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Comparison of daily physical activity between COPD patients from Central Europe and South America

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Summary
Background: In healthy elderly and adults, lower physical activity level in daily life has been associated with lower socio-economic level and non-Caucasian race. The objective of this study was to determine if this is also applicable in chronic obstructive pulmonary disease (COPD) by comparing physical activity levels in daily life in stable patients from two countries (Austria and Brazil) with different socio-economic and ethnic characteristics.
Methods: Physical activity in daily life was objectively assessed in 40 Austrian and 40 Brazilian COPD patients. Groups were matched for age, gender, body mass index, disease severity, smoking history, presence of concomitant heart disease, lung function, dyspnea and functional exercise capacity. In addition, climatic conditions were similar during the period of data collection in the two groups.
Results: In comparison to Brazilian patients, Austrian patients had a significantly lower walking time ($p = 0.04$), higher sitting time ($p = 0.02$) and lower movement intensity ($p = 0.0001$). The proportion of patients who did not reach an average of 30 min of walking per day was 48% in the Austrian group and 23% in the Brazilian group.

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Conclusions: Austrian patients with COPD showed a significantly lower daily physical activity level in comparison to matched Brazilian patients. Socio-economic and ethnic factors appear to influence stable COPD patients differently than described in previous studies including healthy subjects.

Introduction

Objective and accurate assessment of physical activity level in daily life has been made more widely available due to recent technological advances. The use of real-life activity monitors has allowed detailed study of the characteristics of daily physical activity patterns in various populations, including patients with chronic obstructive pulmonary disease (COPD).[1] Previous investigations have demonstrated, for example, that patients with COPD from Belgium are significantly less active compared to age- and gender-matched healthy controls.[2] Similar findings were reported in studies performed in cohorts from European countries such as England,[3] Germany[4] and Switzerland.[5] However, to the authors' knowledge, a comparison of the time spent actively in daily life between COPD patients from different countries and continents, using advanced activity monitors, has never been performed. This may be of clinical interest since it allows investigation of whether and to what extent COPD patients' profile of daily physical activity differs across diverse world regions.

In healthy elderly and adult populations, studies performed in different countries have shown that the amount of physical activity performed in daily life may vary considerably depending on various factors such as ethnicity, education level and socio-economic status.[6–10] In general, a lower physical activity level appears to be associated with the non-Caucasian race,[6,7] lower educational level[8,9] and lower income.[9,10] However, it is unknown whether these same factors have a similar influence on the physical activity level of a generally sedentary population diagnosed with a chronic disease, such as patients with COPD. If the trends demonstrated in healthy cohorts translate to individuals diagnosed with a chronic disease, it is likely that patients from a country with a multi-racial population, lower educational level and social status, such as Brazil, will have a lower physical activity level in comparison to a country with disparate characteristics, such as Austria.

Given the present knowledge gaps in the literature, the purpose of the present study was to compare the daily physical activity patterns of patients with COPD from Brazil and Austria.

Methods

Design

In this cross-sectional study, the level of physical activity in daily life was assessed using an advanced activity monitor in two COPD cohorts from Brazil and Austria, respectively. Austrian and Brazilian patients were matched for age, gender, body mass index (BMI), smoking history, presence of concomitant heart disease, lung function (spirometry), self-reported degree of dyspnea in daily life (modified version of the Medical Research Council scale – MMRC), functional exercise capacity (6-min walking test – 6MWT) and disease severity as assessed by the GOLD stage and the BODE index. In addition, climatic conditions were similar during the period of data collection in both groups since data in Brazil were collected during the whole year of 2006, whereas data collection in Austria occurred almost entirely during the summer and spring seasons of 2006 (see more details below).

Subjects

The study included 40 Brazilian patients with COPD (18 male; 66 ± 8 years; forced expiratory volume in 1 s [FEV_1] $46 \pm 17\%$ predicted; BMI $26 \pm 6\ kg/m^2$) and 40 matched Austrian patients with COPD (21 male; 63 ± 7 years; FEV_1 $48 \pm 17\%$ predicted; BMI $26 \pm 4\ kg/m^2$). All subjects included in the study were recruited during the initial screening for admission to a pulmonary rehabilitation program in their respective centers. The diagnosis of COPD was established based on internationally accepted criteria determined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD).[11] No patient included in this study was using domiciliary long-term oxygen therapy (LTOT). Moreover, all subjects were officially retired, although five patients in the Austrian group (12.5%) and 14 patients in the Brazilian group (35%) were still performing ''informal'' professional activities defined as occasional and not registered work (few hours per week, not every day). No patients in either the Brazilian or Austrian groups took part in any rehabilitation program in the year prior to the initiation of this study. Inclusion criteria were: (1) clinical stability (absence of exacerbations) for at least 3 months prior to study initiation and (2) the absence of neuromuscular comorbidities that might interfere with the performance of physical activities in daily life. The study was approved by the Committee for Ethics in Research of both the institutions involved, and all subjects gave formal written consent to participate.

Data from Brazil

In Brazil, data from all subjects were collected at the Laboratory of Research in Respiratory Physiotherapy (Laboratório de Pesquisa em Fisioterapia Pulmonar – LFIP) from the Department of Physiotherapy, Universidade Estadual de Londrina (UEL) and Hospital Universitário Regional Norte do Paraná (HURNPR), Londrina.

Londrina is situated in the southern region of Brazil and has approximately 500,000 inhabitants as of July 2008. Londrina's only means of public transport is by bus. In the Brazilian group, 30 patients (75%) depended on public

transportation (bus), seven patients (17.5%) used a privately owned car and three patients (7.5%) used an ambulance transportation service.

All Brazilian subjects were living in their own home: 34 patients (85%) were living with a spouse or relative(s) and six (15%) were living alone.

During the data collection period (throughout the whole year of 2006), Londrina's average temperature in the four seasons was: winter 17.3 °C; spring 21.1 °C; summer 24 °C; autumn 21.5 °C; precipitation was approximately 117 mm/month; and the average humidity was 78%.[12,13] Eight patients (20%) were assessed during the summer season, eight (20%) were assessed during autumn, 13 (32.5%) were assessed during winter and 11 patients (27.5%) were assessed during spring.

With respect to the level of education, nine patients (22.5%) were illiterate, 25 patients (62.5%) were literate but did not complete primary level education, two patients (5%) had completed primary level, two patients (5%) had completed secondary level and two patients (5%) had completed university level. Regarding race, 26 patients (65%) were Caucasian, four (10%) were black, eight (20%) were multi-ethnic (Caucasian and black) and two (5%) were Asian (Japanese). As of 2006, the monthly average income for retired individuals in Londrina, Brazil corresponded to 355 €[14] (or R$ 919 in the Brazilian currency). Clinical characteristics of the group of Brazilian patients with COPD are described in Table 1.

Data from Austria

In Austria, data were collected at the Department of Respiratory and Critical Care Medicine, Otto Wagner Hospital, Vienna. Vienna is situated in the eastern region of Austria and has approximately 1,675,000 inhabitants as of July 2008.

Despite the fact that Vienna has a well developed public transport system (bus, tram and underground train), fewer Austrian patients (21 or 52.5%) depended on these transit options compared to the Brazilian group. Conversely, more patients (14 or 35%) used a privately owned car. No Austrian patient used the ambulance service and two patients (5%) reported the use of a bicycle for transportation. In three patients, it was not possible to retrieve information concerning the transportation means.

All Austrian subjects were living in their own home. Twenty-one patients (52.5%) were living with a spouse or relative(s) and 19 (47.5%) were living alone.

The majority of patients (25 or 62.5%) were assessed during summer, whereas 11 (or 27.5%) were assessed during spring and only four (10%) were assessed during autumn or winter. During the data collection period (mostly spring and summer of 2006), Vienna's average temperature was: spring 13 °C; summer 21.5 °C; precipitation was approximately 88 mm/month; and the average humidity was 77%.[15]

With respect to the level of education, no Austrian patient was illiterate; 29 patients (72.5%) completed primary level education, six patients (15%) completed secondary level and five patients (12.5%) completed university level. All Austrian patients were Caucasian. As of 2006, the monthly average income for retired individuals in Vienna, Austria was 1286 €.[16] Clinical characteristics of the group of Austrian patients with COPD are described in Table 1.

Table 1 Characteristics of the groups of patients with COPD from Austria and Brazil.

	COPD Austria ($n = 40$)	COPD Brazil ($n = 40$)
Age (years)	63 ± 7	66 ± 8
Gender (M/F)	21/19	18/22
Smoking (pack/years)	44 ± 13	40 ± 34
BMI (kg/m^2)	26 ± 4	26 ± 6
GOLD (II/III/IV)	17/14/9	16/18/6
FEV_1 (%predicted)	48 ± 17	46 ± 17
FVC (%predicted)	78 ± 17	75 ± 22
MMRC (0—4)	2.8 ± 1.1	2.4 ± 1.1
6MWT (%predicted)	68 ± 19	71 ± 19
BODE index (0—10)	4.0 ± 2.6	4.4 ± 2.1

Data are shown as median ± standard deviation (except for gender and GOLD stages). Comparison between patients with COPD from Austria and Brazil was performed with the unpaired t test except for MMRC and BODE index, which were analyzed with the Mann—Whitney test. There were no statistically significant differences between the groups. COPD = chronic obstructive pulmonary disease; M = male; F = female; BMI = body mass index; kg/m^2 = kilograms per meters squared; GOLD = Global Initiative for Chronic Obstructive Lung Disease (stages II, III and IV); FEV_1 = forced expiratory volume in the first second; FVC = forced vital capacity; MMRC = modified version of the Medical Research Council scale; 6MWT = 6-min walking test.

Data collection

The objective quantification of physical activity during daily life was performed in both centers with an accelerometer-based activity monitor (DynaPort Activity Monitor® [DAM], McRoberts BV, The Hague, The Netherlands). The device consists of a small and lightweight box enclosed in a belt worn around the waist and a leg sensor (total weight = 375 g). The DAM was recently validated in patients with COPD, demonstrating the ability to quantify the time spent in walking, cycling, standing, sitting or lying as accurately as video recordings.[17] Technical specifications of the DAM can be found elsewhere.[17] Assessments were done on two consecutive weekdays for 12 consecutive hours per day once the subject awoke in the morning. The average of the 2 days of data collected was used to assess physical activity patterns since it was shown that this duration provides an acceptable intraclass correlation coefficient in patients with COPD.[2] Patients were aware of the aims of the assessments since these have been shown not to influence the results of activity monitoring in patients with COPD.[18] Both in the Austrian and Brazilian COPD groups, no assessments were done on days in which the patient performed any informal professional activity.

In the Brazilian center, assessment of lung function was performed using the Pony Cosmed® spirometer (Cosmed, Italy). In the Austrian center, it was performed using the spirometry PFT unit SensorMedics Vmax 22 (Viasys Healthcare, Germany). The technique in both centers followed the guidelines of the American Thoracic Society/European

Respiratory Society,[19] and the reference values were those from Quanjer et al.[20]

All patients with COPD reported the degree to which dyspnea influences their activities of daily living through the MMRC scale.[21] The 6MWT was performed in both centers according to the guidelines of the American Thoracic Society.[22] Two tests were performed with an interval of at least 30 min, and the highest 6MWT was used for the analysis. Reference values were those from Troosters et al.[23] Results concerning BMI, FEV_1, MMRC and 6MWT were used to calculate the BODE index as described by Celli et al.[24]

Comorbidities

In the group of Brazilian patients with COPD, the number (and proportion) of subjects with clinically diagnosed comorbidities was: 15 patients (37.5%) with systemic hypertension, 13 (32.5%) with stable cardiac disease, 13 (32.5%) with diabetes mellitus, five (12.5%) with osteoporosis and nine (22.5%) with obesity. In the group of Austrian patients with COPD, the number (and proportion) of subjects with clinically diagnosed comorbidities was: 10 patients (25%) with systemic hypertension, 15 (37.5%) with stable cardiac disease, five (12.5%) with diabetes mellitus, three (7.5%) with osteoporosis and eight (20%) with obesity. The criterion for considering patients as having systemic hypertension was the current use of antihypertensive medication; for stable cardiac disease it was the presence of a medical diagnosis of mild atrial arrhythmia treated with medication, ischemic heart disease in the past or dilated cardiomyopathy without significant cardiac functional impairment; for diabetes mellitus and osteoporosis it was the patient's self-report in addition to the presence of a medical diagnosis of these conditions; and for obesity it was a BMI $> 30\ kg/m^2$.

Statistical analysis

Statistical analysis was performed using GraphPad Prism 3 (GraphPad Software, San Diego, USA). Normal distribution of data was assessed with the Kolmogorov–Smirnov test. Results were described as mean ± standard deviation. Comparison between patients with COPD from Austria and Brazil was performed with the unpaired t test except for MMRC and BODE index, which were analyzed with the Mann–Whitney test. Level of significance was set at $p < 0.05$ for all statistical tests.

Results

Table 1 shows that the Brazilian and Austrian patients with COPD had similar age, BMI, lung function, GOLD stage, 6MWT, MMRC and BODE index (all $p > 0.05$). Fig. 1 illustrates that the Austrian patients had significantly lower time spent walking (40 ± 36 min/day *versus* 56 ± 32 min/day; $p = 0.04$), lower movement intensity ($1.5 \pm 0.4\ m/s^2$ *versus* $1.9 \pm 0.4\ m/s^2$; $p = 0.0001$) and higher time spent sitting (388 ± 208 min/day *versus* 296 ± 109 min/day; $p = 0.02$) in comparison to the Brazilian patients. In addition, Austrian patients had lower time spent standing (192 ± 182 min/day *versus* 246 ± 122 min/day) and lower time spent lying

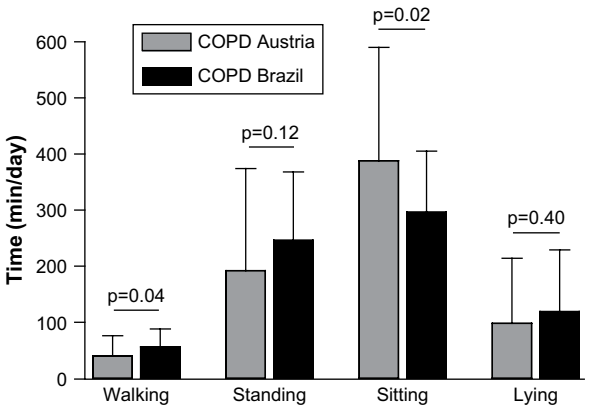

Figure 1 Comparison of the time spent walking, standing, sitting and lying per day between Austrian patients with COPD ($n = 40$) and Brazilian patients with COPD ($n = 40$). Statistical analysis was performed with the unpaired t test.

(98 ± 116 min/day *versus* 119 ± 110 min/day), although these differences did not reach statistical significance ($p = 0.12$ and 0.40, respectively).

Brazilian patients with COPD were divided in two groups based on the involvement ($n = 14$) or no involvement ($n = 26$) in informal professional activities. These two groups did not show significant differences concerning the time spent walking ($p = 0.76$), BODE index ($p = 0.54$) and FEV_1 (both in absolute values [$p = 0.62$] and in the percentage of the predicted values [$p = 0.56$]). Similarly, dividing the Austrian patients with COPD in two groups involved ($n = 5$) or not involved ($n = 35$) in informal professional activities, there were no differences concerning the time spent walking ($p = 0.57$), BODE index ($p = 0.34$) and FEV_1 (both in absolute values [$p = 0.97$] and in the percentage of the predicted values [$p = 0.27$]).

In the Austrian group, 19 out of the 40 patients (48%) did not reach an average of at least 30 min of the time spent walking per day, which is the minimum amount of physical activity recommended by the American College of Sports Medicine (ACSM).[25] In the Brazilian group, nine out of the 40 patients (23%) did not reach this minimum level of physical activity.

Discussion

To the authors' best knowledge, this is the first study to compare the level of physical activity in daily life assessed by an advanced and validated activity monitor in patients with COPD from such different origins as Europe and South America, or more specifically Austria and Brazil. Several differences are readily apparent in the present study: firstly, the educational level and economic condition of Austrian patients are considerably higher, as one would expect when comparing a developed country with another one in development. Secondly, Brazil is a miscegenated country from an ethnic perspective, in contrast to the Caucasian population in Austria. However, despite the fact that a lower physical activity level in healthy elderly and adult populations has been associated with the non-Caucasian race,[6,7] lower educational level[8,9] and lower

income,[9,10] Austrian patients with COPD showed a significantly lower time spent walking, higher time spent sitting and lower movement intensity in daily life in comparison to the matched Brazilian patients. In addition, the lower physical activity level in daily life in Austrian patients occurred despite the fact that the Brazilian patients had a higher prevalence of comorbidities such as hypertension, diabetes and osteoporosis. These results suggest that, in an inactive population such as patients with COPD, the socio-economic and ethnic predictive factors for physical inactivity possibly play a different role than that observed in healthy subjects (*i.e.* worse socio-economic conditions and ethnic miscegenation lead South American patients to be more active than Central European patients). These results are supported by the fact that the time spent walking in daily life in the Brazilian COPD group (56 ± 32 min/day) was also markedly higher than that observed in a previous sample from Belgium[2] (44 ± 26 min/day), which was very similar to the Austrian sample from the present study (40 ± 36 min/day).

The differences in the daily physical activity level between Austrian and Brazilian patients with COPD cannot be explained by anthropometrical and clinical differences between the groups. The groups were similar with respect to age, gender, BMI, lung function, functional exercise capacity (as assessed by the 6MWT), disease severity (as measured by both the GOLD stages and the BODE index) and the presence of comorbidities such as cardiac disease and obesity. Furthermore, LTOT, which has been shown to reduce daily physical activity level in patients with COPD,[18] was not used by any subject in this study. Given the control of confounding factors, the findings of the present study appear to indicate that socio-economic and ethnic factors influence daily physical activity differently in patients with COPD compared to the healthy population. To further support our findings, a study performed with a sample of Spanish patients with COPD has also shown that lower physical activity level is related to a higher socio-economic status.[26] The socio-economic factors which might lead patients in Brazil to be more active than patients in Austria include the fact that the proportion of Brazilian patients who have access to privately owned transportation (*i.e.* automobile) was half that found in the Austrian patients. Therefore, Brazilian patients may have to ambulate more for daily activities as well as to access public transport. Since 85% of the Brazilian patients were living with their spouse or relatives (in comparison to 52.5% in the Austrian group), it may also be argued that this can be a motivating factor in order to undertake more outdoor social activities with the other family members. Ethnic differences are likely linked to the socio-economic discrepancies between the groups.

A study by He et al.[27] showed that leisure time physical activity in healthy adults between 51 and 61 years of age was higher in Caucasian than in non-Caucasian subjects. On the other hand, work-related physical activity showed the reverse pattern, being highest in non-Caucasian subjects with lower education. These variations in physical activity level related to work or leisure cannot explain the present results, since all patients in both groups were officially retired, the vast majority of them were in fact no longer involved in any professional activity and those still involved in informal professional activities were not more active than those not involved. Therefore, irrespective of the fact that more Brazilian patients were involved in informal professional activities, this did not appear to influence the results of the present study since daily physical activity assessments were not performed on days in which the patients performed any professional activity. If assessments were performed on days in which the patients were involved in informal work, the differences in daily physical activity level between the Brazilian and Austrian groups would possibly have been even larger. On the other hand, it cannot be ruled out that the professional activity performed by these individuals before retirement might have influenced their current physical activity habits.

Environmental factors are also known to influence the daily physical activity level. However, data collection in the present study was performed during a period in which the mean temperatures, humidity and precipitation were similar between both countries. In addition, two other factors suggest that environmental factors did not play a role in the present results: firstly, the city of Londrina is located in the southern region of Brazil, *i.e.* the less warm region in the country, with more resemblance to the European general climate. Secondly, Togo et al.[28] observed that, in a healthy elderly cohort, the amount of steps per day increased with a mean ambient temperature over the range of $-2\,^{\circ}C$ to $17\,^{\circ}C$, but decreased over the range of $17-29\,^{\circ}C$. Therefore, if weather was an influencing factor in the present results, previous research supports the contention that activity level would be lower in Brazilian compared to Austrian patients.

Another interesting finding from the present study was that the proportion of Brazilian patients with COPD who reached the minimum amount of daily physical activity recommended by the ACSM[25] was more than twice the proportion of Austrian patients. These results directly affect treatment options, since they indicate that pulmonary rehabilitation programs in Central Europe, even more than in South America, should prioritize the goal of enhancing daily physical activity. Furthermore, since non-compliance with these recommendations is related to a higher risk of death in the retired elderly,[29,30] early mortality would be expected to be higher in Austrian patients than in Brazilian patients, although ethnicity and annual income were not predictive factors of mortality in a sample of American patients with severe emphysema.[31] Given the importance of compliance to physical activity recommendations, especially in chronic disease populations, future research in this area is certainly warranted.

In summary, Austrian patients with COPD demonstrated a significantly lower daily physical activity level in comparison to matched Brazilian patients with COPD. Socio-economic and ethnic factors appear to influence stable patients with COPD differently than described in previous studies including healthy individuals.

Conflict of interest statement

All the authors state that no financial or other potential conflicts of interest exist.

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