Wearing an N95 Respiratory Mask

An Unintended Exercise Benefit?

To the Editor:

The N95 or higher-level respirator is an essential element of personal protective equipment to be worn when in contact with patients with known or suspected coronavirus disease 2019 (COVID-19) infection. Three varieties are commonly available: preformed/cup, flat fold/duck bill, and elastomeric.[1] Wearing an N95 mask invokes a number of physiologic implications, particularly with prolonged use (greater than 1 h), higher workloads, or an overlying surgical mask (table 1).[2,3] Concomitant surgical mask use augments the impact of a cup mask due to further resistance to airflow, but diminishes the impact of a flat fold mask due to a reduction in deadspace.[2]

At 2 metabolic equivalents (*e.g.*, walking slowly during rounds), N95 mask use noticeably increases inhaled carbon dioxide, reduces inspired oxygen, and increases the work of breathing. The resulting inhaled carbon dioxide of 2 to 3% (normal, 0.04%) produces transient acidosis and compensatory increases in minute ventilation, work of breathing, and cardiac output.[2] Symptoms include sweating, visual changes, headache, dyspnea, increased irritability, and decreased reasoning, alertness, and exercise endurance.[3] Independently, the inspired oxygen of 17% (normal, 21%), yields headache, lightheadedness, drowsiness, muscular weakness, dyspnea on exertion, nausea, and vomiting.[4] Simultaneously, the augmented resistance to inspiratory (15% of maximum) and expiratory flow, when experienced for greater than 10 min, results in respiratory alkalosis, increased lactate levels, fatigue, and impaired physical work capacity.[5]

However, a number of exercise benefits can be achieved with surprisingly low effort while wearing an N95 mask. At 2 metabolic equivalents, the inspiratory resistance load of 6 to 7 cm H_2O (4.5 to 5 mmHg; normal, 1.3 mmHg [men] to 1.6 mmHg [women]) of an N95 mask creates a "respiratory pump" that decreases intrathoracic, central venous, and intracranial pressures,[6] and increases preload, cardiac output, and mean arterial pressure, particularly during hypotensive states.[7] At 4 metabolic equivalents, consciously taking 30 dynamic (fast in) inspiratory efforts twice daily for 4 weeks increases respiratory muscle strength. Maintaining 4 metabolic equivalents of activity for 10 to 30 min, 3 to 5 days/week for 4 weeks improves respiratory muscle endurance. Such conditioning of respiratory muscle strength and respiratory muscle endurance improves ventilatory efficiency (*e.g.*, ventilation–perfusion and alveolar capillary exchange), oxygen delivery/lactate removal at locomotor muscles, and overall exercise performance.[5]

Taken together, to inspire us as we don, sustain us as we wear, and cheer us as we doff our N95 masks, we should relish in the many beneficial attributes that are possible "all in a day's work."

Research Support

Support was provided solely from institutional and/or departmental sources.

Competing Interests

The authors declare no competing interests.

Table 1. Physiologic Implications of N95 Mask Use

Workload	Mask Type	Inhaled Carbon Dioxide (%)	Inhaled Oxygen (%)	Peak Inhalation Pressure (mmHg)	Peak Exhalation Pressure (mmHg)
2 Metabolic equivalents	Cup	2.49 ± 0.51	17.40 ± 0.81	−6 ± 1	8 ± 2
	Cup + surgical mask	2.93 ± 0.38	16.81 ± 0.54	−7 ± 2	8 ± 2
	Flat-fold	3.52 ± 0.93	16.10 ± 1.14	−5 ± 2	7 ± 2
	Flat-fold + surgical mask	3.14 ± 0.64	16.52 ± 0.79	−6 ± 2	8 ± 2
8 Metabolic equivalents	Cup	1.43 ± 0.60	19.33 ± 0.70	−35 ± 6	23 ± 7
	Cup + surgical mask	1.75 ± 0.33	18.96 ± 0.37	−41 ± 7	29 ± 7
	Flat-fold	1.81 ± 0.82	18.92 ± 0.84	−34 ± 10	24 ± 4
	Flat-fold + surgical mask	1.67 ± 0.33	19.05 ± 0.35	−43 ± 16	30 ± 8

Data from Sinkule *et al.*[2]

<zdoi; DOI: 10.1097/ALN.0000000000003421>

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DOI: 10.1097/ALN.0000000000003421

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(Accepted for publication May 18, 2020.)