



Investigating the Effect of Multiple Smoking Exposures on Lung Function and Structure in Young Persons Using Hyperpolarized ^{129}Xe MRI and CT



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Introduction

- Multiple smoking exposures in the form of cannabis, vaping and cigarettes among Canadian young adults are common¹
- Long-term cigarette effects are well known, but combined effects of cigarettes, cannabis, and vaping remain under-researched
- ^{129}Xe MRI and computed tomography (CT) are more sensitive to early lung abnormalities compared to traditional pulmonary function tests (PFT)²

What are the effects of multiple smoking exposures on the lungs?

Objective

Evaluate how multiple smoking exposures may alter lung structure-function via ^{129}Xe MRI and CT

Methods

Study Participants and Design

- Participants ≥ 19 yrs were enrolled:
 - Self-reported current or previous vaping, cigarette smoking, or cannabis joint smoking
 - Age matched and healthy, never-vaping, never-smoking controls
- Pulmonary function tests (PFT) reported using GLI race-neutral reference equations
- COPD assessment test (CAT) and St. George's Respiratory Questionnaire (SGRQ) administered

MRI

- ^{129}Xe MRI gas exchange imaging (**Figure 1**):
 - Membrane to gas ratio (Membrane/Gas)
 - Red blood cell to gas ratio (RBC/Gas)
 - RBC to membrane ratio (RBC/Membrane)

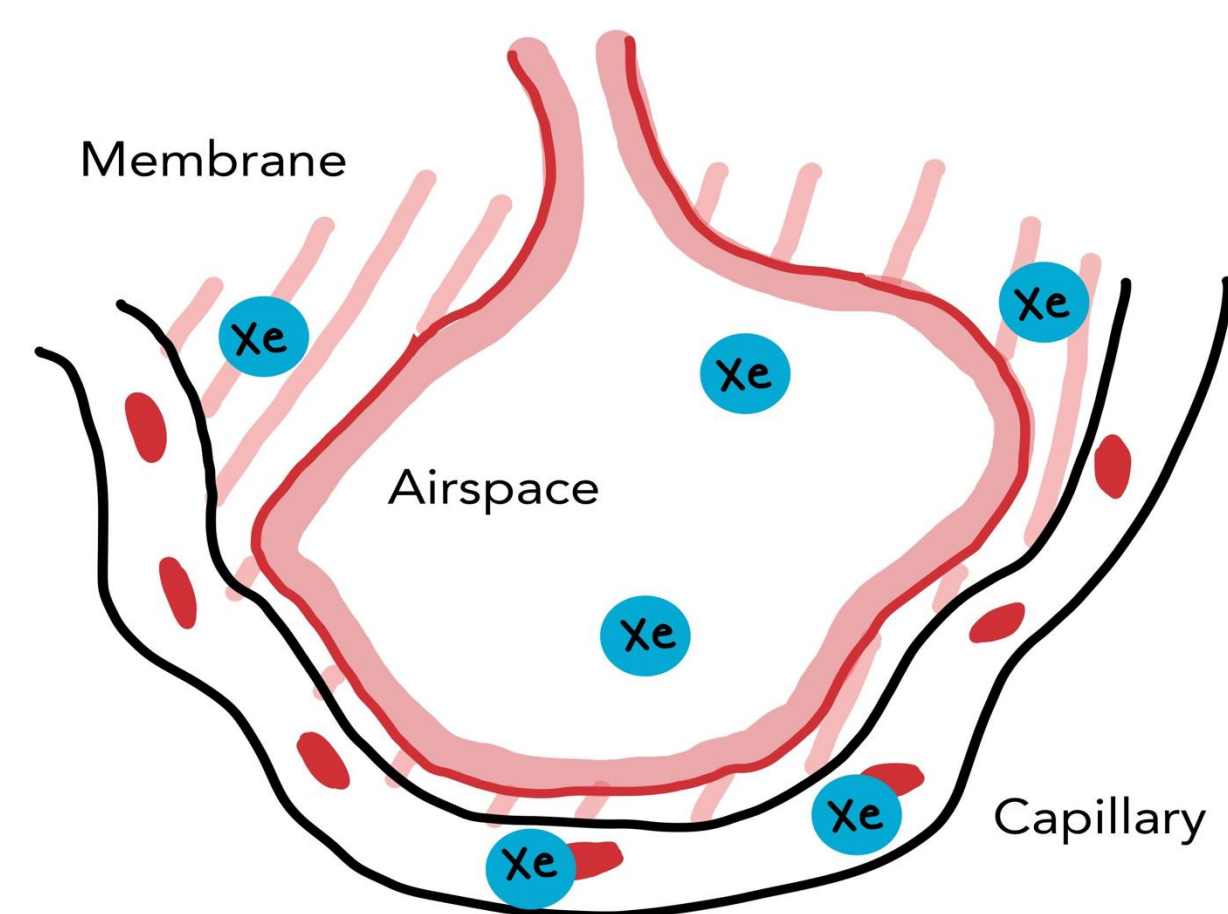


Figure 1. ^{129}Xe MRI gas exchange schematic

CT

- CT performed at full inspiration to measure quantitative mean lung density

Statistical Analysis

- Measurements compared using the t-test or Wilcoxon rank-sum test

Results

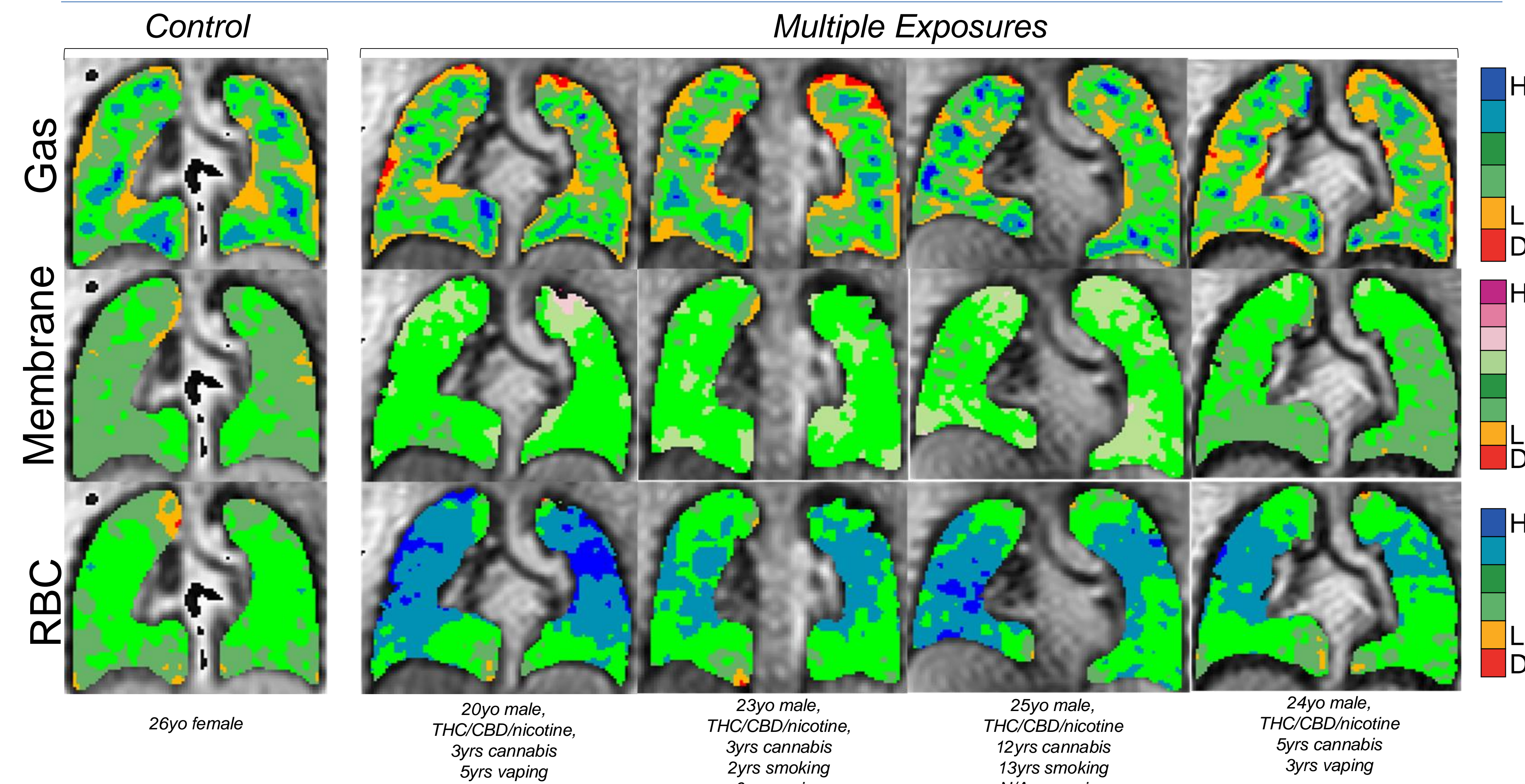


Figure 2. ^{129}Xe MRI gas exchange images in representative control and exposure participants. D=defect (no signal); L=low xenon signal; H=high xenon signal.

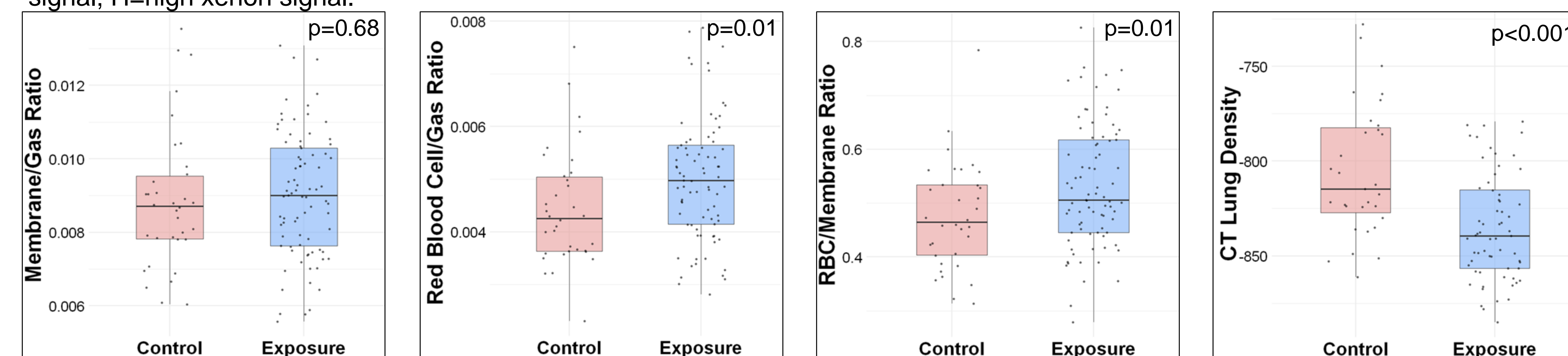


Figure 3. ^{129}Xe MRI shows increased RBC/Gas and RBC/Membrane and CT shows decreased lung density in exposure group.

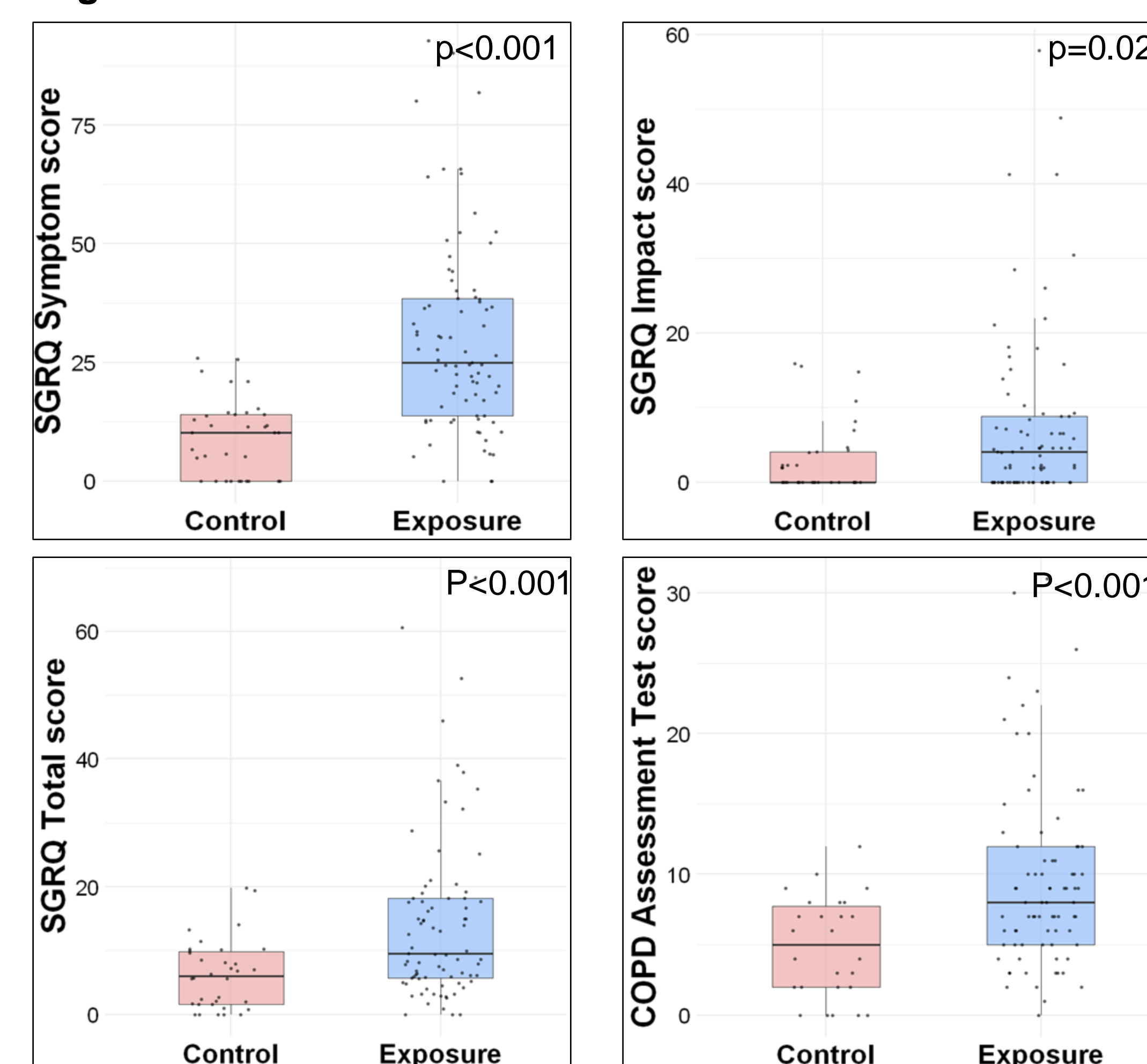


Figure 4. Exposure group reported greater SGRQ and CAT scores.

Table 1. Participant Demographics and PFT Measurements.

Mean \pm SD or Median (range)	Control (n=34)	Exposure (n=81)	p-value
Age yrs	32 \pm 9	30 \pm 8	-
Male n (%)	9 (26)	41 (51)	-
BMI kg/m ²	25 \pm 4	25 \pm 4	-
Exposure			
Vape + Cannabis n(%)	-	31 (38)	-
Vape + Cigarette n(%)	-	10 (13)	-
Cannabis + Cigarette n(%)	-	13 (16)	-
Vape + Cannabis + Cigarette	-	27 (33)	-
PFTs			
FEV ₁ % _{pred}	104 \pm 14	110 \pm 14	0.031
FEV ₁ /FVC	83 \pm 7	80 \pm 6	0.029
FVC% _{pred}	106 \pm 15	117 \pm 15	<0.001
DLCO% _{pred}	105 \pm 13	108 \pm 17	0.45

BMI=body mass index; FEV₁=forced expiratory volume in 1s; %_{pred}=GLI percent predicted; FVC=forced vital capacity; DLCO=diffusing capacity of the lungs for carbon monoxide.

Discussion

Symptoms

- Exposure group reported greater respiratory symptoms than controls

PFTs

- Increased FEV₁ and FVC and decreased FEV₁/FVC in exposure group compared to controls

^{129}Xe MRI

- RBC/Gas and RBC/Membrane ratio greater in the exposure group

CT Scan

- Mean lung density decreased in the exposure group

Study Challenges

- Symptom questionnaires rely on self-reported information, subjective and may be biased
- Large amount of variability in smoking exposure (current, previous, years, frequency)

Future Work

- Evaluating all results from baseline and follow-up
 - Long-term effects on function and structure change
 - Determines whether early abnormalities detected via ^{129}Xe MRI and CT can progress into chronic conditions
 - RBC signal is naturally increased in males³
 - Future work should further investigate this by controlling for sex and by sex matching the exposure and control group

Conclusion

The exposure group has a greater burden of **symptoms** than controls, **RBC signal** was increased in the exposure group as well as **decreased lung density**. These may be potential signs of **early disease manifestation**. Given that the exposure group is relatively young and healthy, these abnormalities are concerning.

References

- Statistics Canada, 2023
- Rao *et al. European Radiology*. 2024;34(11);, 7450–7459
- Collier *et al. Magnetic resonance in medicine*. 2024;92(4), 1471–1483.

Acknowledgments



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