

Physiological and Cognitive Functions During Mask Respirator Use Under Elevated Environmental CO₂

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Introduction

- Mask respirators increase breathing resistance and dead space, potentially elevating inspired CO₂.
- These effects may be amplified in environments with elevated ambient CO₂, increasing physiological and cognitive strain.
- This study evaluated the physiological and cognitive responses to respirator use under progressively increasing externally supplied CO₂ concentrations.

Methods

- Thirty-eight healthy adults (19 males, 19 females; 18-35 yrs) completed four 20 min trials while wearing an M-15 respirator.
 - Each trial consisted of 10 min of cycling (F: 30 W; M: 50 W) followed by 10 minutes of computerized cognitive testing under ambient CO₂ concentrations of 0.04%, 0.5%, 1.5%, and 2.5%.
 - Physiological measurements included minute ventilation, tidal volume, breathing frequency, inspiratory pressure, transcutaneous CO₂, perceived breathing discomfort.
- Cognitive performance was assessed using the Psychomotor Vigilance Test (PVT), the Stroop test, and the Balloon Analogue Risk Task (BART).

Results

- Minute ventilation increased progressively with increasing ambient CO₂, primarily due to an increase in tidal volume.
- Inspired CO₂, transcutaneous CO₂, and perceived breathing discomfort increased significantly across CO₂ conditions.
- Psychomotor vigilance (PVT) and Stroop performance were not significantly affected by increasing CO₂ levels
- Male participants demonstrated greater risk-taking behavior on the BART as ambient CO₂ increased, whereas females showed no significant change.

Key Findings

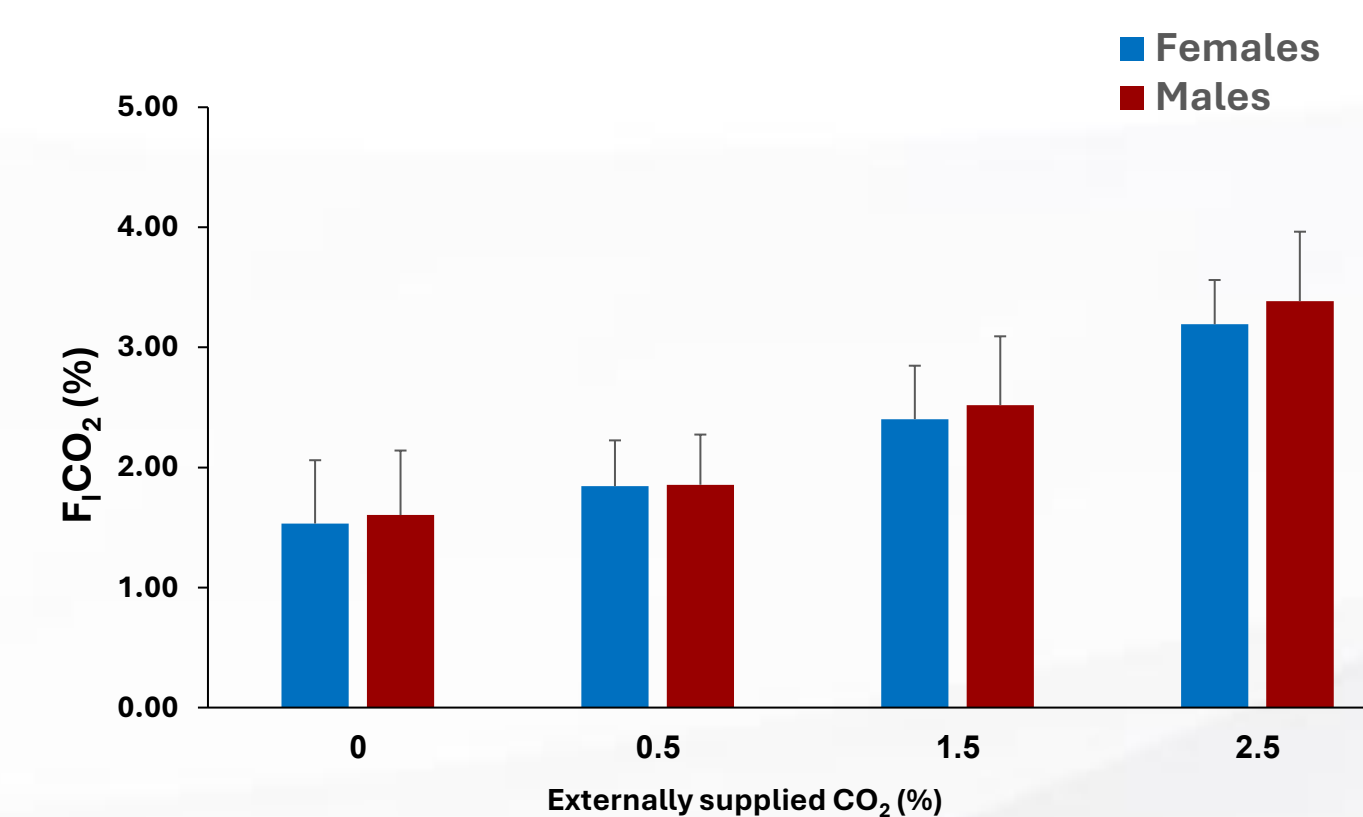


Figure 1. F_ICO₂ increased progressively across the four CO₂ conditions, with similar values in females and males. Data are mean ± SD.

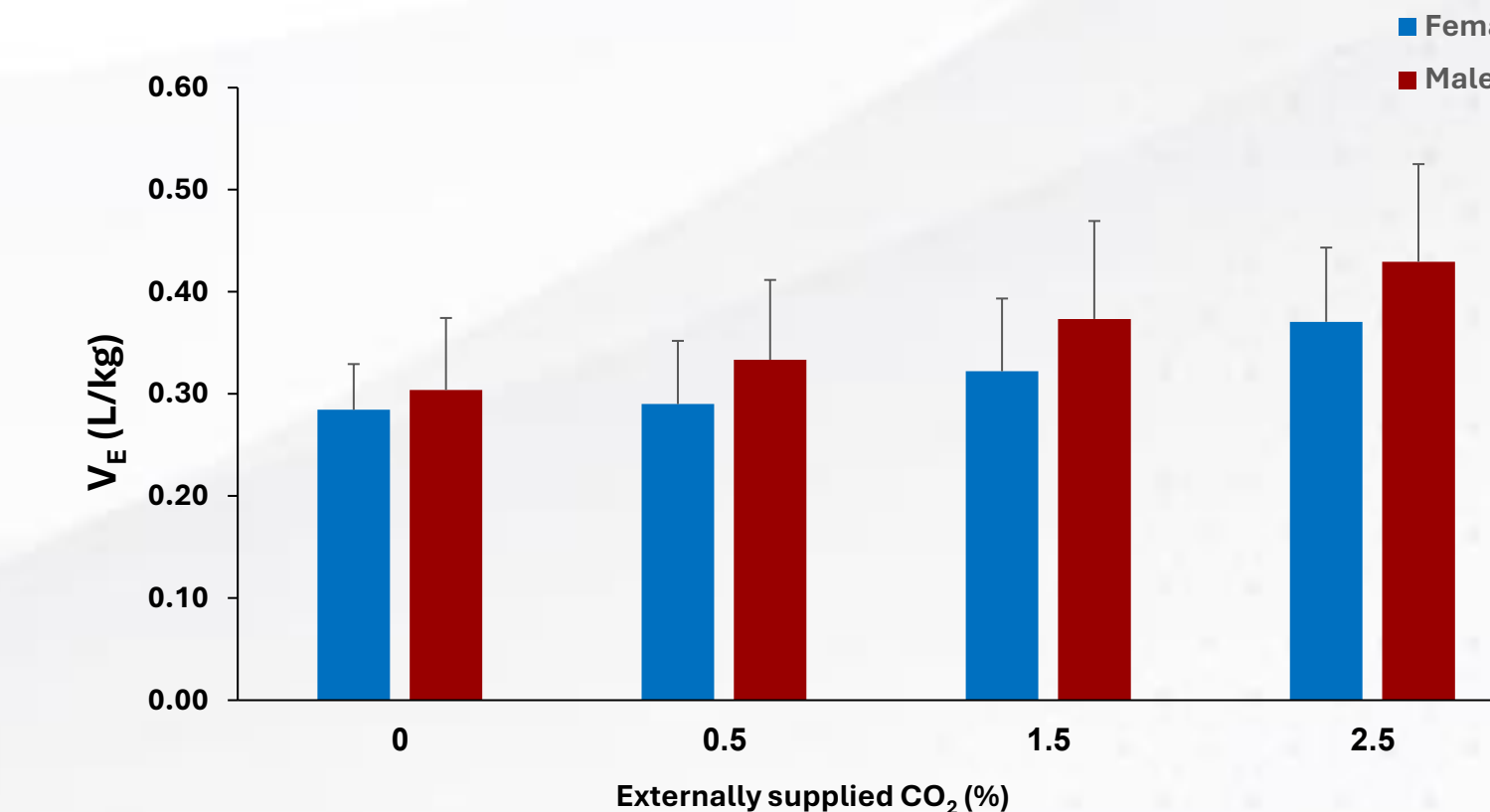


Figure 2. Body mass – normalized minute ventilation increased with F_ICO₂ in both sexes and was higher in males. Data are mean ± SD.

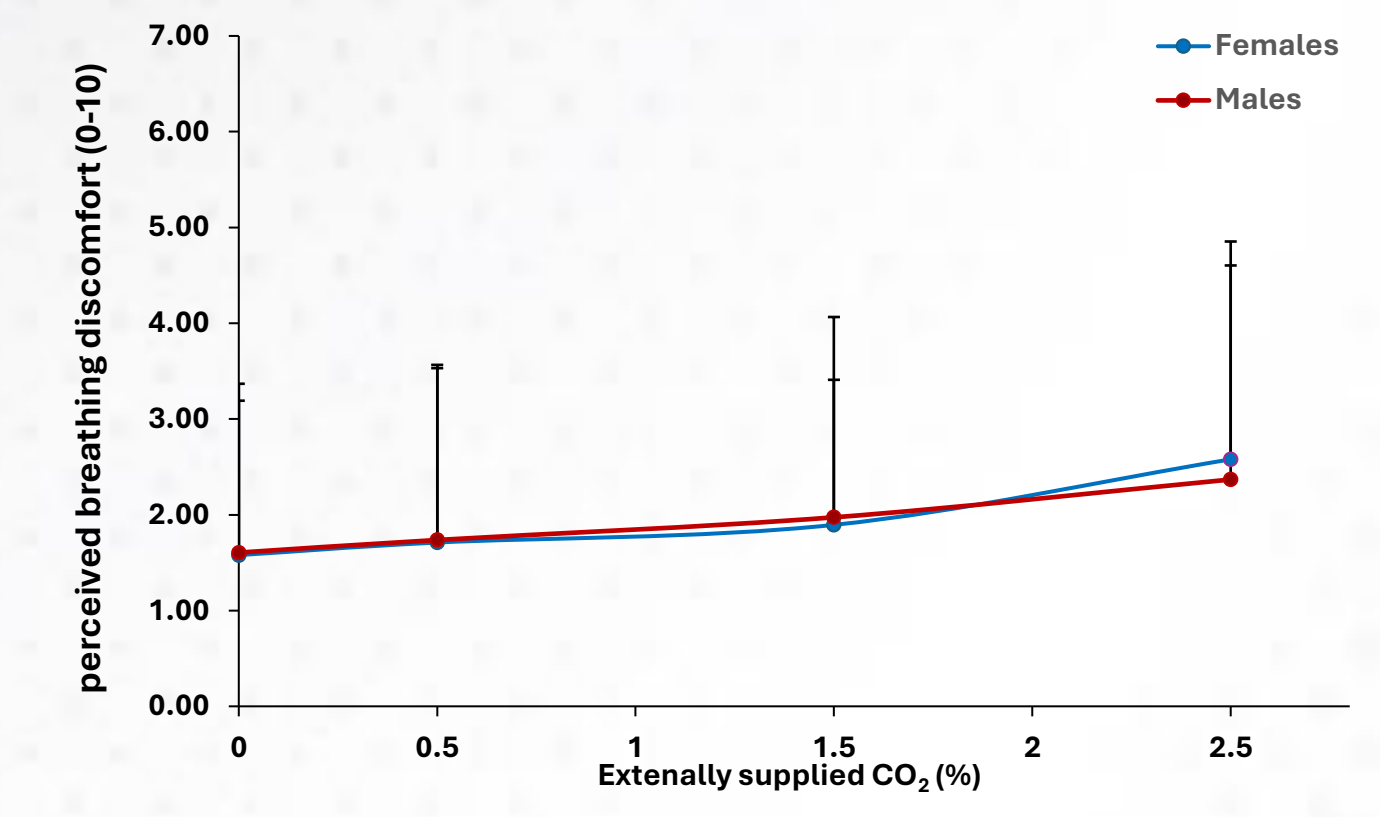
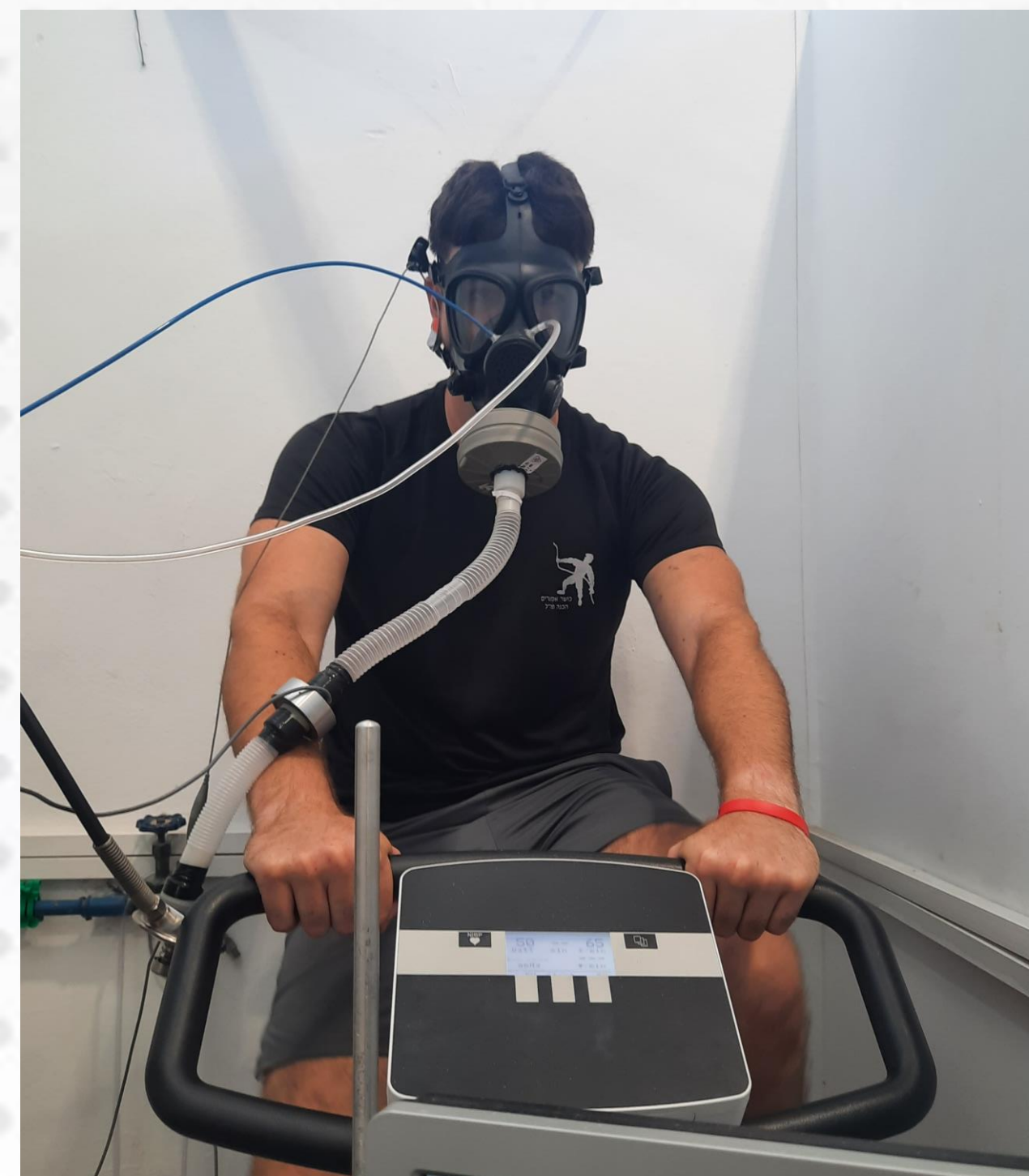


Figure 3. Perceived breathing discomfort increased with F_ICO₂ in both sexes. Data are mean ± SD.

Conclusions

- Elevated inspired CO₂ during respirator use increased ventilatory demand and breathing discomfort, without impairing vigilance or Stroop performance.
- Risk-taking behavior increased in males only.

Pic 1. Experimental setup showing a participant performing cycle exercise while wearing a full-face respirator and breathing CO₂ enriched air.



Abstract disclaimer: The authors declare that they have no conflicts of interest or disclosures relevant to the content of this abstract. All research procedures were conducted in accordance with established ethical guidelines and with the approval of the appropriate institutional review board. The findings presented are based on the data available at the time of submission and may be subject to further analysis or refinement.



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