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## Case studies in cannabis vaporization

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### Abstract

Cannabis remains the world's most popular illicit drug despite its documented contribution to respiratory problems. The vaporizer heats cannabis without igniting it. Previous work suggests that vaporizers have the potential to minimize respiratory irritation, but it has not been used as an intervention yet. We sought to establish the feasibility of the vaporizer as an intervention for cannabis smokers with respiratory problems. Four cannabis users who reported respiratory symptoms (including two tobacco smokers) agreed to stop smoking cannabis and use the vaporizer for 1 month. The vaporizer appeared to be a practical and acceptable method for the administration of cannabis in users with respiratory problems. After 1 month of vaporizer use, self-reported respiratory symptoms improved dramatically. Measures of lung function (forced expiratory volume (FEV1) and forced vital capacity (FVC)) showed more modest improvements. Vaporizing proved reactive for tobacco smokers, leading them to decrease cigarette smoking and confounding interpretations of improvement. Nevertheless, those who smoked cannabis exclusively also benefited from the vaporizer. We attempted a reversal design where participants would then return to smoking but all refused. These results suggest that the cannabis vaporizer is acceptable to users, and has the potential to decrease cannabis-related respiratory problems. The device may increase awareness about respiratory health in cannabis users who also smoke cigarettes. Randomized control trials with large samples of users and longer durations of vaporizing appear warranted. Given the reactive effect of the vaporizer on tobacco use, such trials may have to focus initially on those who smoke cannabis but not tobacco.

**Keywords:** *Cannabis, marijuana, vaporizer, respiratory symptoms, lung disease*

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## Introduction

Pulmonary troubles in cannabis users are well documented. Recent trends in medical uses of cannabis have inspired new technologies for avoiding these problems. One promising line of work focuses on vaporizers – machines that heat cannabis to temperatures that release cannabinoids in a fine mist without creating the toxins associated with combustion. Vaporizers can deliver inhalable cannabinoids at levels comparable to smoking, but without the same level of exposure to respiratory irritants. Separate studies have confirmed that the machine can create THC blood levels that are comparable to smoking, but unlike smoke, the vapor contains little other than cannabinoids (Gieringer et al. 2004; Hazekamp et al. 2006; Abrams et al. 2007). Correlational data suggest that cannabis users who vaporize report fewer respiratory symptoms than those who smoke the plant, particularly among those who smoke tobacco products as well (Earleywine and Smucker Barnwell 2007), but these data may simply reflect some third variable common to vaporizer use and healthy lungs. Little is known about cannabis users who experience respiratory symptoms and switch to the vaporizer. The acceptability of the vaporizer to regular users and its impact on respiratory symptoms and lung function is also poorly understood. Many clinicians are faced with cannabis users who are unwilling to abstain. These users may also prove unwilling to turn to orally administered forms (edibles) as well. These same clinicians may still wish to recommend techniques for minimizing respiratory harms. In an effort to provide detailed case information that could be as useful as possible (Yin 1999), we provided vaporizers to four adult cannabis smokers who reported respiratory symptoms.

## Method

### *Participants*

Four participants, including two women and two cigarette smokers, responded to an advertisement requesting cannabis users interested in participating in research. Previous work revealed that the vaporizer's impact was larger among those who smoked cigarettes (Earleywine and Smucker Barnwell 2007), so recruiting cigarette smokers seemed worthwhile. All participants completed an initial phone screen. They revealed that they experienced at least two respiratory symptoms (detailed below). They had never been dependent on any other illicit psychoactive drugs, based on responses to items modeled on the DSM-IV criteria (American Psychiatric Association (APA) 1994). These included: tolerance, withdrawal, use that exceeds initial intention, persistent desire for the drug or failed attempts to decrease consumption, loss of time related to use, reduced activities because of consumption, and continued use despite problems. They also reported that they had never received treatment for a drug-related disorder, never been diagnosed with a mental disorder, did not have asthma or bronchitis, and were not interested in cannabis cessation treatment.

Participant 1 was a male aged 24 years who had used cannabis for 6 years and smoked cigarettes for 8 years. He held a bachelor's degree and worked in retail sales. He reported an interest in cannabis research in general and thought that the vaporizer seemed an intuitively appealing device. Participant 2 was a female aged 25 years who used cannabis for 7 years and smoked cigarettes for 12 years. She held a bachelor's degree and served as an intake worker in a hospital setting. She claimed that she wanted to turn to the vaporizer not only to improve lung health, but also nursed hopes that it might help her to take steps toward

quitting smoking. Participant 3 was a male aged 38 years who used cannabis for 22 years but never smoked tobacco regularly. He held an advanced degree and worked at a local university. He expressed interest in the study primarily because he thought that the duration of his use was bound to impair his lungs eventually. Participant 4 was a female aged 22 years who had smoked cannabis for 5 years but never smoked tobacco regularly. She held a bachelor's degree and was currently in a graduate program. She was concerned about respiratory function in part because of the participation in club sports that had a large aerobic component (rugby and swimming). All participants had used other illicit psychoactive drugs, including hallucinogens and intranasal cocaine, but not smoked drugs that might have an impact on respiratory symptoms. Two had used prescription stimulants without a prescription. All received a free vaporizer and cash payment for participation.

### *Measures*

Participants came to the laboratory, provided informed consent, and completed an interview assessment of their cannabis and tobacco use in the previous 30 days (the Timeline Followback, Sobell and Sobell 2000). They reported on six respiratory symptoms using a 0 (not at all) to 9 (very much) scale. These questions proved sensitive to cannabis use in a previous study (Taylor et al. 2002) and also showed an impact of the vaporizer in correlational work (Earleywine and Smucker Barnwell 2007). Taylor et al. (2002) examined individual symptoms and found that cannabis users were more likely to report the presence of all six of these. Earleywine and Smucker Barnwell (2007) considered anyone with any symptom as a member of the symptomatic group and found that vaporizer users were less likely to belong to this group than their peers who did not vaporize, even after controlling for gender, quantity, and frequency of cannabis consumption.

The original questions about respiratory symptoms used dichotomous (Yes/No) responses, but a pilot study on attitudes about the vaporizer performed with 90 college student cannabis smokers revealed that participants found the dichotomous format unrealistic and confining. These participants claimed that symptoms varied dramatically in severity even when they were present. We adopted the 10-point scale in an effort to capture more range in symptoms. Questions included: Do you usually have a cough? Does your chest sound wheezy or whistling other than from colds? Are you troubled by shortness of breath when hurrying on the level ground or walking up a slight hill? Do you have to walk slower than most people of your own age on the level ground because of breathlessness? Do you cough up phlegm in the morning?, and Do you wake up at night with tightness in your chest?

Participants also performed spirometry to ATS standards using the Astra 100 Spirometer (SDI Diagnostics). The best forced expiratory volume (FEV1) in 1 s and forced vital capacity (FVC) from three reproducible attempts (within 0.2) were recorded in liters. FEV1 and FVC are the most commonly used measures of lung function in research on respiratory function (Volkova et al. 2009) and have been used in previous work on cannabis and lung health, revealing small impairments in heavy users of cannabis, especially those who also smoke tobacco products (Taylor et al. 2002; Beshay et al. 2007).

### *Procedures*

All participants completed measures and then received a vaporizer (Vapor Brothers Regular) and training in its use. This vaporizer has a mineral heating element warmed via 120 V AC current. A glass whip that holds cannabis is placed over the heating element. Users draw

the warmed air past the heating element and through the cannabis to release cannabinoids in a fine mist. A rheostat can adjust the heat to ensure that the cannabis does not burn. Each participant took a sample draw of a blend of legal herbs in the laboratory to demonstrate appropriate technique. All agreed to use the vaporizer exclusively and not smoke ignited cannabis for the subsequent 30 days.

They also received training in how to keep a calendar for recording their cannabis use each day. A comparable calendar approach has proven useful in work on other drugs (Armeli et al. 2000). Each participant recorded an estimate of the amount of cannabis they used. We had suggested that one joint's worth of cannabis weighed approximately a gram. All four participants had purchased grams of cannabis in the past and suggested that they had a sense for the amount. This approach to the estimation of quantities covaries with other estimates of cannabis consumption as well as meaningful outcomes like negative consequences of use (Walden and Earleywine 2008). Participants also recorded if they smoked cannabis instead of using the vaporizer, and if they smoked tobacco on that day.

## Results

After 30 days the participants returned to the laboratory for an assessment identical to the initial session. Adherence to the protocol was high. None of the participants reported smoking cannabis (instead of vaporizing) on more than two of the 30 targeted days. Results appear in Tables I–IV. FEV1 and FVC values were in the low normal ranges. The ratio of FEV1 to FVC has been used in the previous work to identify impairment by using a cut-off of 0.80 (e.g. Taylor et al. 2000). Participants were near this cut-off at baseline. Changes in measures of lung function were small but positive, ranging from 7% to 10% increases for FEV1 and 2% to 7% increases for FVC. The ratios of these measures also improved, but only Case 3 went from below to above the 0.80 threshold. There were no consistent differences between the cigarette smokers and non-smokers on these measures, but Participant 1, who showed the most dramatic changes, was a cigarette smoker.

Self-reported respiratory symptoms improved dramatically, dropping from 25% to 83%. Nevertheless, each participant still endorsed a '1' or higher on '2' symptoms, which would have qualified for impairment in previous work (e.g. Earleywine and Smucker Barnwell 2007). The cigarette smokers tended to decrease their tobacco use over the month, leading to improved outcomes but a confounded interpretation of the impact of the vaporizer. (As Participant 2 stated, "I was going to all this trouble using the vaporizer and then felt like an idiot lighting up a cigarette.") Respiratory symptom changes were higher among the cigarette smokers (dropping 83% and 66%) than in the non-smokers (dropping 50% and 25%).

Table I. Cannabis and cigarette consumption.

Participant	Grams pre	Grams post	Cigs. pre	Cigs. post
1	0.97	0.88	12	6
2	1	0.92	10	3
3	1.34	1.34	0	0
4	1.93	1.88	0	0

Notes: Grams = grams of cannabis consumed per day on average over 30 days.  
Cigs. = number of cigarettes smoked per day on average over 30 days.

Unstructured questions about the vaporizer at the follow-up interview revealed some recurring themes. We asked their general impressions of the vaporizing experience, how convenient they thought the vaporizer was, and their intentions to continue vaporizing. All four participants reported that the peak subjective experience of the vaporized cannabis occurred noticeably later than when they smoked cannabis. Smoked cannabis apparently led to peak changes in subjective effects within a minute or two, whereas vaporized cannabis required several minutes. Two participants reported that this lag from initial consumption to peak experience led them to inadvertently use a dose higher than they had intended the first time they employed the vaporizer. In addition, all four participants lamented the lack of portability of the vaporizer device. They suggested that a smaller, battery-powered device might prove more appealing to regular users. In fact, the only occasions when participants smoked cannabis instead of vaporizing occurred when they were not at home.

We then asked participants to return to smoking for 1 month in an effort to make a better causal argument for the vaporizer's impact, but emphasized, in accordance with an agreement with the local institutional review board, that this switch back to smoking was not a requirement of the study. Participants declined the chance to return to smoking and seemed eager to continue vaporizing. All reported an intention to vaporize cannabis in the future. The lack of enthusiasm for returning to smoking may reflect a number of factors, but could indicate a positive evaluation of the vaporizer.

Table II. FEV1 and FVC measures of lung function.

Participant	FEV1 pre	FEV1 post	%Change FEV1	FVC pre	FVC post	%Change FVC
1	4.00	4.40	+10	5.30	5.70	+7
2	4.31	4.71	+9	6.05	6.16	+2
3	3.62	3.93	+8	4.70	4.84	+3
4	4.33	4.63	+7	5.31	5.42	+2

Table III. FEV1/FVC ratio measures of lung function.

Participant	FEV1/FVC pre	FEV1/FVC post	% Change FEV1/FVC
1	0.75	0.77	+2
2	0.72	0.77	+7
3	0.77	0.81	+5
4	0.82	0.85	+4

Table IV. Respiratory symptoms.

Participant	Respiratory symptoms pre	Respiratory symptoms post	% Change respiratory symptoms
1	18	3	-83
2	12	4	-66
3	8	6	-25
4	12	6	-50

## Discussion

The potential negative consequences of cannabis use are particularly important as more and more locations legalize medical marijuana and decriminalize adult use. Respiratory symptoms in heavy users are one well-documented negative consequence of cannabis consumption. A handful of publications suggest that the vaporizer, a machine that heats cannabis to release cannabinoids in a fine mist without igniting the plant, might limit these respiratory symptoms. No previous work has actually monitored changes in lung function and respiratory symptoms in users. The present set of cases suggest that further investigations with the vaporizer appear warranted. Participants found this mode of administration acceptable. Although the duration of use was brief (1 month), the vaporizer appears to have potential for minimizing respiratory problems.

The four cannabis smokers who switched to the vaporizer for 1 month reported fewer respiratory symptoms. Spirometry measures of lung function improved slightly as well. Two participants were cigarette smokers; both decreased cigarette smoking while using the vaporizer. They showed the greatest changes in respiratory symptoms and the largest changes in lung function came from a cigarette smoker. Because they altered their cigarette consumption as well, it is unlikely that these changes came solely from the vaporizer. Nevertheless, the idea that the vaporizer primed cigarette smokers to think more carefully about the health of their lungs has intriguing clinical implications. If using the vaporizer encourages cigarette smokers to cut down or contemplate quitting, the result could have quite an impact on lung health.

All four participants refused to return to smoking cannabis when asked to do so for a reversal design, suggesting that the machine is appealing to users. Although the reversal would have allowed for stronger evidence to support the vaporizer as a cause for these improvements, the current data show potential. These results suggest that one of the most troublesome negative consequences of cannabis consumption might decrease with the use of the vaporizer. Interviews suggested that participants' subjective maximum "high" was delayed with vaporizer use relative to smoked cannabis. Those who switch to the vaporizer should be informed of the potential delay in peak effects to avoid ingesting more than they might desire. Participants also revealed that they would prefer a portable device. Their only lapses back to smoking actually occurred when they were not at home.

These results suggest that a randomized clinical trial of the vaporizer may be in order. Since the vaporizer is not particularly expensive and seems to have no negative effects, heavy users of cannabis with respiratory symptoms could turn to the machine now and experiment for themselves. In addition, data from a randomized clinical trial might persuade those who are unwilling to use the vaporizer to give the machine a chance. A large sample of heavy cannabis users with respiratory symptoms could be randomly assigned to continue smoking or use the vaporizer for an extended period to assess changes in lung function and respiratory symptoms. The results of such a trial could prove very informative for assessing the vaporizer's impact on lung health in heavy cannabis users. An initial trial would likely require a focus on participants who do not smoke tobacco. This approach would be the only way to ensure that any changes arose from the vaporizer exclusively and not from altered tobacco consumption. Nevertheless, because previous work suggests that the vaporizer's impact is larger for tobacco consumers (Earleywine and Smucker Barnwell 2007), a trial with participants who used tobacco could prove extremely useful, particularly if careful measures of tobacco consumption could be used as a potential covariate. Given the reactivity we found for the participants who used tobacco, the heightened attention to lung health might actually prove an interesting way to increase contemplation about quitting smoking.



Despite these outcomes, the vaporizer is not a panacea for all cannabis-related troubles. Other negative consequences of use, particularly legal problems and dependence, are unlikely to improve with the vaporizer. Clinicians must continue to caution users about the risks of legal sanctions and dependence as well as offer treatment for limiting or eliminating consumption when desired. Nevertheless, the acceptability of the vaporizer and its potential impact seem quite encouraging. As more areas legalize medical cannabis and limit sanctions for responsible use in adults, popularizing the vaporizer may help keep respiratory complications to a minimum.

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