

# respiratory effects of cannabis

Cannabis smoke contains a similar range of harmful chemicals to that of tobacco smoke (including bronchial irritants, tumour promoters and carcinogens).<sup>1</sup> As inhaled smoke comes into contact with airway mucosa and the distal lung before being absorbed into the circulation, it is likely to effect the respiratory system.<sup>2</sup> Concerns regarding the respiratory effects of inhaling cannabis smoke are heightened by knowledge regarding the harm caused by tobacco smoke and the different way in which cannabis is smoked. That is, when smoking cannabis compared to tobacco, there is a prolonged and deeper inhalation and it is smoked to a shorter butt length and at a higher combustion temperature. This results in an approximate five-fold increase in carboxyhaemoglobin concentration, three-fold greater amount of tar inhaled and retention of one third more tar in the respiratory tract.<sup>3-5</sup>

Several reviews on the respiratory effects of smoking cannabis have been published in the last decade.<sup>6-12</sup> The most recent and systematic review concluded that long-term cannabis smoking is associated with an increased risk of respiratory complications, including an increase in cough, sputum production, airway inflammation, and wheeze - even at a young age and persisting after adjusting for tobacco smoking.<sup>12</sup> However, no consistent association was found between long-term cannabis smoking and measures of airway response (including Forced Expired Volume ratios, carbon monoxide diffusing capacity, and airway hyper-reactivity). Unfortunately, this review also cited methodological complications in many of the 34 reviewed articles, including not controlling for tobacco use, other substance use, or occupational and environmental exposures that may affect lung health.<sup>12</sup>

Large prevalence studies have identified that respiratory effects most commonly manifest as coughing on most days, wheezing apart from colds, exercise-induced shortness of breath, nocturnal waking with chest tightness, and early morning sputum production.<sup>13,14</sup> A small body of research attempted to compare the effects of cannabis and tobacco smoke by dose. Despite the resulting equally harmful effects, a much smaller daily amount of cannabis was smoked compared to tobacco (one joint approximated 2.5–5 cigarettes).<sup>3</sup> Further, the harmful effects of smoking cannabis and tobacco appear to be additive.

The associations between smoking cannabis and lung cancer have also been reviewed in the last decade.<sup>10,15</sup> A recent review of 19 studies highlighted support for an association between cannabis smoking and premalignant lung cancer, however, the few small observational studies available fail to demonstrate the association.<sup>10</sup> The review suggested that this is likely due to methodological considerations and highlighted a need for more research. A separate review of literature specific to bullous lung disease and pneumothorax cited four clinical reports, one epidemiological sample, four reports of operated cases from surgical hospitals, and a prospective histopathological study.<sup>16</sup> This review concluded that bullous lung disease is associated with smoking cannabis although no causal link was established.<sup>16</sup> Since this review, further studies have added to the evidence of an association, however the need for further study on the respiratory effects of smoking cannabis with a non-tobacco smoking group remains.<sup>17-19</sup> Further, the cohort of regular cannabis users is still relatively young compared to the age group where respiratory cancers are most prevalent.

## respiratory effects and route of delivery

Naturally, research on respiratory effects of cannabis does not apply where cannabis is not smoked. Currently there are several alternative methods of administration available including devices with filters, vaporisers, and oral, sublingual, rectal and transdermal ingestion. Smoking devices that use water filters have been shown to involve equivalent amounts of tar and do not reduce risks of inhalation.<sup>20,21</sup> Vaporisers and pyrolysis devices, which heat cannabis below combustion point were also mooted to be a safer method of administration with the ratio of tar to cannabinoids when compared to cigarettes claimed to be reduced from 13:1 to 10:1.<sup>22</sup> However, these devices were since shown to release toxic amounts of ammonia (50-170 p.p.m.).<sup>21</sup> Eating cannabis is perhaps a more obvious means to reduce the respiratory effects when using the drug. However, oral administration has a slower onset of effects (30–60 minutes compared to seconds, peaking at approximately 2–3 hours after ingestion compared to 30 minutes after inhalation) and the effects last longer than some users prefer. Although the subjective effects are similar to smoked cannabis, they are perhaps less pronounced and the delayed onset makes it more difficult to titrate dose, increasing the risk of over dosage.<sup>22-30</sup> Additionally, there is no great consistency in reported subjective effects between different individuals taking the same dose and between the same individual taking the same dose on different occasions (see Grotenhermen, 2001 for a review). Alternative forms of cannabis delivery, including sublingual, rectal and transdermal delivery have not been appropriately investigated.<sup>22</sup>

## conclusion

Inhaling cannabis smoke in the long-term is likely to result in damage to the respiratory tract. The evidence base for this damage includes self report as well as scientific testing of lung capacity and biopsy of mucosa. This damage has been shown to be present even in the absence of tobacco smoke, while harms appear to be additive for individuals who smoke tobacco and cannabis. Further, cannabis smoke is carcinogenic although epidemiological research exploring the association between respiratory cancers and cannabis use is limited. The evidence is strongest for cannabis use being associated with an increase in cough, sputum production, airway inflammation, and wheeze.

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## references

1. **Hoffmann, D., Brunnehan, D.K., Gori, G.B., & Wynder, E.L.** (1975). On the carcinogenicity of marijuana smoke. *Recent Advances in Phytochemistry* 9, 63-81.
2. **Novotny, M., Merli, F., Weisler, D., Fencl, M., & Saeed, T.** (1982). Fractionation and capillary gas chromatographic mass spectrometric characterization of the neutral components in marijuana and tobacco smoke concentrates. *Journal of Chromatography* 238, 141-150.
3. **Wu, T.C., Tashkin, D.P., Djahed, B., & Rose, J.E.** (1988). Pulmonary hazards of smoking marijuana as compared with tobacco. *New England Journal of Medicine* 318, 347-351.
4. **Tashkin, D.P., Gliederer, F., Rose, J., Chang, P., Hui, K.K., Yu, J.L., & Wu, T.C.** (1991). Effects of varying marijuana smoking profile on deposition of tar and absorption of CO and Delta-9-THC. *Pharmacology, Biochemistry and Behavior* 40, 651-656.
5. **Benson, M. & Bentley, A.M.** (1995). Lung disease induced by drug addiction. *Thorax* 50, 1125-1127.
6. **Kalant, H., Van Hoozan, B.E. & Cross, C.E.** (2004). Adverse effects of cannabis on health: An update of the literature since 1996. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 28, 849-863.

7. **Taylor, D.R. & Hall, W.** (2003). Respiratory health effects of cannabis: Position statement of The Thoracic Society of Australia and New Zealand. *Internal Medicine Journal* 33, 310-313.
8. **Tashkin, D.P.** (2005). Smoked marijuana as a cause of lung injury. *Monaldi Archives for Chest Disease* 63, 93-100.
9. **Wolff, A.J. & O'Donnell, A.E.** (2004). Pulmonary effects of illicit drug use. *Clinics in Chest Medicine* 25, 203-216.
10. **Mehra, R., Moore, B.A., Crothers, K., Tetrault, J., & Fiellin, D.A.** (2006). The association between marijuana smoking and lung cancer: A systematic review. *Archives of Internal Medicine* 166, 1359-1367.
11. **Tashkin, D.R., Baldwin, G.C., Sarafian, T., Dubinett, S., & Roth, M.D.** (2002). Respiratory and immunologic consequences of marijuana smoking. *Journal of Clinical Pharmacology* 42, 715-815.
12. **Tetrault, J.M., Crothers, K., Moore, B.A., Mehra, R., Concato, J., & Fiellin, D.A.** (2007). Effects of marijuana smoking on pulmonary function and respiratory complications: A systematic review. *Archives of Internal Medicine* 167, 221-228.
13. **Taylor, D.R., Fergusson, D.M., Milne, B.J., Horwood, L.J., Moffitt, T.E., Sears, M.R., & Poulton, R.** (2002). A longitudinal study of the effects of tobacco and cannabis exposure in young adults. *Addiction* 97, 1055-1061.
14. **Moore, B.A., Augustson, E.M., Moser, R.P., & Budney, A.J.** (2004). Respiratory effects of marijuana and tobacco use in a U.S. sample. *Journal of General Internal Medicine* 20, 33-37.
15. **Marselos, M. & Karamanakos, P.** (1999). Mutagenicity, developmental toxicity and carcinogenicity of cannabis. *Addiction Biology* 4, 5-12.
16. **Hatam, C.T.N. & Treasure, T.** (2006). Bullous disease of the lung and cannabis smoking: Insufficient evidence for a causative link. *Journal of the Royal Society of Medicine* 99, 77-80.
17. **Beshay, M., Kaiser, H., Niedhart, D., Reymond, M.A., & Schmid, R.A.** (2007). Emphysema and secondary pneumothorax in young adults smoking cannabis. *European Journal of Cardio-Thoracic Surgery* 32, 834-838.
18. **Hii, S.W., Tam, J.D., Thompson, B.R., & Naughton, M.T.** (2008). Bullous lung disease due to marijuana. *Respirology* 13, 122-127.
19. **Reece, A.S.** (2008). Cannabis as a cause of giant cystic lung disease. *QJM* 101, 503.
20. **Gieringer, D.** (1996). Marijuana research: Water pipe study. *Bulletin of the Multidisciplinary Association for Psychedelic Studies* 6, 59-66.
21. **Bloor, R.N., Wang, T.S., Spanel, P., & Smith, D.** (2008). Ammonia release from heated 'street' cannabis leaf and its potential toxic effects on cannabis users. *Addiction* 103, 1671-1677.
22. **Grotenhermen, F.** (2001). Harm reduction associated with inhalation and oral administration of cannabis and THC. In **Russo, E.** (Ed). *Cannabis therapeutics in HIV/AIDS*, (pp.134-152). The Haworth Press, Inc.: New York.
23. **Joy, J.E., Watson, S.J. & Benson, J.A.** (Eds). (1999). *Marijuana and medicine: Assessing the science base*. National Academy Press: Washington.
24. **Mendelson, J.H. & Mello, N.K.** (1984). Reinforcing properties of oral D<sub>9</sub>-tetrahydrocannabinol, smoked marijuana, and nabilone: Influence of previous marijuana use. *Psychopharmacology* 83, 351-356.
25. **Mendelson, J.H., Mello, N.K., Lex, B.W., & Bavli, S.** (1984). Marijuana withdrawal syndrome in a woman. *American Journal of Psychiatry* 141, 1289-1290.
26. **Wachtel, S.R., ElSohly, M.A., Ross, S.A., Ambre, J., & de Wit, H.** (2002). Comparison of the subjective effects of D<sub>9</sub>-tetrahydrocannabinol and marijuana in humans. *Psychopharmacology* 161, 331-339.
27. **Chait, L.D. & Zacny, J.P.** (1992). Reinforcing and subjective effects of oral D<sub>9</sub>-THC and smoked marijuana in humans. *Psychopharmacology* 107, 255-262.
28. **Haney, M., Ward, A.S., Comer, S.D., Foltin, R.W., & Fischman, M.W.** (1999). Abstinence symptoms following oral THC administration to humans. *Psychopharmacology* 141, 385-394.
29. **Hart, C.L., Ward, A.S., Haney, M., Comer, S.D., Foltin, R.W., & Fischman, M.W.** (2002). Comparison of smoked marijuana and oral Δ<sup>9</sup>-tetrahydrocannabinol in humans. *Psychopharmacology* 164, 407-415.
30. **Chait, L.D. & Zacny, J.P.** (1992). Reinforcing and subjective effects of oral Δ<sup>9</sup>-THC and smoked marijuana in humans. *Psychopharmacology* 107, 255-262.