Clinical Article

Peak Expiratory Flow at Sea Level

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Abstract

There are no predicted values for peak expiratory flow (PEF) for Latin-American children using TruZone® flow meter, only from the Assess® flow meter. The objective of this study was to obtain predicted values for TruZone® and compare them with those from Assess®. Material and methods were used in 1,398 healthy students (height: 110 to 175 centimeters, ages from 6 to 15 years) using TruZone® and a linear carried out the results, which were then compared to those of Assess®. Population consisted of; 732 male (52.36%) R2 = 0.946, and 666 female (47.63%) R2 = 0.948, average age 10.5 years. The linear regression allows the calculation of male 6.87 x height in centimeters – 615.21 = PEF (L/min), Female: 6.66 x height in centimeters – 602.68 = PEF (L/min). PEF is different for each sex, with higher figures for males using both flow meters. The difference in PEF values is probably due to the shape of each flow meter and their mouthpiece. In conclusion, the figures of TruZone® are lower in males from 110 to 145 centimeters and in females of 110 to 160 centimeters and subsequently are greater in males of 150 to 175 centimeters, and in females from 165 to 175 centimeters when compared with the values obtained using figures of Assess®. We recommend use of normal values specific to each flow meter, to avoid errors. *Int Pediatr. 2001;16(2):89-93.*

Key words: peak expiratory flow (PEF), breathing

Introduction

The Respirometry, the objective measurement of bronchopulmonary function, has become the basic physiological evaluation for the diagnosis, follow-up and evaluation of treatment of patients with respiratory illness.[1] Ever since the 1940s peak expiratory flow (PEF), and the forced expiratory volume in the first second (FEV1) have been used to evaluate the degree of airway obstruction.[2] In PEF the shape of the vertex has given rise to the Anglo-Saxon term Peak Flow or Peak expiratory flow; thus the English abbreviation.[3] At the end of 1994, guidelines were issued regarding the use of the peak flow meter in outpatient treatment of bronchial obstruction.[4] In spite of the fact that for over 15 years peak flow meters have been available for the measurement of PEF.

Only recently have doctors begun to show interest in following the evolution of asthma, or chronic respiratory problems using this modality.[2,5,6] However, the use of PEF at home has not been routinely incorporated into treatment regimens for asthmatics,[7] in spite of the emphasis placed on this technique, and the success achieved in anticipating acute episodes.[8,9] PEF enables us to a) have cognizance of the intensity of the crisis, and make therapeutic decisions; b) monitor the response to a therapy during an exacerbation; c) evaluate the response to chronic treatment; d) diagnose asthma induced by exercise; and e) detect asymptomatic deterioration of the lung function.[13,14]

In practice, we are seriously behind in knowledge of PEF. The few physicians and patients who use a flow meter frequently based their interpretation on the reference or normal values proposed by Polgar[10] almost 30 years ago which in children and adolescents are, the same for males and females. More recently, in 1981, Knudson[11] proposed for children and adolescents, different PEF values for males and females, based on age, sex and size there are distributed with the TruZone® peak flow meter (Fig 1).

Last year, a study of PEF in a Mexican population at sea level was published,[12] emphasizing the following: different figures according to sex; (higher for males) and, formulas for prediction or calculation of PEF with the Assess® peak flow meter (Fig 2). It is important to know whether a difference in PEF values exists between flow meters, as Assess® and TruZone® have different shapes and mouthpieces. Such differences could lead to interpretation errors, depending upon the flow meter used.

Material and Methods

In 22 Primary and Secondary Schools of the Veracruz Municipality, a prospective, observational, and comparative study was carried out on both sexes, from October 1 to November 15, 1997. The development of the study was divided in four phases:

Training of the Support Group. With the help of the Center of Technological Studies on Health Science, 45 students volunteers were taught the correct way to measure PEF with the TruZone® (Fig 1), and how to measure weight, and height (barefooted, with a stadiometer).

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Children and teenagers 6 to 25 years old: Male

Height in.		44	48	52	56	60	64	68	72	76
Height cm.		112	122	132	142	152	163	173	183	193
Age	6	99	146	194	241	289	336	384	431	479
	8	119	166	214	261	309	356	404	451	499
	10	139	186	234	281	329	376	424	471	519
	12	159	206	254	301	349	396	444	491	539
	14	178	226	274	321	369	416	464	511	559
	16	198	246	293	341	389	436	484	531	579
	18	218	266	313	361	408	456	503	551	599
	20	238	286	333	381	428	476	523	571	618
	22	258	306	353	401	448	496	543	591	638
	24	278	326	373	421	468	516	563	611	658
	25	288	336	383	431	478	526	573	621	668

Children and teenagers 6 to 20 years old: Female

Height in.		42	46	50	54	57	60	64	68	72
Height cm.		107	117	127	137	145	152	163	173	183
Age	6	134	164	193	223	245	268	297	327	357
	8	153	182	212	242	264	287	316	346	376
	10	171	201	231	261	283	305	335	365	395
	12	190	220	280	280	302	324	354	384	414
	14	209	239	269	298	321	343	373	403	432
	16	228	258	288	317	340	362	392	421	451
	18	247	277	306	336	358	381	411	440	470
	20	266	295	325	355	377	400	429	459	

Fig 1. - TruZone® and PEF figures commercially recommended by distributor.[11]

Females and Males Children and Teenagers

Height cm.	PEF	Height cm.	PEF
110	147	139	307
111	160	142	320
114	173	144	334
116	187	147	347
120	200	149	360
122	214	152	373
124	227	154	387
127	240	157	400
130	254	160	413
132	267	162	427
134	280	165	440
136	293	168	454

Fig 2. - Assess® flow meter and Peak Expiratory Flow (PEF) figures commercially recommended by manufacturer.[10]

Compiling and Application of Questionnaires. Investigators, teachers, parents or tutors administered a questionnaire that required the following information: complete name; date of birth; age (years); asthma diagnosed by a physician and/or institution; asymptomatic (without crisis or difficulty in breathing) at the moment of the study, with a report of at least one crisis in the last year. Evaluation for respiratory infection was carried out by the investigator, as well as measurement of weight and height. Heights and weights were evaluated according to the standards of Ramos-Galván.[15]

Measurement of the Peak Expiratory Flow (PEF). With the Tru-Zone® under standard conditions, without having done exercise for at least 30 minutes before the test, without having ingested hot drinks or stimulants, standing up, and after instruction in appropriate technique PEF was measured 5 times for each child. This repetition led to familiarity, and decreased errors due to lack of experience.

Information Processing and Statistical Analysis. Data was recorded in a spreadsheet. The *HEALTHY* students were segregated by sex and stature. Healthy students were defined by absence of acute or chronic respiratory infection, not being asthmatic, and having normal height and weight for sex and age according to the Mexican standards of Ramos-Galván.[15] The highest PEF reading of the five was taken, classifying, maximums, minimums and medians. Statistical tools were used for large samples. The male and female difference was calculated according to the median figures, and a Z and Fischer Test was drawn. Finally the regression line was corrected adjusting with the median square figures. The results were then compared with those of the Assess® flow meter and those reported by Polgar,[10] Knudson,[11] and Lara-Pérez.[12]

Results

From a total of 6,335 students interviewed, 1,398 (22.06%) met the criteria for being healthy; 666 (47.6%) females with a mean age of 10.5 years (range 6-15, standard deviation 6.36); and 732 (52.3%) males with a mean (range 6-15, standard deviation 6.36) for demonstrated great dispersion in both sexes. Nevertheless, the mean figures were male 365.07 l/min., female 346.48 l/min. (Z= 0.8416), with confidence level of 80%, that PEF is higher in males.

In the variance comparison: Fischer's figure of 1.266 indicates that males and females can be compared with a 90% confidence level. The linear regression line showed: females B1= 6.66 B0= - 602.68; males B1 = 6.87 con B0 = - 615.21. From those figures the following formulas were developed: for males 6.87 x Height (cm.) – 615.21 = PEF (L/min), in liters per minute; female: 6.66 x Height (cm.) – 602.68 = PEF (L/min). With these formulas, it is possible to calculate the PEF of the both sexes with heights 110 cm. to 175 cm. (Table 1).

The measurements of the correlation between height and PEF were: female R2 = 0.948 and male R2 = 0.946. For regression standard errors, the following was calculated: Standard Error= SSE/(n-2), were SSE is the sum of the square errors and n = number of observations in this study; female 27.98, male 28.17.

There is no way to compare the references of Polgar,[10] as they are unisex, but they predict lower PEF in any of the categories, when compared to values derived from the Knudson[11] table. The heights for each sex would have to be taken and compared with the flow figures, and those found in this study, which are again below the figures for both sexes. Upon comparison to the values of Lara-Pérez[12] with the Assess,® to those from the present study using TruZone® (methodologically identical, both at sea level and with a healthy population) the difference of mean figures gives us "R" values in both sexes, which mean that both studies lead in the same direction and tendency (Table 2).

However, the difference in the formulas is the result if the strength measured in liters per minute, when the resistance of each flow meter mouthpiece or shape is overcome, giving lower figures in TruZone® as compared to Assess® , in both sexes in low height, until crossing later and finishing with higher figures for TruZone® in both sexes (Table 2).

Table 1. - PEF in healthy students at sea level

Flow Meter: TruZone®
Male 6.87 x Height cm. – 615.21
Female 6.66 x Height cm. – 602.68

Height	PEF 1/min.	Height	PEF 1/min.
110	140	110	130
115	174	115	163
120	209	120	196
125	243	125	229
130	277	130	263
135	312	135	296
140	346	140	329
145	383	145	363
150	415	150	396
155	449	155	429
160	483	160	462
165	518	165	496
170	552	170	529
175	587	175	562

n: 1,398

In both sexes ages 6 to 15 years and heights from 110 to 175 cm.

Discussion

Implementing early detection of exacerbations of asthma by means of an objective measurement can provide a solution to these problems and stimulate the development of self-management and self-control techniques.[16] The lack of perception of the degree of pulmonary obstruction is an important cause for delay in treatment initiation.[17,18] This is supported by recent reports of the failure of parents and physicians[19,20] to recognize the severity of an episode, resulting of the deaths of some children before arriving at the hospital specially children with difficult to control asthma.

It has been reported that 71% of asthmatic children show prodromal symptoms from six to eight hours before crisis.[21] Early recognition can be fostered using PEF in a traffic light system as proposed by Mendoza: green zone 80% of expiratory flow or more; yellow zone from 50 a 80%; red zone less than 50% of the expiratory flow.[22] It has also been observed that to predict crisis, it is necessary to monitor PEF for several weeks.[23]

A relapse is suspected when values fall below 30% of the asymptomatic flow or no crisis.[24,25] Having expiratory flow figures in healthy or normal children, is a tool for the pulmonary evaluation of a child with a chronic asthmatic ailment, both in crisis and between crisis, where in spite of having being asymptomatic respiratory process, has a lower expiratory flow than that expected in a healthy child.

The present study is not methodologically comparable to those of Polgar[10] and Knudson.[11] However, the population studied by Lara-Pérez[12] can be compared with this study, since both were comprised of individuals studied under identical circumstances the two populations show similar figures in tendency and direction. This indicates that studying a healthy population at sea level, we must expect higher expiratory flow figures. Possibly the difference in figures and flow meter formulas (Assess® and TruZone®), is due to the shape and mouthpiece of each flow meter, so it would then be necessary to use figures or formulas of each flow meter to avoid errors in interpretation (Table 2).

Table 2 - PEF values in healthy students at sea level

Both sexes with Assess® and TruZone®.[12]

Calculation formulas: PEF

ASSESS® Flow meter		TruZone® Flow meter	
Sex	Formula	Sex	Formula
Male	6.10 x height in cm. – 500.71	Male	6.87 x height in cm. – 615.21
Female	6.17 x height in cm. – 523.19	Female	6.66 x height in cm. – 602.68

Male			Female		
Height in cm.	ASSESS	TruZone	Height in cm.	ASSESS	TruZone
110	170	140	110	155	130
115	200	174	115	186	163
120	231	209	120	217	196
125	261	243	125	248	229
130	292	277	130	278	263
135	322	312	135	309	296
140	353	346	140	340	329
145	383	380	145	371	363
150	414	415	150	402	396
155	444	449	155	433	429
160	475	483	160	464	462
165	505	518	165	494	496
170	536	552	170	525	529
175	566	587	175	556	562

n: 1,398

Conclusions

The values PEF found in this study are higher than those reported by Polgar[10] and Knudson.[11] Also, the values of PEF in this study have the same tendency and direction as those reported by Lara-Pérez,[12] with lower figures in males and females at lower heights and higher at greater heights in both sexes. With both flow meters, there is a difference in the PEF depending on the sex, with higher values in males. It is simple to use the formulas or tables of PEF values, for each flow meter, and thus avoid interpretation errors.

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