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Correlation of Peak Expiratory Flow Rate with Single Breath Count and One Minute Count in Primary School Children

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Abstract

Introduction: Correlation of Single breath count (SBC) with Peak expiratory flow rate (PEFR) in pediatric age group is not a widely studied topic. SBC can be a reliable potential alternative to PEFR, the latter being effort dependent and thus difficult to measure in the said age group. One minute count (OMC) is a new concept that has been used in the study at our institute. OMC is the maximum number count in 1 minute by the subject and it can be an effective alternative in children who can't count rapidly and efficiently in a single breath.

Aims and objectives: To study correlation of Peak expiratory flow rate (PEFR) with Single breath count (SBC) and One minute count (OMC) in healthy asymptomatic children of third and fourth standards from a school in Mumbai.

Materials and Method: PEFR readings were obtained using a Peak flowmeter, while SBC and OMC were done manually. Subjects were first given a demonstration using a Peak flow meter and the readings were then recorded by trained personnel. For SBC and OMC readings, the subjects were shown a video demonstrating the procedure and then readings were taken. Best of 3 readings was considered for all 3 parameters. Correlation of PEFR with SBC and OMC was done with help of Pearson's correlation coefficient. Linear regression analysis of the data was also done.

Results: Mean age of the study group was 8 years. Mean height was 1.18 meters. Boys were 50.9 of the total. SBC was easy to perform. By Pearson's correlation, all 3 parameters were strongly correlated, with p – value at 0.01. On linear regression, all 3 tests had co-linear outcome. They are comparable. The drawback of the study was, it was subject dependent; depending on how rapidly and efficiently the child can count. A video demonstration of the proper procedure helped us overcome the problem.

Conclusion: SBC can be an equally effective screening tool for pediatric respiratory functions in healthy children; as reliable as Peak flowmetry. OMC can be an effective alternative in cases where SBC can't be performed. Further studies in asthmatic children are warranted to learn its implications in disease state.

Keywords: PEFR; SBC; One minute count; Asthma manuscript.

Introduction

Childhood asthma is a global morbidity with rising prevalence in India.[1] Diagnosis of childhood asthma is primarily empirical and purely clinical as there aren't any foolproof tests to diagnose asthma in children.[2] Pulmonary function tests like spirometry and plethysmography are usually helpful in assessing the adult lung function; and in some children who are able to coordinate for the test.

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The need of a machine for PFT (Pulmonary function tests) and device (Peak flowmeter) for PEFR (Peak expiratory flow rate) and the much needed breath coordination for performing these tests adds to the difficulty in performing the test and makes it less feasible in children. Eventually no such tests are done or are possible to perform and interpret at peripheral hospital.

There is a clear need of easy to perform test or at least a screening test for assessment of pulmonary function in children.[3] Keeping the same in mind single breath test was devised.[4,5] There is infrequent research done with the test showing a potential possibility of it emerging as a tool for screening and assessment of pulmonary function in adults and children.[4,5]

If such a clinical device free tool gets available; it will be possible to make an objective partial assessment of pulmonary function which may help one diagnose airway dysfunctions. FEV_1 (Forced expiratory volume in 1 second) and Peak expiratory flow rate (PEFR) are considered equivalent markers of airway dysfunction.[6] This study aims to correlate the SBC (Single breath counting) and OMC (One minute count) with PEFR in healthy asymptomatic primary school children. There are a number of ways of assessing pulmonary function at bedside like cough test, wheeze test, maximum laryngeal height, Debono's Whistle test, Snider's match blowing test, watch and stethoscope test, Single breath count and Sarfarez breath holding test.[6]

Materials and Methods

A respiratory health camp was conducted in a primary school in Mumbai. During the health camp, medical history along with weight, height, school absenteeism was noted. Children were taught breathing exercises in the form of single breath count SBC and one-minute count OMC. The exercises were taught by pediatrician with video clips and face-to-face demonstration. The PEFR was performed for all the kids enrolled in camp. The records were maintained at the school.

Institutional ethics committee permission was asked to access the data for retrospective analysis. Accordingly, permission from school principal, camp coordinator and class teachers was obtained on conditions of anonymity and confidentiality. After permission from institutional ethics committee, the data was fed into excel sheet and details were statistically analyzed.

The study team had no direct contact with the students or parents; accordingly consent waiver was approved by the ethics committee. The tests were not performed by the study team. A communication with camp coordinator revealed the details of the tests performed in the form of training by video demonstration and collection of data as best of three in all these children.

Definitions

SBC: Single breath count (SBC) is the measurement of how far an individual can count in normal speaking voice after a maximal effort inhalation. The subjects were shown a video demonstrating the procedure and then the readings were taken manually. Best of three readings was considered.

OMC: One minute count (OMC) is a new concept that has been used in the study at our institute. OMC is the maximum number count in one minute by the subject and it can be an effective alternative in children who can't count rapidly and effectively in a single breath. The subjects were shown a video demonstrating the procedure and then the readings were taken manually. Best of three readings was considered. It is a new concept; launched as an alternative to SBC.

PEFR: Peak expiratory flow rate (PEFR) is the maximum flow rate generated during a forceful exhalation starting from full lung inflation. It primarily reflects large airway flow and also depends on the voluntary effort and muscular strength of the patient. PEFR readings were obtained using a Peak FlowMeter. Subjects were first given a demonstration using a Peak FlowMeter and the readings were then recorded by trained personnel. Best of three readings was considered.

Results

There were 145 students in total; from standard III and IV. Data was available for only 113 students. For one child it was reported that SBC and OMC testing was not possible due to inability of the child to do basic numerical counting. The rest 31 students were excluded from the study either on the basis of unavailability of complete data reports or on the basis of history of asthma or any other chronic obstructive pulmonary disease (COPD).

For 113 children (n = 113) complete data about SBC, OMC and PEFR was available.

Mean age of children was eight years; median age of children was eight years. Youngest child

who had performed all the three tests was seven -year old. Mean height of children was 1.18 meters. Mean weight of children was 21.41 kg. Four children were having past history of recurrent respiratory symptoms or asthma.

Mean SBC was 29.20. Median SBC was 28. Least SBC recorded was 15, maximum SBC was 47. Mean OMC was 112.49, median OMC was 110, least OMC was 65, maximum OMC was 175. Mean PEFR was 174.84 l/min, Median PEFR was 170 l/min, Least PEFR was 70 l/min, Maximum PEFR was 260 l/min.

By Pearson correlation; all three [PEFR, SBC, OMC] were strongly correlating with p – value at 0.01.

Table 1: Demographic distribution of cases

Age	Demographic distribution of cases as per age and sex				
	7 years old	8 years old	9 years old	10 years old	Total
Number of boys	14	25	16	2	57
Number of girls	15	22	19	0	56
				Total	113

As seen in Table 1, out of a total of 113 students in the range of 7 to 10 years old 57 were males and 56 were females; i.e., 49.55% were females and 50.44% were males. Mean age of study population was 8 years and mean height of the study population was 1.18 meters.

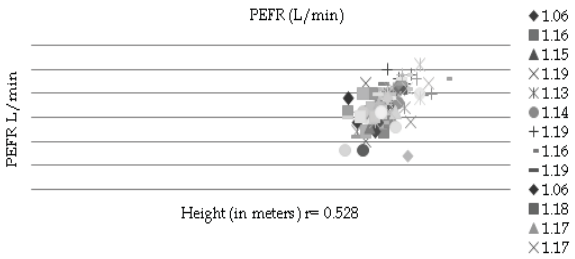

Fig. 1: Distribution of PEFR across height in meters.

Figure 1 shows distribution of PEFR across height in meters. For a height range of 1 to 1.4 meters; PEFR ranged within the values of 50 L/min to 300 L/min. PEFR values were shown to correlate with the height with (r = 0.528), the correlation being significant at p – value of 0.01.

Figure 2 shows distribution of single breath count across height in meters. For a height range of 1 to 1.5 meters; SBC ranged within the values of 15 to 50.

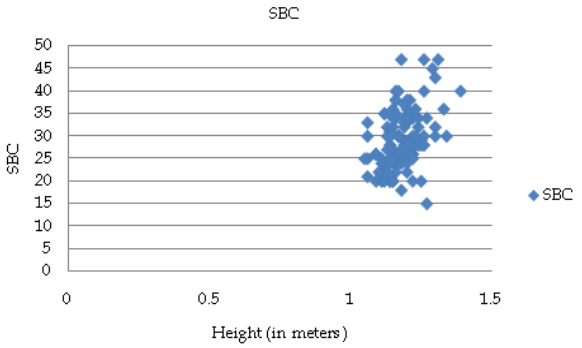

Fig. 2: Distribution of SBC across height.

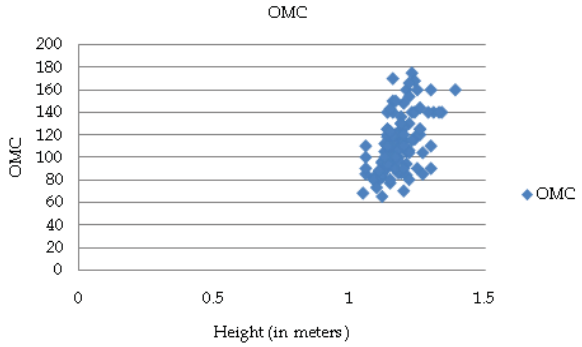

Fig. 3: Distribution of OMC across height.

In Fig. 3, distribution of one minute count is plotted across height in meters. For a height range of 1 to 1.5 meters; the OMC ranged within the values of 60 to 180.

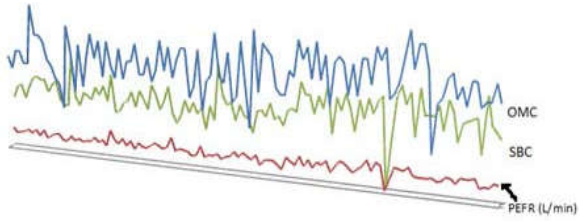

Fig. 4: Distribution of PEFR across SBC and OMC.

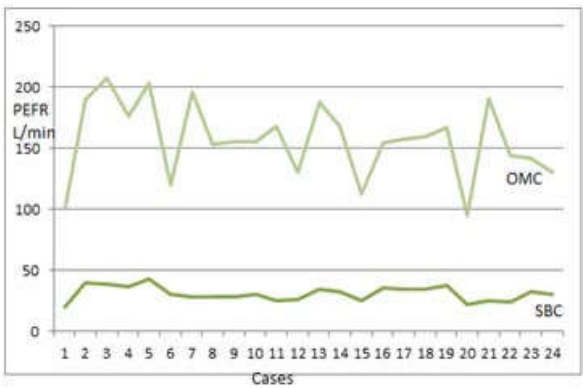

Fig. 5: Distribution of SBC across OMC.

Both SBC and OMC show a linear correlation with PEFR with '*r*' values at 0.503 and 0.525 respectively; with correlation being significant at a *p* – value of 0.01, as seen in Figure 4.

Independent of PEFR and height; in Fig. 5; SBC and OMC were also found to correlate with each other with '*r*' value at 0.488; with correlation being significant at *p* – value of 0.01.

On linear regression, all three tests had colinear outcome. They are comparable.

Bedside tests for assessment of lung function will be a great boon for respiratory practice; if a correlation is established between the bedside test and pulmonary function test.[6]

Bedside tests can be utilized as easy screening test for evaluation and diagnosis of pediatric airway diseases like asthma.[4]

In our study, amongst 145 students, 32 students were excluded from the study; out of which only one was excluded because of inability to perform SBC and OMC testing. That means most students could understand and perform the test as explained.

No other child had any difficulty in understanding and performing breath holding test, one minute rapid counting test and peak expiratory flow rate testing by peak flowmeter; despite these tests requiring some cooperation from children. Same was observed by Bartfiled et al.[4]

This study had shown a satisfactory linear correlation between 1. PEFR and SBC; 2. PEFR and OMC; 3. SBC and OMC; with respective *r* values as 0.503, 0.525 and 0.488.

Median SBC, Median OMC and Median PEFR for age group 7–10 years for Indian urban public school children were 28, 110 and 170 L/min respectively. A further multicentric study involving large number and diverse age and height groups is required to derive normal values for respective ages and standard deviations.

First study regarding efficacy of SBC to FEV_1, PEFR to FEV_1 and SBC to PEFR was published in 1994. Bartfield et al. had studied in 25 consenting adults to conclude that SBC may be an alternative to PEFR or PFT. Our study had significant correlation of SBC and OMC with PEFR; however FEV_1 was not part of our study.[4]

SBC had been used by various researchers as a random marker of respiratory dysfunction; in botulism poisoning epidemic for triage, as a screening for respiratory decompensation in myasthenia gravis and as a screening test for segregating adult COPD patients to plan therapeutic singing to improve outcomes.[7-9] SBC is routinely used to predict respiratory failure in Guillain-Barré syndrome.[10]

First pediatric study (*n* = 67, age 5–18 years) to assess SBC to PEFR, FEV_1, FVC, FEF 25%–75% and FEV_1/FVC ratio was published in 2011 by Ali SS et al. They concluded satisfactory correlation, predicting SBC as a potential tool to grade asthma severity in children in emergency department.[5]

In 2017, Palaniyandi et al. from Chennai; published a study that was conducted in 2010; in 200 patients of chronic airway diseases. The team found good correlation between SBC, BHT (Breath holding test) and PFT.[6]

Our study is first of its kind; as a new concept of one minute count was introduced. OMC is a count which is routinely being used at our center for children who take breaks while doing SBC. In this study, OMC emerged as equivalent test as an alternative to SBC. For all technical issues, SBC refers to PEFR or FEV_1 and OMC refers to minute volume equivalent. Further studies are needed to see how OMC can be a better alternative to SBC as the coordination for holding of breath is not needed.

Large sample size studies are needed to develop normal ranges of SBC and OMC to see its implication in diagnosing and classifying of asthma severity, at respective height groups and weight groups. Also these tests cannot be extrapolated to children below 7 years as they cannot count. A large multicentric prospective study with PFT needs to be planned to extrapolate results.

Despite drawbacks, SBC and OMC prove an effective bedside alternative for assessment of pulmonary function in children 7–10 years.

A study in children suffering from chronic respiratory diseases, like asthma, may also be planned to understand implications of these tests in diseased children.

Conclusion

In resource poor settings where standard pulmonary function tests are not easy to perform and in pediatric age groups where cooperation for performing PFT is not easy; this study launches a novel concept OMC [one minute count]. SBC can be an equally effective screening tool for pediatric respiratory functions in healthy children; as reliable as Peak flowmetry. OMC can be an effective alternative in cases where SBC can't be performed. Further studies in asthmatic children are warranted to learn its implications in disease state.

As a bedside tool and also as a home-based monitoring tool; it is expected that OMC and SBC can be potentially promising in predicting respiratory reserve and dysfunction.

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