

# Analysis of wheeze sounds during tidal breathing according to severity levels in asthma patients

## Abstract

**Objective:** This study aimed to statistically analyze the behavior of time-frequency features in digital recordings of wheeze sounds obtained from patients with various levels of asthma severity (mild, moderate, and severe), and this analysis was based on the auscultation location and/or breath phase. **Method:** Segmented and validated wheeze sounds were collected from the trachea and lower lung base (LLB) of 55 asthmatic patients during tidal breathing maneuvers and grouped into nine different datasets. The quartile frequencies  $F_{25}$ ,  $F_{50}$ ,  $F_{75}$ ,  $F_{90}$  and  $F_{99}$ , mean frequency (MF) and average power (AP) were computed as features, and a univariate statistical analysis was then performed to analyze the behavior of the time-frequency features. **Results:** All features generally showed statistical significance in most of the datasets for all severity levels [ $\chi^2 = 6.021-71.65$ ,  $p < 0.05$ ,  $\eta^2 = 0.01-0.52$ ]. Of the seven investigated features, only AP showed statistical significance in all the datasets.  $F_{25}$ ,  $F_{75}$ ,  $F_{90}$  and  $F_{99}$  exhibited statistical significance in at least six datasets [ $\chi^2 = 4.852-65.63$ ,  $p < 0.05$ ,  $\eta^2 = 0.01-0.52$ ], and  $F_{25}$ ,  $F_{50}$  and MF showed statistical significance with a large  $\eta^2$  in all trachea-related datasets [ $\chi^2 = 13.54-55.32$ ,  $p < 0.05$ ,  $\eta^2 = 0.13-0.33$ ]. **Conclusion:** The results obtained for the time-frequency features revealed that (1) the asthma severity levels of patients can be identified through a set of selected features with tidal breathing, (2) tracheal wheeze sounds are more sensitive and specific predictors of severity levels and (3) inspiratory and expiratory wheeze sounds are almost equally informative.

## Keywords

Airway obstruction; Asthma; Breath sounds; Severity level; Wheeze detection