

**Title:** Measuring Airway Obstruction: Identifying Small Airways Disease in Asthma and COPD

**Trainee Name:** Heather Young

**Supervisor(s):** Dr. Grace Parraga

**Structured Abstract:**

**Introduction:** Asthma and chronic obstructive pulmonary disease (COPD) are characterized by heterogeneous ventilation, or air flow, in the lungs. Previous work has shown that ventilation heterogeneity is related to poor asthma control(1) and asthma attacks(2). In COPD, it is related to symptoms(3) and their worsening over time(4), and predicts future hospitalizations(5). This is studied using hyperpolarized noble gas magnetic resonance imaging (MRI) by measuring regions of the lung that are poorly ventilated, or ventilation defects. The forced oscillation technique (FOT) provides measurements of biomechanical properties of the lungs by applying a low-amplitude multi-spectral pressure oscillation at the mouth. From this test, impedance to airflow (including resistance and reactance) can be measured. The objective of this study is to study ventilation heterogeneity using both FOT and hyperpolarized  $^3\text{He}$  MRI in order to better understand the nature of heterogeneity in asthma and COPD.

**Methods:** Participants with a diagnosis of asthma ( $n = 50$ ) or COPD ( $n = 50$ ) provided written informed consent to approved protocols and underwent pulmonary function tests (including FOT) and hyperpolarized  $^3\text{He}$  MRI to generate ventilation defect percent (VDP) as previously described(6). Quality of life was assessed using validated written questionnaires: the Asthma Quality of Life Questionnaire for asthma, and the St. George's Respiratory Questionnaire for COPD. Data were tested for normality with the Shapiro-Wilk test and Spearman correlations were used to evaluate univariate relationships. All statistics were performed using SPSS 24.0 (IBM, Armonk, NY).

**Results:** Small airway resistance is significantly correlated with quality of life measurements in both asthma ( $\rho = -0.3$ ,  $p < 0.04$ ) and COPD ( $\rho = 0.4$ ,  $p = 0.002$ ). Both whole-lung resistance and small-airways resistance are correlated with VDP in asthma ( $\rho = 0.3$ ,  $p = 0.02$ ,  $\rho = 0.5$ ,  $p < 0.001$ ) and small airways resistance is correlated with VDP in COPD ( $\rho = 0.4$ ,  $p = 0.001$ ).

**Discussion:** Currently, FOT is not a widely-used clinical tool. Here we showed that FOT measurements of impedance are related to patient quality of life and MRI-measured heterogeneity, which is predictive of asthma attacks and hospitalizations in COPD. This study supports the use of FOT as a clinical tool for evaluating asthma and COPD.

**References:**

1. Svenningsen S et al. Eur Respir J (2016).
2. Svenningsen S. et al. Thorax (2014).
3. Kirby, M. et al. Radiology (2015).
4. Kirby, M. et al. Thorax (2017).
5. Kirby, M. et al. Radiology (2014).
6. Kirby, M. et al. Acad Radiol (2012).