*p*-value)	Cohen's *d*	% Estimated Weight/ Actual Weight
Flower-Combined	.400	.583	.182	104	.661 (<.001)	5.198 (<.001)	.557	145.75%
Flower-Bowl	.246	.414	.168	63	.406 (=.001)	5.944 (<.001)	.823	168.29%
Flower-Joint	.583	.800	.217	41	.618 (<.001)	2.866 (=.007)	.569	137.22%
Concentrate	.076	.162	.086	59	.273 (=.036)	4.177 (<.001)	.621	213.16%

Table 3

Spearman Rho Correlations among User Characteristics and Amount of Marijuana Used in the Quantity Estimation Task

Actual Weight (in grams):		Flower Combined	Flower in Joint	Flower in Bowl	Concentrate
Race (0=non-White, 1=White)	ρ	0.002	−0.065	−0.132	0.003
	p	0.983	0.687	0.303	0.981
	n	104	41	63	59
Ethnicity (0=non-Hispanic, 1=Hispanic)	ρ	−0.012	0.201	0.047	0.093
	p	0.911	0.226	0.737	0.516
	n	92	38	53	51
Sex (0=female, 1=male)	ρ	**.259** **	**.463** **	0.128	0.231
	p	0.008	0.002	0.319	0.079
	n	104	41	63	59
Type of User (0=medical, both, CBD only, 1=recreational only)	ρ	**.365** **	**.455** *	0.348	**.587** **
	p	0.005	0.017	0.059	0.000
	n	58	27	30	34
Current Intoxication (0=no, 1=yes)	ρ	0.090	−0.034	0.120	0.209
	p	0.368	0.834	0.354	0.112
	n	103	41	62	59
Frequency of Marijuana Flower Use (# of days during typical week)	ρ	0.125	−0.011	−0.014	−0.055
	p	0.228	0.950	0.916	0.693
	n	95	36	58	53
Years of Use (Age minus Age of Onset)	ρ	0.091	0.207	−0.025	−0.148
	p	0.359	0.195	0.846	0.263
	n	104	41	63	59
Age of Onset	ρ	−0.175	−0.227	0.001	0.092
	p	0.076	0.154	0.994	0.486
	n	104	41	63	59

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Actual Weight (in grams):		Flower Combined	Flower in Joint	Flower in Bowl	Concentrate
Cannabis Industry (0=no, 1=yes)	ρ	0.153	**.401** **	**.267** *	**.412** **
	p	0.121	0.009	0.034	0.001
	n	104	41	63	59

Note: Significant effects are bolded with single ($p < .05$) or double ($p < .01$) asterisks for emphasis.

Table 4

Spearman Rho Correlations among User Characteristics and Absolute Estimation Accuracy in the Quantity Estimation Task

Estimation Accuracy (Absolute Difference between Actual and Estimated Weights in grams):		Flower Combined	Flower in Joint	Flower in Bowl	Concentrate
Race (0=non-White, 1=White)	ρ	−0.059	−0.127	−0.016	−0.104
	p	0.551	0.428	0.904	0.434
	n	104	41	63	59
Ethnicity (0=non-Hispanic, 1=Hispanic)	ρ	−0.027	−0.108	0.074	**.323** *
	p	0.800	0.517	0.600	0.021
	n	92	38	53	51
Sex (0=female, 1=male)	ρ	0.031	0.165	−0.078	−0.128
	p	0.757	0.302	0.545	0.334
	n	104	41	63	59
Type of User (0=medical, both, CBD only, 1=recreational only)	ρ	−0.143	**−.402** *	0.044	−0.069
	p	0.283	**0.038**	0.818	0.698
	n	58	**27**	30	34
Current Intoxication (0=no, 1=yes)	ρ	−0.047	−0.049	−0.080	0.224
	p	0.634	0.759	0.538	0.088
	n	103	41	62	59
Frequency of Marijuana Flower Use (# of days during typical week)	ρ	0.044	0.081	−0.012	0.196
	p	0.671	0.637	0.929	0.159
	n	95	36	58	53
Years of Use (Age minus Age of Onset)	ρ	0.102	0.059	0.104	−0.035
	p	0.304	0.714	0.419	0.795
	n	104	41	63	59
Age of Onset	ρ	−0.134	−0.136	−0.127	−0.154
	p	0.176	0.395	0.322	0.243

Estimation Accuracy (Absolute Difference between Actual and Estimated Weights in grams):		Flower Combined	Flower in Joint	Flower in Bowl	Concentrate
	n	104	41	63	59
	ρ	0.027	0.134	−0.094	0.061
Cannabis Industry (0=no, 1=yes)	*p*	0.783	0.402	0.465	0.648
	n	104	41	63	59

Note: Significant effects are bolded with single ($p < .05$) or double ($p < .01$) asterisks for emphasis.