

Comparison between PEF values obtained from a population sample in the city of São Carlos, Brazil, and reference values*

Comparação de valores de PFE em uma amostra da população da cidade de São Carlos, São Paulo, com valores de referência

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Abstract

Objective: To compare the reference values for PEF suggested by other authors in 1963, 1989 and 2001 (for populations in the USA, England and Cuba, respectively) with those obtained from a population sample in the city of São Carlos, Brazil, and to determine whether there is concordance among them. **Methods:** A total of 243 volunteers (123 females and 120 males; 20-70 years of age) participated in the study. The PEF measurements were performed with the volunteer standing, using a nose clip, by means of a portable peak flow meter. These measurements were compared with the reference values using the Friedman test and Dunn's post-hoc test ($p < 0.05$). **Results:** Significant differences were found in all age groups from both genders regarding the values predicted in 1989; the same occurred in the 20-30 and 31-40 age groups (both genders), as well as in the 61-70 age group (females only), regarding those predicted in 2001, as well as in the 20-30 age group (males only) regarding those predicted in 1963. **Conclusions:** The values predicted in 1963 are appropriate for a population of individuals with the same characteristics as the study sample, except for males in the 20-30 age group. Our study is relevant due to the fact that our sample was larger than that evaluated in the 1963 study. The majority of the values predicted in 1989 and 2001 overestimated the PEF values obtained in our study, proving to be inappropriate for the population studied.

Keywords: Reference values; Respiratory function tests; Airway obstruction; Peak expiratory flow rate.

Resumo

Objetivo: Comparar os valores de referência para PFE sugeridos por outros autores em 1963, 1989 e 2001 (para populações nos EUA, na Inglaterra e em Cuba, respectivamente) com os valores de PFE coletados de uma amostra da população da cidade de São Carlos (SP), verificando se há concordância entre estes. **Métodos:** Participaram do estudo 243 indivíduos (123 mulheres; 120 homens) na faixa etária entre 20 e 70 anos. A coleta de PFE foi realizada com o indivíduo em pé, utilizando um clipe nasal, através de medidor de PFE portátil. Os valores obtidos foram comparados com os previstos, utilizando-se o teste de Friedman e post hoc de Dunn ($p < 0,05$). **Resultados:** Observou-se diferença significativa para todas as faixas etárias, em ambos os sexos, quanto aos valores previstos em 1989; o mesmo ocorreu para as faixas etárias 20-30, 31-40 anos, em ambos os sexos, e 61-70 anos para mulheres quanto aos valores de 2001, assim como para a faixa etária 20-30 anos para homens quanto aos valores previstos em 1963. **Conclusões:** Os valores previstos em 1963 são aceitáveis para uma população de indivíduos com as mesmas características da amostra estudada, exceto para os homens de 20-30 anos. Nosso estudo provou ter grande relevância devido ao tamanho da amostra estudada quando comparado ao do trabalho realizado em 1963. A maioria dos valores previstos em 1989 e 2001 superestimou os valores de PFE obtidos nesse estudo, indicando sua inadequação para a população estudada.

Descritores: Valores de referência; Testes de função respiratória; Obstrução das vias respiratórias; Pico do fluxo expiratório.

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Introduction

One measurement of pulmonary function is PEF, which can be defined as the greatest flow obtained in a forced exhalation starting from a complete inhalation to total lung capacity.^(1,2) Measurements of PEF can be obtained using a spirometer (in L/s) or a portable manual system (in L/min). The latter is a simple, reliable and inexpensive instrument, as well as being easily transported, handled and understood.^(1,3-5)

In hospitals and outpatient clinics, and even in the home, PEF measurement has been increasingly gaining space. It plays an important role in the diagnosis and quantification of the intensity of involvement of ventilatory disorders, as well as in monitoring and controlling diseases, principally asthma, in the adult and pediatric populations.^(3,5,6)

The recommendations for monitoring asthma are based on the following advantages: detection of increase of airflow obstruction, allowing early treatment; assistance in the correction of treatment; providing feedback to the patient on the status of the airways; identification of environmental triggering factors; and evaluation of response to treatment. However, due to the fact that it is an isolated test of pulmonary function, the validity and reliability of PEF measurement depend on the use of the correct technique and the production of a maximal effort. Patients have difficulty in maintaining compliance to the regular long-term follow-up due to the inconvenience of the repeated performance of the measurement, lack of motivation or lack of a useful plan of self-management based on the PEF.⁽⁷⁾

One of the forms of evaluating PEF is the comparison of PEF values of the individuals with reference values. Population studies have been carried out with this objective. In 1963, Leiner et al. proposed two predictive equations of PEF values for the population of the USA, one for males and another for females, both based on age and height.⁽⁸⁾ In order to establish these equations, PEF was determined in 155 healthy individuals (105 males and 50 females) aged between 15 and 69 years using a portable Wright® PEF meter (Clement Clarke International Ltd., Harlow, United Kingdom). Using the same PEF meter, Gregg and Nunn^(9,10) published studies in England proposing, as in the aforementioned study,⁽⁸⁾ two equations, one for each gender, also

based on height and age. To that end, PEF was measured in 453 healthy individuals (225 males and 228 females), ranging from 15 to 85 years of age.

Between and after these studies, various studies were published showing that PEF correlates strongly with gender, height and age.^(3,4,6,11) In addition, these studies show that the PEF also varies according to ethnicity,^(6,12) being carried out in locales where the populations are ethnically different than those evaluated in the aforementioned studies. In 2001, Cabrera et al.⁽⁶⁾ published a study in which PEF reference values were determined for the population of the city of Ranchuelo, Cuba. The authors concluded that the PEF reference values for this population were lower than those proposed in the 1973 study.⁽⁹⁾ Cabrera et al.⁽⁶⁾ measured the PEF of 481 healthy individuals (245 females and 236 males) with the Mini-Wright® PEF meter.

Due to the differences that the PEF as well as other pulmonary volumes and flows can present, the American Thoracic Society (ATS),⁽¹³⁾ in a norm review published in 1991, recommended that equations adapted to the particularities of each population group be chosen.

In Brazil, according to the databases surveyed (Medline and LILACS), three studies have been carried out aiming to establish equations for the determination of PEF reference values using portable PEF meters.^(3,4,11) However, those studies encompassed population samples from regions with particular social and cultural characteristics, as well as specific age brackets. One such study, carried out in the city of Rio Claro, Brazil, involved 456 healthy individuals (235 males and 221 females), ranging from 14 to 18 years of age.⁽¹¹⁾ Two equations were proposed, one based on weight and the other based on height. In that study, in which a Wright® PEF meter was used, height correlated with PEF better than did weight. With the same objective, other authors,⁽³⁾ using a Mini-Wright® PEF meter, obtained the PEF of 1,037 students (445 males and 592 females) in the city of Porto Alegre, Brazil, ranging from 10 to 18 years of age, and two equations were proposed: one for each gender and both based on age and height. The third study was carried out in Pelotas, Brazil.⁽⁴⁾ That study comprised 410 healthy individuals (70 males and 340 females) ranging from 40 to 80 years of age. A Mini-Wright® PEF meter was used.

Although some authors^(14,15) have proposed spirometric reference values for the Brazilian population, including PEF values, another study has shown that, despite presenting a strong correlation, there are differences between spirometric PEF values and those obtained with the portable meter.⁽¹⁶⁾ In one of the previously cited studies,⁽⁴⁾ two comparative figures (one for males, the other for females) of the PEF reference values established by the equations of the study were presented and compared with those of two other studies.^(10,14) Height was chosen for that comparison, and the figures indicated that PEF varies according to age. The figures showed that the PEF reference values for the population in question were higher than those proposed in one of the two studies⁽¹⁴⁾ and lower than those suggested in the other.⁽¹⁰⁾

Therefore, studies comparing the PEF reference values routinely used by health professionals with the PEF values obtained in a specific population are important for the assessment of the appropriateness of the reference values. According to the databases consulted (Medline and LILACS), there have been no studies comparing different PEF reference values measured using portable equipment with values obtained, also with a portable PEF meter, in a Brazilian sample.

Therefore, the objective of the present study was to compare the PEF reference values suggested in the 2001,⁽⁶⁾ 1989⁽¹⁰⁾ and 1963⁽⁸⁾ studies with PEF values obtained from a population sample in the city of São Carlos, Brazil, in order to determine whether the reference values from those studies are consistent with those of the studied sample.

Methods

Individuals resident in the city of São Carlos, Brazil, were included in the study. We obtained PEF values from 243 individuals, 123 females and 120 males, ranging from 20 to 70 years of age. The individuals met the following inclusion criteria: being neither smokers nor former smokers; presenting no neurological or respiratory diseases, nor temporomandibular joint dysfunctions which would affect the PEF values; being sedentary; and satisfactorily performing the maneuvers used in order to obtain the PEF values. All individuals who had not engaged in physical activity for a period of 6 months prior to

the study, exercised for less than 30 min per day or less than three times per week were considered sedentary, since the literature reports this to be the minimal physical activity necessary to promote beneficial alterations to the body.^(17,19)

This study was approved by the Ethics in Human Research Committee of the institution, according to the Brazilian National Health Council Resolution 196/96, ruling no 012/2007. Prior to the collection of the PEF values, all participants gave written informed consent. Subsequently, they were submitted to anamnesis and a physical examination in which data such as weight, height, presence of diseases and habits such as smoking were collected.

We used six new Assess[®] meters (HealthScan, Cedar Grove, NJ, USA), duly calibrated by the manufacturer. According to some authors,⁽²⁰⁾ the Assess[®] meter is more precise than is the Mini-Wright[®] in measuring PEF values, even after 200 measurements. In order to obtain the PEF values, the individual was asked to perform three forced exhalations starting at total lung capacity, in the orthostatic position, using a nose clip. Three attempts were made. If the two highest PEF values presented a difference of greater than 40 L/min, the volunteer was asked to make two additional attempts.⁽²⁾ However, if the two new measurements also presented a difference of the same magnitude, the individual was evaluated again on another day. During measurements, the volunteers received verbal encouragement and

Table 1 - Demographic and anthropometric characteristics of the individuals, divided by gender and age bracket.

Age bracket (years) by gender	n	Weight ^a (kg)	Height ^a (cm)
Male			
20-30	35	73.8 ± 11.6	177 ± 0.1
31-40	35	74.1 ± 11.1	171 ± 0.1
41-50	27	78.4 ± 12.5	173 ± 0.1
51-60	11	81.7 ± 12.3	176 ± 0.1
61-70	12	72.3 ± 10.8	170 ± 0.1
Female			
20-30	39	57.0 ± 7.8	163 ± 0.1
31-40	30	58.7 ± 7.2	164 ± 0.1
41-50	18	64.5 ± 12.3	159 ± 0.1
51-60	16	63.2 ± 7.4	158 ± 0.1
61-70	20	65.7 ± 7.6	160 ± 0.1

^aData expressed as mean ± SD.

Table 2 – Values of PEF obtained and predicted (in L/min) for males and females.^a

Age bracket (years) by gender	Obtained	Cabrera et al. ⁽⁶⁾	Gregg & Nunn ⁽⁹⁾	Leiner et al. ⁽⁸⁾
Male				
20-30	559.6 ± 8.2	598.6 ± 17.4*	597.1 ± 14.3*	622.0 ± 31.9*
31-40	556.3 ± 63.0	605.1 ± 23.7*	620.5 ± 15.4*	570.5 ± 34.2
41-50	571.3 ± 85.8	592.3 ± 17.9	620.4 ± 15.1*	553.1 ± 29.8
51-60	536.8 ± 49.7	555.7 ± 28.4	600.7 ± 15.4*	536.7 ± 24.3
61-70	492.1 ± 82.0	509.8 ± 23.0	559.7 ± 18.8*	493.0 ± 25.9
Female				
20-30	413.3 ± 17.3	465.7 ± 17.9*	466.3 ± 10.9*	432.4 ± 22.9
31-40	395.2 ± 54.5	459.3 ± 16.5*	480.1 ± 7.8*	424.4 ± 20.0
41-50	390.0 ± 64.8	434.1 ± 16.0	464.1 ± 11.3*	398.9 ± 20.6
51-60	383.4 ± 58.0	420.0 ± 20.6	444.3 ± 15.9*	389.1 ± 26.5
61-70	331.0 ± 53.7	415.6 ± 10.1*	425.3 ± 11.5*	387.2 ± 18.9

^aData expressed as mean ± SD. *Friedman test, Dunn's post hoc test and significant difference $p < 0.05$.

the highest PEF value among the valid maneuvers performed was selected for data analysis.

For the purposes of the statistical analysis, the PEF values obtained were distributed according to age in five 10-year age brackets. For each age bracket, the mean of the PEF values was calculated for individuals of different heights, in intervals. The statistical software InStat version 3.05 (GraphPad Software Inc, San Diego, CA, USA) was used in order to analyze the results of the study. The data did not present normal distribution (Kolmogorov-Smirnov test, $p < 0.05$), and the nonparametric method of analysis was used. The Friedman test was used in order to compare values predicted by the tables suggested in the three studies^(6,8,10) with those obtained from the volunteers, and the Dunn's post hoc test⁽²¹⁾ was used to determine where the differences were. A significance level of 5% ($p < 0.05$) was adopted.

Results

This study comprised 243 individuals (123 females and 120 males), distributed in five age brackets, each spanning a 10-year interval. The demographic and anthropometric characteristics of the individuals included in the study are presented in Table 1.

Table 2 presents the observed and predicted PEF values for males and females. It is worthy of note that, in the 41-50 and 51-60 age brackets for both genders, as well as in the 61-70 age bracket for males, the values suggested in the 2001 study⁽⁶⁾ presented no statistically signifi-

cant difference ($p > 0.05$) when compared with the values obtained in the present study. When comparing the values suggested in the 1989 study⁽¹⁰⁾ with those of our sample, a significant difference was observed ($p > 0.05$) for all age brackets and both genders. In relation to the values suggested in the 1963 study⁽⁸⁾ for males in the 31-40, 41-50, 51-60 and 61-70 age brackets, as well for females in all age brackets, there was no significant difference ($p > 0.05$) in comparison with those obtained in our study.

Discussion

According to the ATS,⁽¹³⁾ the values obtained in a sample of normal individuals must be compared with the predicted values obtained by several authors when local studies are unavailable, justifying the comparison of such PEF reference values with those obtained in our study.

Considering the results, it was observed that the reference values described in the 1989 study⁽¹⁰⁾ for all age brackets in both genders, those described in 2001⁽⁶⁾ for the 20-30 and 31-40 age brackets, in both genders, and for the 61-70 age bracket for females; and those described in 1963⁽⁸⁾ for the 20-30 age bracket, for males, overestimate the PEF values obtained from the sample of the present study.

The difference observed in all age brackets and for both genders between the PEF values obtained and those predicted by the reference values in the 1989 study⁽¹⁰⁾ can be attributed to population aspects^(2,4,6,10,12) and to the use of

different measurement devices in our study. Our results are in concordance with those of another group of authors,⁽⁴⁾ who observed that the PEF values obtained in their study were lower than those suggested by the authors of the study conducted in England.

As for the values predicted in the 2001 study,⁽⁶⁾ all were higher than those obtained in the present study, and the differences were statistically significant for females in the 20-30, 31-40 and 61-70 age brackets, as well as for males in the 20-30 and 31-40 age brackets. These results can be explained by differences among the populations^(2,4,6,10,12) and by the different portable PEF meters used in the two studies.

There were no significant differences between the reference values obtained in our study and those obtained in the 1963 study,⁽⁸⁾ except for males in the 20-30 age bracket. It is possible that the small size of the sample evaluated by those authors (155 individuals), as well as their inclusion of smokers, was responsible for the fact that neither the population factor nor the model of the meter had a strong influence, as they did in previous studies.

The predicted values for a given age/height combination can differ considerably, due to the criteria of selection of the population samples, equipment used, measurement techniques and biological variability of the populations.⁽²²⁾ In addition, the values change with time due to changes in the environmental conditions, technological progress of the equipment used and greater precision in the measurement conditions.⁽²²⁾

According to one group of authors,⁽²⁰⁾ the Assess® PEF meter is more precise than the Mini-Wright®, the precision of the latter notably diminished after a short time of use.

In conclusion, the values predicted in 1963⁽⁸⁾ are acceptable for a population of individuals with the same characteristics of that studied in the city of São Carlos, Brazil, except for male individuals in the 20-30 age bracket. Our study has great relevance due to the fact that our study sample was larger than that evaluated in the 1963 study.⁽⁸⁾ Most values predicted in the 2001⁽⁶⁾ and 1989⁽¹⁰⁾ studies overestimated the PEF values obtained in our study, proving to be inappropriate for the studied population.

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