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CIRCADECENNIAN PEAK EXPIRATORY FLOW AND THE PUTATIVE MERIT OF SELF-MEASUREMENT

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A b s t r a c t

Peak expiratory flow (PEF) can be self-measured. Self-measurements of PEF on a long-term basis permit assessment of the time structure of PEF and its relation to solar activity expressed in Wolf's relative sunspot number. The results from a longitudinal record spanning 32.5 years were compared with four other shorter series. It appeared that the most prominent periodicity in the annual and infra-annual response of the spectrum was a component with a period of 11.74 years. This periodicity was comparable with the periodicity found for Wolf's relative sunspot number (10.27) during the same span of time.

K e y w o r d s

Circadecennian rhythm, Peak expiratory flow, Self-measurement

INTRODUCTION

Peak expiratory flow (PEF) has a circadian rhythm, peaking usually in the afternoon (*1–10*). A circadian rhythm has been reported in clinical health as well as in patients with asthma and other respiratory disorders *(3, 5*). Smoking, chronic obstructive pulmonary disease and interstitial lung disease are associated with alterations of the circadian pattern of PEF (*3,9*).

Population studies based on transverse sampling, with each subject usually providing only a single measurement, indicate that PEF increases during adolescence to reach the maximum around 35 years of age and decreases thereafter *(11*). A trend increasing with age has been observed in five subjects who carried out self-measurements for several years (*2*). The aim of this study was to evaluate longitudinal records of PEF (over the period of 32 years) and to characterise long-lasting rhythms in this respiratory parameter.

MATERIAL AND METHODS

In 1967, a 21-year old man started self-measuring his PEF, on an average of 5-times daily (range, 3- to 9-times), during waking hours only, using a Wright Peak Flow Meter (Armstrong Industries, IL). PEF was measured upon awakening, prior to retiring to bed, and every 2–5 h, as daily activities permitted. During each measurement session, three readings were obtained and recorded in local time on a log sheet. On December 31, 1999, the total data reached 53,501 measurements (160,503 in triplicate).The subject, who was usually in good clinical health, followed a diurnal schedule; he went to bed between 00:00 and 02:00 a.m. and got up between 07:30 and 09:30 a.m.

In order to show the cumulative distribution of PEF in relation to advancing age, the data published previously on daily PEF values in five other subjects (A,B,C,D,E) who carried out long-term self-measurements were used (*2*).

RESULTS

When all yearly data were analysed by a four-component cosine model, a circadian rhythm was consistently present during each year of study, with an average overall peak near midday ($P<0.001$). The circannual rhythm was validated (in 30 of the 32 years tested) and the lowest value was generally found in January and the peak in mid-summer. The most prominent periodicity in the annual and infra-annual response of the spectrum was a component with a period of 11.74 years, with a 95% confidence interval (CI) extending from 10.36 to 13.11 years. The most prominent periodicity of PEF overlapped the CI of the periodicity found in Wolf's relative sunspot number of 10.27 (10.06 to 10.50) during the same span. A significant ($P<0.05$) circaseptan (7-day) rhythm of PEF was recorded in 18 of the 32 years tested (with a $P<0.10$ in 4 additional years), with most validated rhythms found in the second half of the series. An overall rhythmic component with a period of 7 days was found by the population mean cosinor method ($P<0.001$), with PEF values lower at weekends. The least-square fit of a 6-month cosine curve was statistically significant in the majority of records, with the exception of six years. The mean cosinor analysis showed this component to be significant, when using data as a percentage of the mean ($P=0.048$).

Monthly PEF MESOR values were also analysed for periodicities longer than 1 year by the single cosinor method. All statistically significant periods from the single cosinor analysis were then used in a multiple-component cosine fit. Cosinor analysis of the monthly values for sunspots showed a large-amplitude rhythm with a period of 10.5 years, with minor, but statistically also significant, periodic components of 21.8 and 5.0 years. Significant periods in PEF near those found in the sunspots were present. In both sunspots and PEF values, the highest amplitude was found at 10.5 years, with acrophases being nearly the same for both sunspots and for PEF.

In *Fig. 1*, the data on five subjects (A, B, C, D, E,) are presented. These published data (*2*) were pooled in terms of changes per year, integrated thereafter

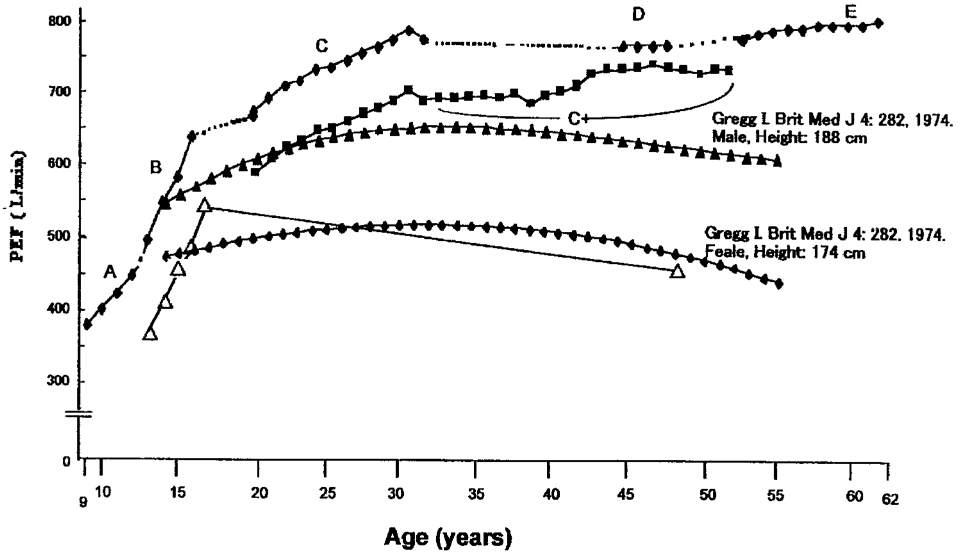

Fig. 1

Daily peak expiratory flow (PEF) measurements in five subjects (A, B, C, D, E) carried out for 5 to 12 years (*2*). The values were plotted by adding the year-to-year differences. PEF values were expressed in litre per min, age in years.

to form a single composite curve as a function of age. Despite the reported population-based decline in PEF with age, the overall trend in this record remained positive. The data obtained during the first 12 years on subject C were compared with those of four other subjects (A, B, D, E) who also recorded PEF several times a day on most days for several years (*2*).

Although the PEF values based on a 32-year self-measurement record, as reported in this study, were in keeping with the overall population-based trend, they decreased with respect to the original trend seen during adolescence (*Fig. 1*).

DISCUSSION

Self-measurement of PEF during waking hours can only serve to monitor the main features of the PEF circadian rhythm. This has been described in healthy subjects as well as in patients (*1, 3 –11*). The circadian rhythm in PEF is also used for the evaluation of treatment in different obstructive pulmonary diseases. Infradian rhythms of several frequencies, some with relatively small amplitudes, characterise PEF throughout adulthood. A decrease in PEF with advancing maturity has been reported (*2*). The great advantage of the results described here is that a very long period of time, i.e., 32 years, was covered. This provided evidence of the existence of the circannual rhythm of PEF, with the lowest values generally found in January and peaks in mid-summer.

The most prominent periodicity in the annual and infra-annual response of the PEF spectrum was found to be a component with a period of 11.74 years that corresponded to the geomagnetic periodicity of PEF expressed by Wolf's relative sunspot number (10.27) for the same period (*12*). The monthly PEF values obtained in this study allowed us to analyse periodicities longer than one year and to show, for the first time, that the PEF periodicity of 10. 5 years was close to that of Wolf's sunspot number (*12*).

A k n o w l e d g e m e n t s

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CIRCCADENIÁLNÍ VRCHOLOVÁ VÝDECHOVÁ RYCHLOST (PEF) ZÍSKANÁ VLASTNÍM DLOUHODOBÝM MĚŘENÍM

S o u h r n

Vrcholová výdechová rychlost (PEF) může být také získaná vlastním dlouhodobým měřením. Skutečnost, že toto měření může být základem pro odhalení časových struktur v respiračním parametru PEF a jejich vztahem k sluneční aktivitě vyjádřené Wolfovým relativním číslem, je prezentována v tomto sdělení. Výsledky získané z longitudinálního záznamu měření po dobu 32 let byly doplněny údaji o měření u dalších pěti osob. Ukázalo se, že nejvýznamnější periodicita v ročních odpovědích je komponenta s periodou 11.74 let. Tato perioda je srovnatelná s Wolfovým relativním číslem (10.27) pro stejné časové období.

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