Low Levels of Marijuana Smoking Do Not Have a Negative Effect on Pulmonary Function

Pletcher MJ, Vittinghoff E, Kalhan R, et al. Association between marijuana exposure and pulmonary function over 20 years. JAMA 2012;307:173–81.

Study Overview

Objective. To examine the association of current and lifetime marijuana exposure and pulmonary function.

Design. Longitudinal study.

Setting and participants. The Coronary Artery Risk Development in Young Adults (CARDIA) study is a longitudinal study examining the development of clinical and subclinical cardiovascular disease. In 1985–1986, 5115 black and white men and women aged 18–30 years were recruited from 4 U.S. cities (Birmingham, Alabama; Chicago, Illinois; Minneapolis, Minnesota; and Oakland, California). Participants were asked to return for follow-up examination during 1987–1988 (Year 2), 1990–1991 (Year 5), 1992–1993 (Year 7), 1995–1996 (Year 10), 2000–2001 (Year 15), and 2005–2006 (Year 20). At enrollment and at each of the 6 follow-up visits, participants were asked about marijuana and tobacco exposure. At each of the visits, they were asked to perform pulmonary function testing. The authors included all visits for which pulmonary function, smoking behavior, secondhand smoke exposure, height, and waist circumference were available.

Main outcome measures. The 2 main outcome measurements were forced expiratory volume in the first second of expiration (FEV1) and forced vital capacity (FVC). The study assessed current intensity of smoking (cigarettes per day), and used that to calculate lifetime exposure to cigarettes in pack-years. Current intensity of marijuana use (episodes in the past 30 days) and number of joints or filled pipe bowls smoked were used to assess lifetime intensity of marijuana joints in joint-years. Participants were characterized according to the intensity of current and lifetime tobacco and marijuana exposure; the authors assessed pulmonary function across these categories. The authors explored linear associations with pulmonary function using continuous outcomes of tobacco and marijuana exposure. To explore non-linear associations with pulmonary function, the authors modeled tobacco and marijuana exposure (both current and lifetime) as flexible cubic splines in adjusted models. The models were adjusted for fixed effects such as year, study center, center-year (interaction), race-sex category, education, and asthma. In addition, the models were adjusted for cubic splines for age, height, waist circumference, second-hand smoke exposure, and exposure to airborne

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particulate matter, and interactions between these variables.

Main results. The analytic sample included 5016 participants (98% response rate), who contributed an average of 3.9 visits per participant (n = 19703 visits total). Across all participants, 54% reported current marijuana smoking, tobacco smoking, or both at 1 or more examination. Tobacco smokers had lower educational attainment and incomes compared to marijuana smokers. The median intensity on tobacco use was 8–9 cigarettes per day, which was significantly lower than that for marijuana use (2–3 episodes in the past 30 days). In adjusted models (categorical models), both current and lifetime tobacco smoking were associated with lower FEV1, and current smoking was associated with lower FVC. For example, compared to 0 exposure to tobacco smoking, FEV1 was 63 mL lower (95% CI –89 to –36) and FVC was 69 mL lower (95% CI –97 to –41) with current tobacco exposure > 20 cigarettes per day. In contrast, exposure to both current and lifetime marijuana use was associated with higher FVC, and lifetime exposure was associated with higher FEV1. The authors modeled tobacco exposure as continuous outcomes and allowed for nonlinear associations in the form of cubic splines, and as expected, found that higher exposures to tobacco use were associated with lower FEV1 and FVC. For example, an additional cigarette smoked was associated with a declining slope as steep as –2.8 mL (95% CI –4.8 to –0.7), and an additional pack year smoked was associated with a declining slope as steep as –7.0 mL (95% CI –10 to –3.7) for FEV1. A similar trend persisted for FVC. However for marijuana use, there was a dose-dependent relationship: lower exposures of lifetime marijuana use were associated with an increase in FEV1 (13 mL/joint-year higher) and FVC (20 mL/joint-year higher), but for higher cumulative exposures of marijuana (> 7 joint years) the slope flattened out or turned downward. For instance, having more than 20 episodes of marijuana use per month was associated with a significant decline in FEV1 of –3.2 mL per episode (95% CI –5.8 to –0.6), and more than 20 joint-years of exposure was associated with a non-significant decline of –2.2 mL per episode (95% CI –4.6 to 0.3). FVC remained high even with very high exposures of current or lifetime marijuana use.

Conclusion. Low level of exposure to marijuana (< 7 joint-years) was associated with higher FEV1 and FVC. Higher cumulative exposure to marijuana may be associated with declines in pulmonary function.

Commentary

Marijuana smoke contains the same toxins as tobacco smoke, but whether marijuana smoking is associated with similar declines in pulmonary function as tobacco smoking is unclear. Studies that have examined the association of marijuana smoking and pulmonary function have yielded mixed results [1,2]. Some studies that have focused on the FEV1:FVC ratio have found an absence of an association [3], while others have suggested a lower FEV1:FVC ratio (suggestive of obstructive disease) with marijuana use [4]. The current study examined the association of current and cumulative exposure to marijuana use and pulmonary function and found a non-linear, dose-dependent relationship with exposure: at lower exposures to marijuana both FEV1 and FVC were higher, and at higher exposures (ie, > 7 joint-years measured as 1 joint/day for 7 years or 1 joint/week for 49 years) the relationship reached a plateau or turned negative. These results suggest that occasional use of marijuana may not be associated with adverse consequences in pulmonary function. However, heavy use may be associated with an accelerated decline in pulmonary function, suggesting a need for caution and moderation in the use of marijuana.

The authors provided several explanations for their paradoxical findings. The current study and others have shown an association with marijuana smoking and high FVC. Thus, the low FEV1:FVC ratios observed with marijuana smoking could, in part, be explained by the high FVC. In contrast to previous studies, the current study found that higher exposures to marijuana smoking were associated with significant reductions in FEV1. Previous studies modeled marijuana use as dichotomous (yes/no) or linear outcomes, and found no relation with marijuana smoking and FEV1. By modeling the relationship as non-linear, the authors were able to establish trends in FEV1 that varied with the dose of marijuana exposure.

The authors suggest several mechanisms for the effects of marijuana on pulmonary function. The deep breathing practiced by marijuana smokers may cause increased stretch in the lung, leading to greater lung volumes and higher FVC. Another putative explanation for the high FVC among marijuana smokers is that the chest wall musculature is strengthened with each deep inspiration ("training effect"), allowing for marijuana

smokers to inspire more fully on spirometry testing. Thus, the higher FVC observed among marijuana smokers could be related to the stretch/training effect, whereas the negative association with FEV1 at higher doses could be a result of damage to airways and loss of pulmonary function.

Although the study focused independently on tobacco and marijuana users, another important group to focus on are the dual users of marijuana and tobacco. A significant proportion of the study sample included dual users of marijuana and tobacco. Studies have suggested a synergistic effect on pulmonary function, with an increase in respiratory symptoms and the prevalence of chronic obstructive pulmonary disease among persons who smoke both tobacco and marijuana [5]. Thus for dual users, smoking cessation counseling should also incorporate strategies to reduce marijuana smoking.

The study had several limitations. The authors relied on self-reports of marijuana and tobacco use, which could result in recall bias and measurement error. Given that chronic use of marijuana is associated with cognitive decline, the recall bias among marijuana users may be particularly problematic. However, the authors suggested that it was unlikely that the recall bias varied by pulmonary function; therefore, the misclassification in measurement of marijuana exposures was likely to be non-differential, leading to a bias toward the null. Despite this potential bias, the authors noted a positive association with marijuana use and FEV1 and FVC. The study had a limited number of heavy marijuana smokers; therefore the pulmonary function estimates at very high doses of marijuana need to be replicated in other observational studies. This would add much needed clarity on the potential long-term pulmonary complications among heavy users of marijuana. The authors were unable to assess the effect of the medium of marijuana smoking (eg, pipe, joint) on pulmonary function. Despite these limitations, the current longitudinal study is among the first to highlight the dose response relationship with marijuana smoking and pulmonary function.

Applications for Clinical Practice

Medicinal marijuana has been suggested for the treatment of chronic pain, low appetite, and other chronic conditions. The results of this study suggest that low levels of marijuana use for these reasons may not have adverse effects on pulmonary function. However, heavy use of marijuana may be associated with declining pulmonary function, suggesting a need for caution with high levels of exposure. Until there is further evidence, clinicians should assess intensity of marijuana smoking among all of their patients and advise against heavy use given the potential pulmonary complications.

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