DOI: 10.1590/1809-2950/18031826032019

Effect of the seasons on the peak expiratory flow in institutionalized and noninstitutionalized elderly

Efeito das estações do ano no pico de fluxo expiratório de idosos institucionalizados e não institucionalizados

Efecto de las estaciones del año en el flujo espiratorio máximo de ancianos institucionalizados y no institucionalizados

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ABSTRACT | Respiratory diseases affect millions of people, especially the elderly, and climate change is among the predisposing factors interfering with the health of this population. This study aimed to evaluate the peak expiratory flow in institutionalized and noninstitutionalized elderly during the four seasons of the year. A prospective cohort study with 67 elderly men and women living in the city of Maringá, Paraná, Brazil, divided into two groups: institutionalized elderly (n=37) and noninstitutionalized elderly (n=30). The data were collected for one month, once a week in the four seasons of the year, totaling 16 evaluations. The peak expiratory flow was evaluated using the Peak-Flow Meter equipment. The two groups of elderly were compared by two-way analysis of variance using the Bonferroni post-hoc. The lowest mean peak expiratory flow for institutionalized and noninstitutionalized elderly was observed in the summer (176.2±60.2 and 263.2±116.2), followed by fall (193.4±59.5 and 287.5±118), winter (215.3±82.5 and 291.5±08.4), and spring (221.7±83.5 and 291.5±08.4). The conclusion was that the peak of expiratory flow of the elderly varies according to the seasons, but the institutionalized ones have lower values. The highest values are found in the spring, although below the value predicted for the elderly of both groups.

Keywords | Aging; Climate Change; Health Promotion.

RESUMO | As doenças respiratórias afetam milhões de pessoas, principalmente os idosos, e as mudanças climáticas estão entre os fatores predisponentes, interferindo na saúde dessa população. O objetivo deste estudo foi avaliar o pico de fluxo expiratório de idosos institucionalizados e não institucionalizados durante as quatro estações do ano. Estudo de coorte prospectivo com 67 idosos de ambos os sexos, residentes na cidade de Maringá (PR) e divididos em dois grupos: idosos institucionalizados (n=37) e idosos não institucionalizados (n=30). Os dados foram coletados durante um mês, uma vez por semana nas quatro estações do ano, totalizando 16 avaliações. O pico de fluxo expiratório foi avaliado com o equipamento *peak flow meter*. A comparação dos dois grupos de idosos foi feita por análise de variância de dois fatores utilizando o post-hoc de Bonferroni. A menor média de pico de fluxo expiratório para os idosos institucionalizados e não institucionalizados foi no verão (176,2±60,2 e 263,2±116,2), seguido pelo outono (193,4±59,5 e 287,5±118), inverno (215,3±82,5 e 291,5±08,4) e primavera (221,7±83,5 e 291,5±08,4). Conclui-se que o pico de fluxo expiratório de idosos varia de acordo com as estações do ano, porém os institucionalizados apresentam valores mais baixos. Os mais altos são encontrados na primavera, embora aquém do valor predito para os idosos de ambos os grupos.

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Descritores | Envelhecimento; Mudança Climática; Promoção da Saúde.

RESUMEN | Las enfermedades respiratorias afectan a millones de personas, especialmente a los ancianos, y el cambio climático es uno de los factores predisponentes que interfieren en la salud de esta población. El presente estudio tuvo como objetivo evaluar el flujo espiratorio máximo de ancianos institucionalizados y no institucionalizados durante las cuatro estaciones del año. Se realizó un estudio prospectivo de cohorte con 67 ancianos de ambos sexos que viven en la ciudad de Maringá (PR), los cuales se dividieron en dos grupos: ancianos institucionalizados (n=37) y ancianos no institucionalizados (n=30). Los datos se recolectaron durante un mes, una vez a la semana en las cuatro estaciones del año, y totalizó 16 evaluaciones. El flujo espiratorio máximo se evaluó con la herramienta *peak flow meter*. La comparación de los dos grupos de ancianos se realizó mediante el análisis de la varianza de dos factores utilizando el post hoc de Bonferroni. El promedio más bajo del flujo espiratorio máximo para los ancianos institucionalizados y no institucionalizados se registró en verano (176,2±60,2 y 263,2±116,2), seguido del otoño (193,4±59,5 y 287,5±118), invierno (215,3±82,5 y 291,5±08,4) y primavera (221,7±83,5 y 291,5±08,4). Se concluye que el flujo espiratorio máximo de los ancianos varía según las estaciones del año, sin embargo, los ancianos institucionalizados tienen los valores más bajos. Los más altos se encuentran en la primavera, aunque por debajo del valor previsto para los ancianos de ambos grupos.
Palabras clave | Envejecimiento; Cambio Climático; Promoción de la Salud.

INTRODUCTION

Respiratory diseases affect millions of people, especially the elderly, and are one of the most frequent causes of deaths and illnesses. They represent 16% of hospitalizations, due to both chronic and acute factors, and 30% of causes of death. Climate change is among the predisposing factors, interfering with the health-disease framework, both directly and indirectly, especially regarding diseases in the airways[1].

Exposure to pollutants from environmental conditions (dust, fungi, and poor hygiene), smoking, low socioeconomic status, exposure to biological agents, and climatic seasonality influence airways[2]. During the year, weather varies in Brazil, which includes intense drought periods or heavy rains[3]. Climate change is related to several factors and is influenced by the atmosphere, the ozone layer, the industrialization and urbanization processes, as well as by cars and waste[4]. These factors make the air more harmful to the population's health, with significant effects on respiratory and heart conditions[3].

The high concentration of air pollution is a strong indication of respiratory, cardiovascular and neurological diseases, and of several types of cancer[5]. Long periods of both rain and drought influence these conditions, since drier periods increase exposure to dust, which easily irritates respiratory tract, and rainier days are more conducive to respiratory diseases, thus possibly representing a strong health aggravating factor. In this sense, being aware of respiratory parameters at different periods of the year becomes important[6].

An important parameter is the peak expiratory flow (PEF), defined as the maximum flow rate achieved during a forced exhalation maneuver, based on the maximum lung volume (vital capacity). It is a parameter used to spot the presence or absence of airway obstruction, to measure the degree of bronchial narrowing and obstruction, and to evaluate cough efficacy and responsiveness to bronchodilators[7]. PEF is a low-cost, easy-to-use and noninvasive equipment[8].

Although the relationship between environment and health is clear, almost all analyses are retrospective through database and hospital admissions. Therefore, conducting studies to verify the association between the seasons and the PEF in institutionalized and noninstitutionalized elderly is necessary, aiming at creating actions to promote the elderly's health, focusing on the environment in the context of interdisciplinarity. This study hypothesized that institutionalized elderly have a lower PEF than that of noninstitutionalized elderly. This study aimed to analyze the effect of the seasons on the peak expiratory in institutionalized and noninstitutionalized elderly.

METHODOLOGY

This is a prospective cohort study with institutionalized and noninstitutionalized elderly from the city of Maringá, PR. The data were collected between January and November 2017, for one month, once a week in the four seasons, totaling 16 evaluations. It was approved by the Ethics Committee of Centro Universitário de Maringá, opinion number 1.911.479. All participants signed the informed consent form.

The inclusion criteria were: elderly, both males and females, aged over 60 years, residents in long-term care facilities (LTCF) for the elderly, or noninstitutionalized elderly registered in a Basic Health Unit in Maringá, PR. The exclusion criteria were: elderly clinically diagnosed with chronic obstructive respiratory diseases or with decompensated heart diseases, as well as elderly who had dementia, were bedridden, or were wheelchair users. The elderly who, at the time of the interview, could not understand the instructions due to cognitive problems, assessed using the Mini-Mental State Exam (MMSE)[9], considered an easy-to-use and reliable tool.

A convenience sample was used to facilitate the collection of data from noninstitutionalized elderly who lived in the same neighborhood where the LTCF is located. Initially, of a total of 105 elderly, 55 were institutionalized in a LTCF and 50 were not institutionalized, being residents of the same neighborhood where the institution is located. Throughout this extensive study, some losses occurred. Therefore, a total of 67 elderly participated in this study; 37 in the institutionalized group and 30 in the noninstitutionalized group, shown in Figure 1.

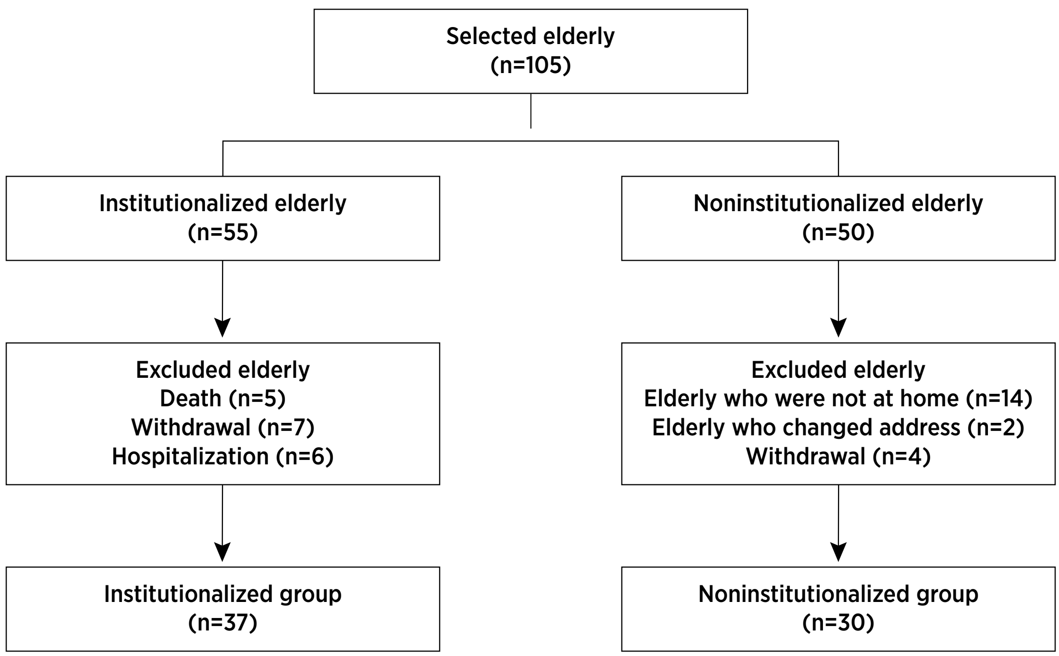

Figure 1. Flowchart of participation in the study

PEF was assessed using the Medicate peak flow meter, registered by the Brazilian Health Regulatory Agency (Anvisa) under number 10332170038, which is a reliable, low-cost, portable, plastic equipment, with a graduated measurement system that evaluates the strength and velocity of the air coming out the lungs in liters per minute (L/min). To perform the test, all the elderly were asked to sit comfortably with their feet flat on the floor and subsequently to perform a maximal inspiration and to expire forcibly and quickly on the mouthpiece of the equipment. Thus, the researchers observed carefully any air escape to avoid interfering with the measurements. The test was performed thrice, and the average of the results was calculated to identify possible differences in the comparisons between groups. To analyze the results, the values predicted were used, according to sex, age, and height[10].

Data were collected weekly for four weeks, always on Wednesday afternoons, totaling 16 evaluations in the course of the four seasons; the first one in the summer (from January 18 to February 8), the second one in the fall (from April 19 to May 10), the third one in the winter (from July 19 to August 9), and the last one in the spring (from October 25 to November 15).

The descriptive statistics was based on calculating the mean and standard deviation of the data collected, after confirming normality using the Kolmogorov-Smirnov test. Thus, to compare the two groups of elderly (institutionalized and noninstitutionalized), an analysis of variance of two factors (Anova) was used: group vs season, using the Bonferroni *post hoc* test in case of significant difference. For Anova, the Mauchly test was used to test sphericity and, if necessary, the Greenhouse-Geisser correction. For the analyses performed using Statistica 12.0 software (StatSoft, Inc., Tulsa, USA), a 5% significance level was set.

RESULTS

The final sample comprised 67 elderly; 37 (55.2%) institutionalized elderly and 30 (44.8%) noninstitutionalized elderly. The average age was 73.6±7.42 and 69.8±7.88 years for institutionalized elderly and noninstitutionalized elderly, respectively (Table 1).

Table 1. Sociodemographic data of institutionalized and noninstitutionalized elderly in the city of Maringá, PR

Sociodemographic data	Institutionalized elderly (n=37/%)	Noninstitutionalized elderly (n=30)
Gender		
Male	14 (37.8%)	7 (23.3%)
Female	23 (62.2%)	23 (76.7%)
Age (years)		
60-69	11 (29.7%)	17 (56.7%)
70-79	18 (48.6%)	8 (26.6%)
80-89	8 (21.7%)	5 (16.7%)
Smoking		
Yes	7 (18.9%)	4 (13.3%)
No	30 (81.1%)	26 (86.7%)

Table 2 shows the PEF in different seasons. The values predicted were 453.8±41.8 and 425.5±37.9, for the group with institutionalized elderly and for the noninstitutionalized elderly, respectively . Summer and fall were the seasons with the lowest values, but without statistically significant difference between groups.

Table 2. Mean, standard deviation, and p-value of the comparisons of peak expiratory flow in different seasons

Seasons	Institutionalized elderly (n=37)	Noninstitutionalized elderly (n=30)	p
Summer	176.2±60,2[a]	263.2±116.2[a]	<0.01*
Fall	193.4±59.5[b]	287.5±118.8[b]	<0.01*
Winter	215.3±82.5	291.5±08.4	0.05
Spring	221.7±83.5	295.4±115.2	0.05

a: lower values for the summer in both groups when compared with the other seasons of the year; b: lower values for the fall in both groups when compared with the spring. * Significant difference (p<0.05).

Table 3 shows the comparison between the PEF at different weeks of the seasons, for both groups. As this study shows, PEF showed different values in all seasons of the year in both groups, although the differences were significant only in the summer compared with the other seasons and in the fall compared with the spring and the summer.

Table 3. Comparisons of peak expiratory flow between different weeks of the four seasons

Seasons	Institutionalized elderly (n=37)	Noninstitutionalized elderly (n=30)	p
Summer 1	163.2±58.8[a]	261.7±113.5[a]	0.01*
Summer 2	177.8±64.3[a]	269.1±117.8[a]	0.01*
Summer 3	175.5±63.1[a]	249.9±117.3[a]	0.01*
Summer 4	188.5 ± 65.4[a]	272.0±128.0[a]	0.01*
Fall 1	176.5±60.5[b]	274.3±122.4[b]	0.01*
Fall 2	195.0±61.8[c]	293.1±121.7[c]	0.01*
Fall 3	198.6±65.5[d]	287.2±122.1[d]	0.01*
Fall 4	203.5±65.9[e]	295.6±118.1[e]	0.01*
Winter 1	189.8±75.9[f]	288.6±111.8[f]	0.01*
Winter 2	215.2±87.2[g]	287.2±107.1[g]	0.01*
Winter 3	220.4±59.5	288.1±107.0	0.05
Winter 4	235.8±91.8	302.0±119.3	0.05
Spring 1	196.0±76.3	292.6±115.2	0.05
Spring 2	222.1±90.3	290.6±115.2	0.05
Spring 3	226.6±88.3	293.4±115.0	0.05
Spring 4	242.0±92.7[h]	305.1±115.9[h]	0.01*

a: lower values when compared with all the weeks in the fall, the winter, and the spring; b: lower values when compared with fall 4, winter 2, 3 and 4, and spring 2, 3 and 4; c: lower values when compared with winter 4 and spring 4; d: higher values when compared with summer 1 and 3 and lower values when compared with winter 4 and spring 4; e: higher values when compared with fall 1 and lower values when compared with spring 4; f: lower values when compared with winter 4 and spring 4; g: lower values when compared with winter 4; h: higher values when compared with spring 1. * Significant difference (p<0.05).

When the values obtained in the spring, season with the best scores, were compared with the value predicted, the difference was highly significant (p<0.001) for both groups (Table 4).

Table 4. Mean, standard deviation, and p-value of institutionalized and noninstitutionalized groups concerning the spring and the value predicted

Seasons	Institutionalized elderly (n=37)	Noninstitutionalized elderly (n=30)	p
PEF obtained	221.7±83.5	295.4±115.2	0.001*
PEF predicted	453.83±41.85	425.53±37.91	0.001*

PEF: Peak expiratory flow. *Significant difference (p<0.05).

DISCUSSION

Our study aimed to analyze the effect of the seasons on the PEF of institutionalized and noninstitutionalized elderly. Our results point that the elderly's PEF varies according to the seasons, and the best values are found in the spring, although below the value predicted for the elderly.

In this study, summer was the season with lower PEF in both groups. Temperature rise affects the respiratory system, and summer is the period in which the risk of developing inflammatory or infectious diseases is higher. As the rainfall decreases in summer, temperature and air humidity change, which contributes to health problems[11]. The mortality rate induced by heat is 5.33%, with greater risk of pneumonia[12].

As expected, summer temperatures have increased, on average, at a rate 0.32 °C per decade[13]. In Spain, the heat-related vulnerability decreased to the range of extreme summer temperatures, indicating that the Spanish society showed an adjustment response to rising temperatures, despite the population's aging[14]. Another potential factor contributing to the reduction in mortality risks may have been the Spanish Ministry of Health's national plan of preventive actions against the effects of excess temperature on the health in Spain[15], implemented in 2004. In Brazil, heat-related mortality data increase; however, in 2016, the Brazilian Climate Change Adaptation Plan was created[16], which seeks to promote the management and reduction in the risk associated with climate change.

Recently, a study[17] on the impact of extreme temperatures on people's health analyzed twenty countries from four continents and envisaged that the increase in mortality in the cold in the coming years (2031-2080) must be greater near the equatorial line; Brazil, the Philippines, and Colombia will be the most affected countries, while the least affected regions will be the United States and Europe. These results show the currently available information on climate in the future are enough to guide regional planning in public health[18].

Humidity is one of the factors contributing to the feeling of comfort and welfare related to the individuals' health. With climate changes and a 30% reduction in air humidity, the body ends up being subjected to changes for maintaining body temperature according to the room temperature[19]. These changes harm the immune system, making individuals more susceptible to respiratory complications, mucosal dryness, and nose bleed[20].

The elderly population is more vulnerable to temperature changes. Heat-related stress causes the immune system not to react positively to this temperature change, leading to complications in the body. Exposure to climate changes makes the old ones more susceptible, especially to respiratory problems, and the exacerbation of chronic bronchitis and pneumonia are severities in this temperature rise period[21].

Higher PEF values were found in the spring, followed by the winter; however, these values are lower than those predicted for the elderly. As shown in the study by Ruivo et al.[22], breathing pattern is different between young adults and healthy elderly, suggesting that pulmonary function is influenced by chronological aging.

Although winter was the second station with the best PEF results, worsening of respiratory impairment and functional disability is also observed in this season due to the decreased humidity and temperature, making the respiratory tract more exposed to change. This causes bronchial hyperreactivity, which induces chronic inflammation and increases respiratory symptoms[23].

Decreased relative air humidity with values below 30% is considered a risk to the integrity of the airways, hindering the internal homeostasis of the respiratory system. In rainy months, contrary to the problems faced during the dry season, high relative humidity, combined with more time spent in indoor environments and with the lower aeration and sun exposure of household spaces, favors the growth of mold and fungi. These factors can contribute to the increase in respiratory diseases, especially allergic ones[24]. Moreover, some viruses show highly seasonal pattern, being more frequent in the cold period in temperate regions and in the rainy period in tropical climate regions. These viruses frequently cause respiratory infections, particularly of the upper airways[25].

In a study by Antunes et al.[26], who evaluated and compared the PEF between institutionalized and noninstitutionalized elderly, PEF values were significantly higher in noninstitutionalized elderly. In this study, PEF values are also lower in institutionalized elderly compared with those of noninstitutionalized elderly.

In this sense, the conduction of pulmonary function tests by physical therapists helps health professionals in detecting pathological conditions[26,27], as well as in evaluating functions of organs and body systems[28,29]. Creating new strategies and actions to promote health in institutionalized elderly and noninstitutionalized elderly in the context of interdisciplinarity is necessary.

A favorable point of this investigation was the data collection period, as well as having collected data circumscribed elderly in the same geographical area and characterized with good mental condition. This study shows the importance of the therapist's role in conducting tests aimed at monitoring the elderly's health both in the community and in the LTCF.

Some limitations of this study should be highlighted: in addition to the size and type of sample, and the lack of knowledge of physical activity practiced by the elderly, which could influence the results, data on meteorological parameters such as atmospheric pressure, temperature and relative air humidity, precipitation, solar radiation, and wind direction and speed were not collected. Other limitation while conducting this study was the commitment of the elderly to participate in the collections during the year, because the data had to be collected all on the same day, but many elderly were not in their houses to receive the researcher on the date and time scheduled for evaluation.

CONCLUSION

The conclusion was that peak expiratory flow in the elderly varies according to the seasons and has similar behavior regardless of the group, and the best values are found in the spring, although below the value predicted for the elderly.

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