

infected by COVID-19, suffering worse symptoms and dying from it, say the researchers. They join the World Health Organization (WHO), the US Centers for Disease Control and Prevention, the Food and Drug Administration and the European Society of Cardiology in urging smokers to try to give up the habit, regardless of which smoking method they use.

The study is the world's first comparison of the effects of the three forms of smoking and vaping on human health and the function of cells that line blood vessels (the endothelium). It provides an overview of the available evidence about the [harmful chemicals](#) produced and the mechanisms by which smoking and vaping affect the body. The researchers also looked at the effects of each on [medical conditions](#) ranging from stroke to heart attacks and lung cancer.

The researchers found there were multiple good studies showing that, overall, tobacco cigarettes were more harmful than e-cigarettes. However, there were few good, large studies about the adverse effects of waterpipes (often referred to as hookahs, shisha or narghile) and e-cigarettes on endothelial dysfunction and so the evidence was more variable. The researchers say the long-term effects of water pipes and e-cigarettes need to be investigated more thoroughly. In the meantime, they write, "waterpipe smoking is not less harmful than [tobacco smoking](#) and thus cannot be considered a healthy alternative".

The researchers reviewed a range of studies, which they graded as providing strong, good or medium levels of evidence on the harmfulness of the three types of smoking and vaping. Compared to non-smokers, tobacco cigarettes increased the risk of chronic obstructive pulmonary disease (COPD) by 704% (good level of evidence), waterpipes by 218% (strong) and e-cigarettes by 194% (good); tobacco cigarettes and waterpipes increased the risk of lung cancer by 1210% (strong) and 122% (strong) respectively, while the level of evidence for e-cigarettes

was not sufficient to draw reliable conclusions.

They also looked at how much the three smoking techniques stiffened the arteries, an important prognostic indicator for the risk of heart problems and stroke. Compared to non-smokers, tobacco cigarettes increased arterial stiffness by 10%, waterpipes by 9% and e-cigarettes by 7% (medium level of evidence for all three).

The first author of the review, Professor Thomas Münzel, of the Department of Cardiology of the University Medical Centre Mainz in Mainz, Germany, said: "Our review focuses primarily on the adverse effects of these three smoking and vaping techniques on endothelial dysfunction and the relation to oxidative stress and, secondly, on clinical disease. All three forms of smoking and vaping lead to increased production of oxygen-derived free radicals in blood vessel tissue, such as superoxide. This breaks down nitric oxide, which is released by the endothelium, and is important for helping blood vessels to dilate and for protecting against inflammation and clogging of the arteries."

The researchers say the main toxic chemicals in e-cigarette vapour include formaldehyde and acrolein, as well as traces of chemicals called transition metals and volatile organic compounds (VOCs), all of which are known to damage cells. In contrast, tobacco cigarettes and waterpipe smoke contain a much more complex mixture of harmful chemicals and other substances. Waterpipe smoke contains solid particulate matter, originating mainly from the charcoal used to burn the tobacco; this is also present in lower concentrations in cigarette smoke. Nicotine is present in all three tobacco products, is addictive and is responsible for harmful biological effects as well as, to a minor extent, some beneficial effects.

Prof. Münzel said: "These different as well as overlapping profiles of toxic compounds may be a key to understand the similarities and

differences in the adverse health effects of smoking and vaping, and should be further investigated in detail by future studies."

The researchers looked at the effects of smoking and vaping on COVID-19 infections. In the EHJ paper, they write: "As outlined by the WHO, tobacco cigarette and waterpipe smoking may contribute to increased burden of symptoms due to COVID-19 compared to non-smoking, including being admitted to intensive care, requiring mechanical ventilation, and suffering severe health consequences."

They conclude: "There is no doubt...that smoking cessation is and will remain the most powerful approach to prevent [smoking](#)-induced cardiovascular and respiratory disease. This may be even more important in light of the...COVID-19 pandemic as the use of tobacco products likely increases the risk for COVID-19 associated cardiovascular and other severe complications in smokers and vapers."

Prof. Münzel said: "Given the well-established harms associated with tobacco use and second-hand smoke exposure, the WHO recommends that tobacco users should quit. Proven interventions to help users give up include toll-free quit lines, mobile text-messaging cessation programmes, nicotine replacement therapies and other approved medications, particularly if you have smoked for a long time, and especially if you use tobacco cigarettes and water pipes.

"The WHO also warns that although e-cigarettes appear to be less harmful than [tobacco cigarettes](#), there is growing evidence that they also may cause side effects in the lungs, heart and blood vessels and that e-cigarette use may increase the risk of COVID-19 infection."

The authors also address the issue of tobacco advertising. In the EU, TV and radio advertising of cigarettes, and tobacco products is not permitted. Some countries, such as Slovenia and Norway, have strict

laws that ban all types of advertising, even at the point of sale. Germany is the only EU country where tobacco products, including e-cigarettes, can be advertised in public spaces via billboards. In the US, advertising of both [tobacco](#) products and e-cigarettes on billboards is allowed. The EHJ study includes maps to show where in the world [e-cigarette](#) sales are legal, and where in Europe advertising permitted.

Prof. Münzel said: "E-cigarettes are mostly considered as [tobacco products](#), but the regulations on their advertising are not always clear."

More information: Thomas Münzel et al, Effects of tobacco cigarettes, e-cigarettes, and waterpipe smoking on endothelial function and clinical outcomes, *European Heart Journal* (2020). [DOI: 10.1093/eurheartj/ehaa460](#)

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