



# Specific airway resistance in preschool children: why not panting after all?

*To the Editor:*

Specific airway resistance ( $sRaw$ ) is measured with minimal cooperation in the preschool child during tidal breathing [1]. Methodological difficulties have been encountered in modern plethysmographs when the warming and humidification of the inspired gas [2] are replaced by numerical algorithms to eliminate the thermo hygrometric artefact [1, 3, 4]. Measuring  $sRaw$  during panting [5] had been dismissed in preschool children based on the assumption that the ventilatory manoeuvre would be difficult to perform and standardise. The feasibility of such an assumption, however, has not been verified. Therefore, the aim of this study was to assess the feasibility of measuring  $sRaw$  during panting in preschool children with asthma and compare the outcome with the tidal breathing method.

Preschool children with a doctor diagnosis of asthma were recruited from the paediatric pulmonology clinics (Hôpital d'enfants, Vandoeuvre-lès-Nancy, France). Written informed consent was obtained from the children and their parents. The protocol was approved by the ethics committee (Comité de Protection des Personnes EST III, CHU de Nancy, Nancy, France). The plethysmography equipment, which has been described elsewhere [6], is operated by software that includes an algorithm which should eliminate the thermo hygrometric artefact from the plethysmographic volume signal ( $\Delta V_{pleth}$ ), which may be activated during tidal breathing and disabled during panting. Acquisition consisted of a series of four breaths selected automatically by the software and displayed on the computer screen. Three acquisitions were collected for each condition. Measurements were selected to retain those showing no artefact and where breathing frequency was lower than 50 breaths·min<sup>-1</sup> during tidal breathing or higher than 60 breaths per·min<sup>-1</sup> during panting.  $sRaw$  was computed between points of maximum  $\Delta V_{pleth}$  ( $sR_{tot}$ ) and in the flow range  $\pm 0.5$  L·s<sup>-1</sup>  $sRaw_{0.5}$ . The overall flow interval within a given acquisition was measured graphically. Data were analysed with Pearson's Chi-squared test or analysis of variance as appropriate, and are expressed as mean $\pm$ SD.

A total of 127 preschool children (73 boys) aged 3.5–6.5 years took part in the protocol. Measurements were achieved during tidal breathing in 83 children ( $34\pm 7$  breaths·min<sup>-1</sup>; flow amplitude  $1.3\pm 0.3$  L·s<sup>-1</sup>) and during panting in 90 children ( $130\pm 36$  breaths·min<sup>-1</sup>; flow amplitude  $2.0\pm 0.6$  L·s<sup>-1</sup>;  $p<0.0001$  for both breathing frequency and flow amplitude). Feasibility of measurement during tidal breathing and panting was not significantly different overall (65 and 71% respectively;  $p=0.35$ ), nor within age categories (figure 1a;  $p>0.05$ ). There was no difference between boys and girls during tidal breathing (64 versus 67%;  $p=0.9$ ) or panting (71 versus 70%;  $p=0.9$ ). In those with successful measurements, the average number of validated breaths was  $8.9\pm 2.8$  during tidal breathing and  $9.6\pm 2.4$  during panting ( $p=0.089$ ). The percentage of valid breaths obtained did not differ between either breathing regimens (figure 1b) or sexes.

$sRaw_{0.5}$  and  $sR_{tot}$  were significantly smaller during panting ( $0.71\pm 0.2$  kPa·s·L<sup>-1</sup> and  $0.96\pm 0.3$  kPa·s·L<sup>-1</sup>) than the respective value during tidal breathing ( $1.14\pm 0.2$  kPa·s·L<sup>-1</sup> and  $1.33\pm 0.2$  kPa·s·L<sup>-1</sup>;  $p<0.0001$  for both  $sRaw_{0.5}$  and  $sR_{tot}$ ).  $sR_{tot}$  was also significantly larger than  $sRaw_{0.5}$  for both protocols ( $p<0.0001$ ). The intra-subject coefficient of variation was significantly larger during panting than during tidal breathing for both  $sRaw_{0.5}$  ( $13\pm 7\%$  versus  $8.5\pm 6\%$ ;  $p<0.0001$ ) and  $sR_{tot}$  ( $15\pm 9\%$  versus  $10\pm 7\%$ ;  $p=0.0001$ ) and significantly larger for  $sR_{tot}$  than  $sRaw_{0.5}$  during panting ( $p=0.02$ ).

The potential of  $sRaw$  in paediatric lung function testing was formerly demonstrated in studies where the thermal component in  $\Delta V_{pleth}$  was properly eliminated by warming and humidifying the respired gas [2]. Recent studies eventually showed important equipment-dependent variability [1, 3] when numerical algorithms were used to correct for the thermo hygrometric artefact. The lack of agreement on  $sRaw$  standardisation in lung function centres across the world was recently highlighted [7]. The finding that panting achieves a similar rate of successful measurements as tidal breathing suggests the interesting possibility of avoiding the methodological difficulties encountered with automated software that corrects for the thermo hygrometric component using algorithms only known to the manufacturers. With smaller tidal volumes and higher breathing frequencies, the thermo hygrometric component in  $\Delta V_{pleth}$  is minimised [8] and the  $\Delta V_{pleth}$ –flow relationship is studied within a time domain mostly unaffected by the dynamics of airways – gas thermo hygrometric exchanges [9].

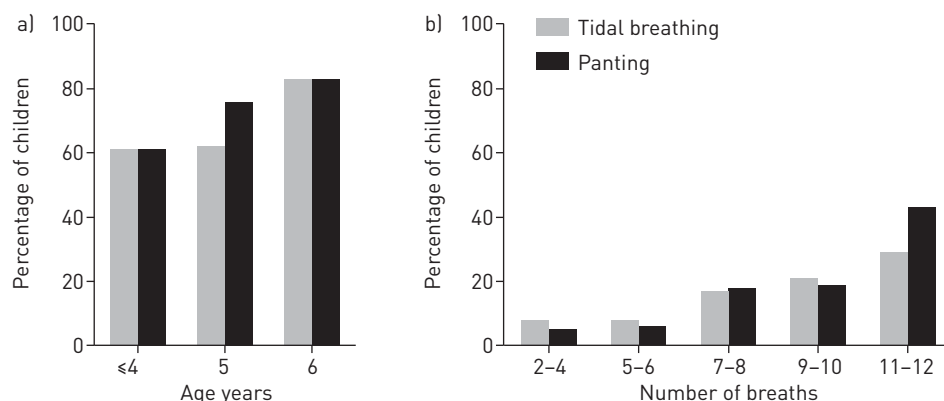


FIGURE 1 a) The success rate of specific airway resistance among age groups and b) the percentage of children achieving a given number of valid breaths are similar during tidal breathing and panting.

The current results raise the question of which estimate of  $sRaw$  would be optimal as a routine paediatric lung function end-point. Panting opens the glottis [10], but turbulent airstream has the opposite influence on the measurement outcome. When  $sRaw_{0.5}$  is examined, however, the second mechanism is minimised, and the glottic opening should be more fully expressed to decrease  $sRaw$ . In fact, similar to a previous report in older children [6], in the current study  $sRaw$  was consistently lower during panting than during tidal breathing, and the highly significant difference was observed with both  $sR_{tot}$  and  $sRaw_{0.5}$ . During tidal breathing,  $sRaw$  was also reported to be smaller in preschool children when the respired gas was conditioned to body temperature, ambient pressure, saturated with water vapour (BTPS) than when it was numerically corrected for the thermo hygrometric effect [11]. Taken together, these observations in preschool children indicate that either BTPS conditioning or panting, by adequately correcting for the thermo hygrometric artefact, lead to an estimate of  $sRaw$  being smaller than that achieved through software corrections applied during tidal breathing. However, the intra-subject variability in the current study was larger during panting than during tidal breathing, and whatever the mechanism, this might impede the ability of  $sRaw$  to detect airway obstruction and reversibility. The fact that  $sR_{tot}$  was significantly larger than the corresponding  $sRaw_{0.5}$  was expected because of the enhanced contribution of nonlinearities and increased slope of airway pressure – flow relationship. Since flow is turbulent mostly in proximal airways, the diagnostic value of  $sR_{tot}$  may be lower than for  $sRaw_{0.5}$ . Furthermore, the larger variability observed with  $sR_{tot}$  compared with  $sRaw_{0.5}$  was also expected, especially during panting, as the ventilatory effort is likely to vary from one breath to another, resulting in variable flow amplitude and contribution of nonlinearities throughout the acquisition. Hence, computation over a limited flow interval as reported in adults should be recommended [12], with the recent indication of better separation of children with asthma from controls based on  $sRaw_{0.5}$  [13]. However, it should be kept in mind that, in preschool children where  $\Delta V_{pleth}$  and flow signals are small, computation of  $sRaw$  within a limited flow range may compromise the signal-to-noise ratio. The fixed flow interval  $\pm 0.5 \text{ L}\cdot\text{s}^{-1}$  is also likely to provide age-dependent estimates of  $sRaw$  with more significant nonlinearities in shorter than taller children. An important step towards standardisation would be to define the optimal flow range to estimate  $sRaw$  and the optimal breathing frequency interval for measuring with minimal variability.

In summary, valid measurements of  $sRaw$  may be obtained during panting in preschool children. Since  $\Delta V_{pleth}$  requires no correction, the test should be more readily applicable to any equipment, which is particularly helpful in the context of international collaborative studies. Compared with tidal breathing, however, the technique achieves lower  $sRaw$  and larger intra-subject variability. Further case-control studies, including other lung function outcomes such as spirometry, are required to establish normative data and assess which estimate of  $sRaw$  is the most useful for routine paediatric lung function studies.



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**Specific airway resistance may be measured in preschool children during routine lung function**

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