

ONLINE SUPPLEMENTARY TABLES

Table 1. The relationship between P₁ cough sound from Free-field microphone, flow and oesophageal pressure

a) Flow

P ₁ sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.88 (0.78-0.93)	0.83 (0.78-0.92)	0.92 (0.87-0.95)	0.79 (0.76-0.92)	0.89 (0.85-0.95)
Ep	0.87 (0.78-0.92)	0.84 (0.77-0.89)	0.91 (0.86-0.96)	0.82 (0.76-0.92)	0.89 (0.86-0.95)
RT	0.31 (0.02-0.48)	0.29 (0.05-0.42)	0.33 (-0.02-0.48)	0.28 (-0.08-0.43)	0.41 (0.12-0.48)
D	0.29 (-0.11-0.59)	0.15 (-0.21-0.60)	0.43 (-0.11-0.62)	0.47 (-0.08-0.69)	0.02 (-0.17-0.43)
Fp	0.11 (-0.25-0.34)	0.18 (-0.24-0.34)	0.10 (-0.28-0.49)	0.03 (-0.22-0.32)	0.28 (-0.27-0.45)
BW	-0.24 (-0.53-0.11)	-0.22 (-0.54-0.11)	-0.41 (-0.57-0.09)	-0.26 (-0.63-0.02)	-0.16 (-0.53-0.11)
Fc	0.49 (0.25-0.71)	0.47 (0.18-0.68)	0.61 (0.29-0.75)	0.47 (0.21-0.67)	0.62 (0.24-0.83)

b) Oesophageal pressure

P ₁ sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.89 (0.84-0.95)	0.87 (0.81-0.91)	0.94 (0.88-0.96)	0.88 (0.85-0.94)	0.91 (0.82-0.95)
Ep	0.89 (0.82-0.95)	0.84 (0.81-0.91)	0.94 (0.88-0.96)	0.84 (0.81-0.94)	0.91 (0.86-0.95)
RT	0.35 (-0.04-0.45)	0.35 (-0.02-0.42)	0.40 (-0.06-0.48)	0.35 (-0.14-0.45)	0.36 (0.07-0.46)
D	0.23 (-0.11-0.54)	0.10 (-0.26-0.51)	0.37 (-0.07-0.61)	0.51 (-0.03-0.55)	-0.05 (-0.26-0.42)
Fp	0.06 (-0.30-0.41)	0.16 (-0.3-0.43)	0.00 (-0.31-0.53)	0.05 (-0.31-0.38)	0.08 (-0.29-0.47)
BW	-0.40 (-0.58-0.10)	-0.43 (-0.59-0.10)	-0.34 (-0.64-0.11)	-0.34 (-0.70-0.10)	-0.43 (-0.52-0.11)
Fc	0.53 (0.22-0.76)	0.52 (0.20-0.80)	0.64 (0.26-0.76)	0.52 (0.24-0.78)	0.64 (0.22-0.76)

Data presented as median (IQR) within-subject Spearman's correlation coefficients between P₁ cough sound and cough flow (a) or oesophageal pressure (b). Peak cough flow normalised to predicted peak expiratory flow. PW: power; Ep: peak energy; RT: rise time; D: duration; Fp: peak frequency; BW: bandwidth; Fc: centroid frequency.

Table 2. The relationship between P₁ cough sound from Contact microphone, flow and oesophageal pressure

a) Flow

P ₁ sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.82 (0.71-0.91)	0.79 (0.68-0.89)	0.89 (0.78-0.93)	0.82 (0.74-0.91)	0.81 (0.68-0.89)
Ep	0.83 (0.74-0.90)	0.80 (0.72-0.89)	0.89 (0.82-0.92)	0.82 (0.75-0.90)	0.84 (0.72-0.89)
RT	0.20 (-0.06-0.35)	0.19 (-0.09-0.33)	0.21 (0.05-0.46)	0.15 (-0.09-0.43)	0.21 (0.14-0.33)
D	0.29 (-0.11-0.59)	0.15 (-0.21-0.60)	0.43 (-0.11-0.62)	0.47 (-0.08-0.69)	0.02 (-0.17-0.43)
Fp	0.20 (-0.19-0.62)	0.15 (-0.21-0.39)	0.57 (0.01-0.76)	0.17 (-0.17-0.52)	0.39 (-0.21-0.72)
BW	-0.09 (-0.46-0.33)	-0.17 (-0.48-0.08)	0.03 (-0.24-0.41)	-0.09 (-0.52-0.23)	0.01 (-0.42-0.33)
Fc	0.68 (0.33-0.86)	0.49 (0.10-0.71)	0.86 (0.70-0.91)	0.62 (0.36-0.72)	0.81 (0.11-0.92)

b) Oesophageal pressure

P ₁ sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.86 (0.76-0.90)	0.83 (0.70-0.88)	0.90 (0.86-0.94)	0.88 (0.81-0.92)	0.83 (0.68-0.90)
Ep	0.86 (0.79-0.90)	0.83 (0.75-0.89)	0.90 (0.87-0.93)	0.89 (0.82-0.92)	0.84 (0.75-0.90)
RT	0.21 (-0.07-0.42)	0.21 (-0.08-0.45)	0.28 (0.06-0.48)	0.22 (-0.12-0.48)	0.20 (0.03-0.45)
D	0.23 (-0.11-0.54)	0.10 (-0.26-0.51)	0.37 (-0.07-0.61)	0.51 (-0.03-0.55)	-0.05 (-0.26-0.42)
Fp	0.21 (-0.19-0.73)	0.08 (-0.25-0.49)	0.68 (0.05-0.81)	0.18 (-0.17-0.55)	0.41 (-0.21-0.81)
BW	-0.13 (-0.45-0.36)	-0.18 (-0.51-0.16)	0.06 (-0.24-0.55)	-0.14 (-0.45-0.26)	-0.10 (-0.45-0.49)
Fc	0.71 (0.43-0.92)	0.58 (0.22-0.74)	0.91 (0.74-0.94)	0.64 (0.43-0.84)	0.88 (0.17-0.94)

Data presented as median (IQR) within-subject Spearman's correlation coefficients between P₁ cough sound and cough flow (a) or oesophageal pressure (b). Peak cough flow normalised to predicted peak expiratory flow. PW: power; Ep: peak energy; RT: rise time; D: duration; Fp: peak frequency; BW: bandwidth; Fc: centroid frequency.

Table 3. The relationship between P₁₋₃ cough sound, flow and oesophageal pressure

a) Flow

P ₁₋₃ sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.82 (0.60-0.90)	0.80 (0.56-0.90)	0.85 (0.63-0.94)	0.79 (0.59-0.89)	0.83 (0.65-0.95)
Ep	0.81 (0.56-0.90)	0.79 (0.49-0.89)	0.84 (0.59-0.96)	0.77 (0.55-0.87)	0.89 (0.60-0.96)
RT	0.01 (-0.18-0.3)	-0.03 (-0.25-0.29)	0.16 (-0.18-0.60)	-0.05 (-0.18-0.27)	0.27 (-0.21-0.56)
D	0.60 (0.23-0.82)	0.59 (0.23-0.78)	0.64 (0.22-0.84)	0.58 (0.24-0.77)	0.66 (0.23-0.83)
Fp	0.35 (0.07-0.53)	0.16 (-0.21-0.43)	0.39 (0.27-0.63)	0.34 (0.07-0.53)	0.38 (0.03-0.57)
BW	0.05 (-0.16-0.35)	-0.08 (-0.38-0.10)	0.30 (0.21-0.38)	-0.03 (-0.21-0.28)	0.22 (-0.02-0.45)
Fc	0.63 (0.26-0.79)	0.41 (0.07-0.79)	0.67 (0.52-0.78)	0.64 (0.35-0.79)	0.57 (0.11-0.77)

b) Oesophageal pressure

P ₁₋₃ sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.85 (0.65-0.91)	0.85 (0.65-0.89)	0.90 (0.63-0.96)	0.85 (0.59-0.89)	0.88 (0.67-0.95)
Ep	0.85 (0.58-0.93)	0.82 (0.58-0.88)	0.93 (0.49-0.97)	0.82 (0.49-0.88)	0.90 (0.58-0.97)
RT	0.05 (-0.33-0.53)	-0.05 (-0.35-0.45)	0.20 (-0.21-0.65)	-0.06 (-0.35-0.32)	0.38 (-0.20-0.70)
D	0.70 (0.47-0.84)	0.72 (0.45-0.82)	0.70 (0.59-0.85)	0.64 (0.45-0.80)	0.76 (0.52-0.85)
Fp	0.36 (0.12-0.60)	0.16 (-0.11-0.53)	0.43 (0.23-0.73)	0.31 (0.16-0.56)	0.39 (0.09-0.62)
BW	0.06 (-0.13-0.39)	-0.05 (-0.24-0.21)	0.32 (0.00-0.46)	-0.06 (-0.30-0.28)	0.29 (-0.03-0.43)
Fc	0.68 (0.48-0.82)	0.60 (0.23-0.77)	0.69 (0.60-0.87)	0.69 (0.31-0.79)	0.66 (0.60-0.86)

Data presented as median (IQR) within-subject Spearman's correlation coefficients between P₁₋₃ cough sound and cough flow (a) or oesophageal pressure (b). Sound recorded with free-field microphone. Peak cough flow normalised to predicted peak expiratory flow. PW: power; Ep: peak energy; RT: rise time; D: duration; Fp: peak frequency; BW: bandwidth; Fc: centroid frequency.

Table 4. The relationship between P_{0.5} cough sound, flow and oesophageal pressure

a) Flow

P _{0.5} sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.88 (0.79-0.92)	0.85 (0.77-0.90)	0.93 (0.83-0.96)	0.80 (0.77-0.91)	0.91 (0.85-0.96)
Ep	0.87 (0.79-0.91)	0.81 (0.78-0.87)	0.91 (0.84-0.95)	0.81 (0.76-0.90)	0.89 (0.82-0.95)
RT	0.23 (-0.05-0.42)	0.17 (-0.07-0.32)	0.25 (-0.05-0.51)	0.10 (-0.06-0.33)	0.27 (0.04-0.48)
D	N/A	N/A	N/A	N/A	N/A
Fp	0.17 (-0.06-0.45)	0.27 (-0.25-0.45)	0.14 (-0.01-0.50)	0.13 (-0.05-0.40)	0.38 (-0.25-0.47)
BW	-0.10 (-0.35-0.19)	-0.10 (-0.44-0.21)	-0.19 (-0.32-0.12)	-0.10 (-0.34-0.13)	-0.03 (-0.46-0.26)
Fc	0.48 (0.19-0.78)	0.36 (0.16-0.79)	0.51 (0.21-0.79)	0.36 (0.18-0.61)	0.65 (0.19-0.81)

b) Oesophageal pressure

P _{0.5} sound parameter	All subjects	All females	All males	Chronic coughers	Controls
PW	0.89 (0.81-0.94)	0.87 (0.76-0.89)	0.94 (0.92-0.96)	0.89 (0.79-0.92)	0.89 (0.83-0.96)
Ep	0.89 (0.82-0.94)	0.84 (0.80-0.89)	0.94 (0.88-0.96)	0.88 (0.82-0.93)	0.89 (0.80-0.96)
RT	0.23 (-0.13-0.50)	0.11 (-0.24-0.37)	0.25 (-0.11-0.56)	0.11 (-0.19-0.50)	0.25 (0.01-0.52)
D	N/A	N/A	N/A	N/A	N/A
Fp	0.26 (-0.11-0.46)	0.32 (-0.14-0.47)	0.13 (-0.04-0.55)	0.23 (-0.10-0.42)	0.30 (-0.14-0.53)
BW	-0.15 (-0.43-0.24)	-0.13 (-0.46-0.32)	-0.19 (-0.39-0.12)	-0.19 (-0.41-0.18)	-0.03 (-0.48-0.32)
Fc	0.53 (0.25-0.80)	0.50 (0.25-0.79)	0.65 (0.24-0.82)	0.50 (0.28-0.71)	0.61 (0.18-0.87)

Data presented as median (IQR) within-subject Spearman's correlation coefficients between P_{0.5} cough sound and cough flow (a) or oesophageal pressure (b). Sound recorded with free-field microphone. Peak cough flow normalised to predicted peak expiratory flow. PW: power; Ep: peak energy; RT: rise time; D: duration; Fp: peak frequency; BW: bandwidth; Fc: centroid frequency.

Table 5. Repeatability of cough sound measures during maximum voluntary cough

	ICC (2-way average)	P-value
Phase 1, P₁		
PW	0.93	<0.001
Ep	0.94	<0.001
Constant time 0.5s, P_{0.5}		
PW	0.93	<0.001
Ep	0.94	<0.001

Data presented as intraclass correlation coefficients (ICC). Sound recorded with free-field microphone. PW: power; Ep: peak energy.

Table 6. The impact of microphone position on cough sound power

	Cough sound power	P-value vs Centre
Centre	55.8 ± 4.3	-
Top	53.3 ± 5.3	0.004
Bottom	48.8 ± 5.6	<0.001
Left	54.0 ± 4.9	0.002
Right	53.1 ± 4.8	<0.001

Data presented as mean ± SD and paired t-test p-values. Data is for P₁ sound power (arbitrary units) recorded with free-field microphone. See online supplement Figure 1 for depiction of microphone positions.

Table 7. Individual correlation coefficients between cough sound and subjective cough strength visual analogue score

Sound parameter	Subject							
	1	2	3	4	5	6	7	8
PW	0.85*	0.67*	0.38	0.82*	0.99*	0.73*	0.89*	0.98*
Ep	0.70*	0.62	0.43	0.77*	0.98*	0.84*	0.88*	0.95*
RT	0.44	-0.09	0.12	0.78*	0.90*	-0.3	0.77*	0.14
D	0.78*	0.15	0.41	0.66*	0.36	0.12	0.81*	0.54
Fp	0.25	0.33	0.83*	0.32	0.76*	0.24	0.55*	-0.16
BW	-0.64*	0.31	0.22	-0.15	0.26	-0.03	0.31	-0.21
Fc	0.15	0.24	0.90*	0.18	0.65*	0.81*	0.89*	-0.56

Data presented as Spearman correlation coefficients between cough sound and cough strength visual analogue score (VAS) in eight patients with chronic cough. Sound recorded with free field microphone and measures derived from P₁ time window. *: p<0.05.