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Effects of COVID-19 protective face masks and wearing durations on respiratory haemodynamic physiology and exhaled breath constituents

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Abstract

Background While assumed to protect against coronavirus transmission, face masks may have effects on respiratory–haemodynamic parameters. Within this pilot study, we investigated immediate and progressive effects of FFP2 and surgical masks on exhaled breath constituents and physiological attributes in 30 adults at rest.

Methods We continuously monitored exhaled breath profiles within mask space in older (age 60–80 years) and young to middle-aged (age 20–59 years) adults over the period of 15 and 30 min by high-resolution real-time mass-spectrometry. Peripheral oxygen saturation (S_{pO_2}) and respiratory and haemodynamic parameters were measured (noninvasively) simultaneously.

Results Profound, consistent and significant ($p \leqslant 0.001$) changes in S_{pO_2} (⩾60_FFP2-15 min: 5.8±1.3%↓, ⩾60_surgical-15 min: 3.6±0.9%↓, <60_FFP2-30 min: 1.9±1.0%↓, <60_surgical-30 min: 0.9±0.6%↓) and end-tidal carbon dioxide tension (P_{ETCO_2}) (⩾60_FFP2-15 min: 19.1±8.0%↑, ⩾60_surgical-15 min: 11.6±7.6%↑, <60_FFP2- 30 min: 12.1±4.5%↑, <60_surgical- 30 min: 9.3±4.1%↑) indicate ascending deoxygenation and hypercarbia. Secondary changes ($p \leqslant 0.005$) to haemodynamic parameters (*e.g.* mean arterial pressure (MAP) ⩾60_FFP2-15 min: 9.8±10.4%↑) were found. Exhalation of bloodborne volatile metabolites, *e.g.* aldehydes, hemiterpene, organosulfur, short-chain fatty acids, alcohols, ketone, aromatics, nitrile and monoterpene mirrored behaviour of cardiac output, MAP, S_{pO_2}, respiratory rate and P_{ETCO_2}. Exhaled humidity (*e.g.* ⩾60_FFP2-15 min: 7.1±5.8%↑) and exhaled oxygen (*e.g.* ⩾60_FFP2-15 min: 6.1±10.0%↓) changed significantly ($p \leqslant 0.005$) over time.

Conclusions Breathomics allows unique physiometabolic insights into immediate and transient effects of face mask wearing. Physiological parameters and breath profiles of endogenous and/or exogenous volatile metabolites indicated putative cross-talk between transient hypoxaemia, oxidative stress, hypercarbia, vasoconstriction, altered systemic microbial activity, energy homeostasis, compartmental storage and washout. FFP2 masks had a more pronounced effect than surgical masks. Older adults were more vulnerable to FFP2 mask-induced hypercarbia, arterial oxygen decline, blood pressure fluctuations and concomitant physiological and metabolic effects.