

Artigo Original

Potential consequences for stable chronic obstructive pulmonary disease patients who do not get the recommended minimum daily amount of physical activity^{*,**}

Possíveis conseqüências de não se atingir a mínima atividade física diária recomendada em pacientes com doença pulmonar obstrutiva crônica estável

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ABSTRACT

Objective: The present study attempted to determine whether patients with chronic obstructive pulmonary disease (COPD) get the minimum daily amount of physical activity recommended in the guidelines established by the American College of Sports Medicine (ACSM), as well as to characterize the consequences of noncompliance with those guidelines. **Methods:** This study involved 23 patients (median age: 61 - range, 59-69 years; FEV₁: 39% of predicted - range, 34-53%; BMI: 24 kg/m² - range, 21-27 kg/m²). The following parameters were evaluated: daily physical activity (DynaPort activity monitor); pulmonary function; muscle force; exercise tolerance; quality of life; functional status; and various indices of disease severity (GOLD, BODE and MRC). **Results:** Based on compliance with the guidelines (minimum of 30 minutes of walking per day), 12 patients were considered "physically active", and 11 were considered "physically inactive". No significant differences were observed between the two groups in terms of age, gender, BMI, muscle force, ventilatory reserve, hyperinflation or quality of life. The inactive group presented more impaired pulmonary function and lower exercise tolerance, as well as lower MRC and BODE scores ($p < 0.05$). In their daily life, patients in the inactive group also walked for less time and more slowly than did those in the active group ($p < 0.05$). The MRC and BODE indices were superior to the GOLD index in predicting compliance with the guidelines, both presenting a specificity of 0.83, compared with 0.50 for the GOLD index. The BODE index score increased significantly with each day of inactivity. **Conclusion:** A large number of COPD patients do not walk more than 30 minutes per day and are therefore not getting the minimum daily amount of physical activity recommended by the ACSM. Inactivity correlates with a higher mortality rate. The MRC and BODE indices proved superior to the GOLD index in predicting whether patients are physically inactive in their daily lives.

Keywords: Pulmonary disease, chronic obstructive; Body mass index; Exercise tolerance; Exercise; Guidelines; Severity of illness index

RESUMO

Objetivo: O presente estudo investigou se pacientes com Doença Pulmonar Obstrutiva Crônica (DPOC) atingem a mínima atividade física recomendada pelos guidelines do *American College of Sports Medicine* (ACSM), assim como as conseqüências da não-aderência a esses guidelines. **Métodos:** Atividade física na vida diária (DynaPort activity monitor), função pulmonar, força muscular, capacidade de exercício, qualidade de vida, estado funcional e diferentes índices de severidade (GOLD, BODE, MRC) foram avaliados em 23 pacientes (61 [59-69] anos; VEF₁ 39[34-53]%predito; IMC 24[21-27]kg/m²; mediana [intervalo interquartilico 25-75%]). **Resultados:** De acordo com a aderência aos guidelines (andar no mínimo 30 minutos todo dia), 12 pacientes foram considerados "fisicamente ativos", e 11 "fisicamente inativos". Não foram observadas diferenças significativas entre os dois grupos em termos de idade, sexo, composição corporal, força muscular, reserva ventilatória, hiperinsuflação e qualidade de vida. O grupo inativo tinha pior função pulmonar, capacidade de exercício, MRC e BODE ($p < 0.05$). Além disso, na vida diária, o grupo inativo andou menos tempo e numa velocidade menor ($p < 0.05$). O BODE e a MRC foram superiores ao GOLD na predição de aderência aos guidelines (especificidade 0.83 para BODE e MRC e 0.50 para o GOLD). O BODE aumentou significativamente para cada dia de inatividade física. **Conclusão:** Grande parte dos pacientes com doença pulmonar obstrutiva crônica não andam mais de 30 minutos por dia, e portanto não atingem a mínima atividade física recomendada pelos guidelines do *American College of Sports Medicine*. Inatividade está relacionada com maior taxa de mortalidade. O BODE e a MRC mostraram-se superiores ao GOLD para prever pacientes fisicamente inativos na vida diária.

Descritores: Doença pulmonar obstrutiva crônica; Índice de massa corporal; Tolerância ao exercício; Exercício; Diretrizes; Índice de gravidade de doença

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INTRODUCTION

Public health guidelines of physical activity published by the American College of Sports Medicine (ACSM) recommend that a minimum of 30 minutes of daily physical activity of moderate intensity (e.g., walking) is necessary to maintain or develop fitness irrespective of age.⁽¹⁾ Those not meeting these minimum standards are considered insufficiently active and have higher risk for morbidity and mortality.⁽²⁻⁶⁾

Chronic obstructive pulmonary disease (COPD) is a disease state characterized by airflow limitation, dyspnea, reduced exercise capacity, muscle force and quality of life.⁽⁷⁾ Previous research showed that physical activity in daily life in patients with COPD is very limited⁽⁸⁻⁹⁾ and deteriorates even more over time due to factors such as acute exacerbations.⁽¹⁰⁻¹¹⁾ However, the proportion of patients who reach the minimum recommended physical activity remains unknown.

It has been shown that the forced expiratory volume in the first second (FEV₁) is not strongly correlated to physical activity in daily life⁽⁸⁾ and the degree of dyspnea⁽¹²⁾ in COPD patients. Nevertheless, the most commonly used staging system for this population (the Global Initiative for Chronic Obstructive Lung Disease-'GOLD'⁷) is based in the FEV₁, which may not reflect well the systemic manifestations of COPD. Recently, multicomponent staging of COPD including not only FEV₁ but also exercise tolerance, symptoms and body mass index (the BODE-index) showed to be a better predictor of survival in COPD.⁽¹³⁾ However, it is unclear whether this multicomponent staging index could be a good indicator of inactivity or non-compliance to physical activity recommendations.

The present study had 3 main objectives: to compare COPD patients who reach the minimum recommendation of physical activity according to the ACSM with patients who do not reach this recommendation; to investigate to what extent established disease severity indexes predict compliance to guidelines of minimum recommended physical activity; and to study whether strict compliance with general activity guidelines leads to a reduction in the risk of death indirectly assessed by a multicomponent index.

METHODS

Twenty three COPD patients (GOLD I to IV) were included in the study. Inclusion criteria were: absence of severe cardiac disease as demonstrated by ECG during rest and maximal exercise test and of other pathologic conditions that can potentially impair physical activities in daily life. COPD diagnosis was done based on established criteria:⁽⁷⁾ clinical findings and spirometry (FEV₁/forced vital capacity[FVC]<70% and postbronchodilator FEV₁<80%). Patients were recruited and assessed during the screening period before inclusion in a pulmonary rehabilitation program. Data were collected from February/2003 to October/2004. In each patient, all tests were performed within a maximum period of 2 weeks, and all patients remained stable during this 2-week assessment period. All subjects signed a written informed consent prior to participation.

An accelerometer-based activity monitor (DynaPort [DAM], McRoberts, The Hague, The Netherlands) as accurate as video-recordings was used to measure the physical activity level in daily life.⁽¹⁴⁾ The device is able to distinguish between time spent in different activities and positions: walking, standing, cycling, sitting and lying. In addition, walking, cycling and standing time may be summed as 'active time' and sitting and lying time may be summed as 'passive time'. Besides time recording, the DAM also reports movement intensity during walking. Assessments were done on 5 consecutive weekdays, and each assessment day had 12 hours of duration starting at waking-up time.

According to the results of the activity monitoring during the 5 days of assessment, patients were classified into 2 groups: reaching or not reaching the minimum physical activity recommended by the guidelines of the ACSM (i.e., a minimum of 30 minutes of walking every day).⁽¹⁾ For the purpose of the present study, these two groups were denominated "active" and "inactive", respectively.

The Chronic Respiratory Disease Questionnaire (CRDQ) was used to assess health-related quality of life.⁽¹⁵⁾ This 20-item questionnaire scores quality of life into four domains: dyspnea, mastery, emotional functioning, fatigue and has been validated for the Dutch language.⁽¹⁶⁾ A total score is obtained by summation of the four above-

mentioned domains and can range from 20 to 140 with higher scores indicating better quality of life.

The modified Medical Research Council scale (MRC)⁽¹⁷⁾ was used to rate the degree of dyspnea in daily life. This 5-point scale (0-4) is based on degrees of various activities that lead to breathlessness, ranging from score "0" (patient is not troubled with breathlessness except with strenuous exercise) to score "4" (patient is too breathless to leave the house or breathless even when dressing or undressing). Subjects have to select the number on the scale that best fits their shortness of breath, and higher scores mean higher disability.

The modified version of the Pulmonary Functional Status and Dyspnea Questionnaire (PFSDQ-M)⁽¹⁸⁾ assesses the capacity to perform activities of daily living. It consists of three components; activity, dyspnea and fatigue. For all the 3 components, higher values mean worse functional status.

The BODE-index,⁽¹³⁾ a multidimensional scale, was used in the present study to indirectly predict the risk of death. Four factors are used to calculate it: body-mass index or BMI (B), degree of airflow obstruction with the FEV₁ in % of the predicted values (O), dyspnea with the MRC scale (D) and exercise capacity (E) measured by the 6MWD. Patients receive points according to their results in the four variables (0-3 for O, D and E and 0-1 for B) and these are added into a score ranging from 0 to 10. A higher index is associated with a greater risk of death.

In the present study, we divided the general group according to values obtained on the GOLD, MRC and BODE in order to investigate to what extent the established disease severity indexes predict compliance to guidelines of minimum recommended physical activity. The sub-classification of the indexes was based on a simple differentiation in scores which denote more severity (highest values) or less severity (lowest values). For the GOLD, patients were classified as being included in classes 1 or 2 (low GOLD) versus patients included in classes 3 or 4 (high GOLD). For the MRC, patients were classified as having values of 1 and 2 (low MRC) versus patients with values of 3 and 4 (high MRC). For the BODE, patients were classified as having values between 0 and 4 (low BODE) versus

patients having values between 5 and 10 (high BODE). In theory, high (i.e., worse) GOLD, MRC and BODE should represent the inactive patients, whereas low (i.e., better) GOLD, MRC and BODE should represent the active patients.

Pulmonary function, maximal inspiratory and expiratory pressures, quadriceps peak torque, maximal (cycling) exercise capacity and six-minute walking distance (6MWD) were also assessed. Detailed description of all methods and equipment concerning these measurements can be found in a previous publication from our group.⁽⁸⁾

Based on the maximal exercise test, the ratio between peak ventilation (VE) and maximal voluntary ventilation (MVV) (VE/MVV ratio, or ventilatory reserve) was calculated. In addition, based in the pulmonary function test, the ratio between inspiratory capacity (IC) and TLC (IC/TLC ratio) was also calculated since it has been recently shown to be a mortality predictor in COPD.⁽¹⁹⁾

Statistics were performed using GraphPad Prism 3.0 (GraphPad Software, San Diego, USA) and SAS statistical package (SAS Institute Inc., Cary, USA). Normal distribution was checked with the Kolmogorov-Smirnov test.

All comparisons between patients reaching and not reaching the minimum recommended physical activity were done with the Mann-Whitney test. Correlations were analysed with the Spearman coefficient. Level of significance was set at $p < 0.05$. In addition, sensitivity and specificity of the GOLD, BODE and MRC to predict patients reaching or not the minimum recommended daily physical activity were analysed. Since inactivity is of prognostic importance, in the analysis of sensitivity and specificity we referred to patients classified in the inactive group as those with a positive test result.

RESULTS

The 23 patients included in the study were characterized by impaired pulmonary function, exercise capacity and muscle force (table 1). Out of these 23 patients, 12 reached the minimum recommendation of daily physical activity (group here denominated as "active group"), and 11 did not ("inactive group"). Results from the total group of COPD patients, and the active and inactive groups are shown in table 1. There were no significant differences between the active and

inactive groups in terms of age, gender, BMI, muscle force, ventilatory reserve, IC/TLC ratio and quality of life (total score and the 4 domains of the CRDQ). However, when compared to the active group, the inactive group had significantly worse FEV₁, 6MWD, maximal workload, peak VO₂, MRC and BODE, besides trends for worse values for the 3 domains of the PFSDQ-M.

The amount of time spent daily in different activities for the general group, active and inactive groups is presented in table 2. Walking time and movement intensity during walking were significantly lower in the inactive group. In addition, this group also tended to have lower standing time and higher sitting time. Consequently, active time was significantly lower and passive time was significantly higher in the inactive group (p=0.03 for both).

The three severity indexes studied had similar

high sensitivity (0.82), which means that high (i.e. worse) MRC, BODE and GOLD were equally able to correctly diagnose the truly inactive patients (true positive). However, the MRC and the BODE had higher specificity (both 0.83) than the GOLD (0.50), which means that low (i.e. better) BODE and MRC were more accurate than low GOLD to correctly diagnose the truly active patients (true negative). In addition, there were significant negative correlations between walking time in daily life with MRC (r = -0.75; p < 0.0001) and BODE (r = -0.68; p = 0.0007), but not with GOLD (r = -0.06; p = -0.8).

In order to study whether strict (i.e., daily) compliance with general activity guidelines is related to a reduction in the risk of death indirectly assessed by the BODE-index in COPD patients, walking time and BODE were compared between

TABLE 1

Results from the general group of COPD patients, active and inactive groups according to the guidelines of the American College of Sports Medicine

	Total (n = 23)	ACSM active (n = 12)	ACSM inactive (n = 11)	p value (active versus inactive)
Age (y)	61 (59-69)	61 (58-67)	63 (60-70)	0.406
Gender (M/F)	16/7	8/4	8/3	-
BMI (kg/m ²)	24 (21-27)	25 (22-30)	21 (21-26)	0.281
FEV ₁ % pred	39 (34-53)	50 (40-58)	34 (33-44)	0.021
FVC % pred	80 (76-94)	80 (74-113)	80 (78-87)	0.902
IC/TLC	0.28 (0.24-0.31)	0.28 (0.21-0.34)	0.27 (0.26-0.31)	0.923
Plmax % pred	73 (56-88)	66 (48-88)	74 (62-102)	0.644
PEmax % pred	94 (76-108)	101 (89-109)	78 (67-121)	0.132
QF% pred	76 (56-90)	75 (54-87)	76 (58-97)	0.806
6MWD % pred	71 (54-77)	76 (69-79)	66 (42-72)	0.019
Wmax % pred	53 (41-73)	69 (58-77)	40 (27-67)	0.013
Peak VO ₂ % pred	57 (49-78)	71 (55-102)	49 (36-78)	0.049
VE/MVV	92 (73-108)	100 (85-114)	83 (64-105)	0.178
CRDQ total	84 (65-90)	82 (63-88)	87 (65-104)	0.399
PFSDQ ch act	41 (32-53)	33 (29-52)	47 (41-77)	0.057
PFSDQ dyspnea	43 (32-54)	33 (28-52)	51 (44-79)	0.052
PFSDQ fatigue	34 (26-52)	28 (21-47)	50 (40-76)	0.099
MRC	2 (2-3)	2 (1-2)	3 (3-4)	0.002
BODE-index	4 (3-5)	2.5 (1.5-3.5)	5 (5-8)	0.001

The group denominated "ACSM active" was composed by patients who reached the minimum daily physical activity recommended by the American College of Sports Medicine, whereas the group denominated "ACSM inactive" did not reach the recommendations; Data are expressed as median (interquartile range). BMI = Body mass index; FEV₁ = Forced expiratory volume in the first second; FVC = forced vital capacity; IC/TLC = inspiratory capacity / total lung capacity ratio; Plmax = maximal inspiratory pressure; PEmax = maximal expiratory pressure; QF = quadriceps force; 6MWD = six-minute walking distance test; Wmax = maximal workload; Peak VO₂ = peak oxygen consumption; VE/MVV = ventilatory reserve; CRDQ total = Chronic Respiratory Disease Questionnaire - total score; PFSDQ ch act, dyspnea and fatigue = Pulmonary Functional Status and Dyspnea Questionnaire domains change in activity, dyspnea and fatigue, respectively; MRC = medical research council scale; BODE-index = body mass index, airflow obstruction, dyspnea and exercise capacity index.

TABLE 2

Amount of time spent in different activities for the general group, active and inactive groups according to the guidelines of the American College of Sports Medicine

	Total (n = 23)	ACSM active (n = 12)	ACSM inactive (n = 11)	p value (active versus inactive)
Walking time (min)	57 (34-71)	71 (64-85)	30 (10-52)	0.001
Cycling time (min)	0 (0-6)	0 (0-4)	1 (0-9)	0.474
Standing time (min)	208 (139-293)	288 (167-331)	165 (92-260)	0.069
Sitting time (min)	338 (299-457)	311 (272-400)	420 (337-555)	0.079
Lying time (min)	39 (15-92)	29 (10-60)	67 (37-134)	0.242
Movement intensity during walking (m/s ²)	1.86 (1.65-1.97)	1.96 (1.87-2.05)	1.66 (1.58-1.85)	0.006

Data are expressed as median (interquartile range)

subjects reaching the minimum daily physical activity level in different number of days (figures 1 and 2, respectively). Figure 1 shows that patients did not compensate inactive days by being extra-active in other days, since mean walking time is significantly lower in patients not reaching the minimum recommended physical activity in 1 or more days. Figure 2 shows that there was a “dose-response” effect between compliance with the guidelines and mortality, since patients had significantly lower mortality risk if they had more active days per week.

DISCUSSION

The present study showed that inactive COPD patients (not reaching the ACSM minimum recommendation of 30 minutes of daily physical activity) have lower exercise capacity and higher risk of death (indirectly assessed through the BODE-index) than active patients. This active group spends more time actively in daily life, and walks at a faster speed. In addition, we observed that the MRC and the BODE-index are better than the FEV₁-based ‘GOLD’ in predicting patients who are active in daily life. Furthermore, the relationship between BODE-index and inactivity in COPD patients supports the general concept that inactivity increases the risk of death.

Public health guidelines recommend a minimum of 30 minutes of daily physical activity at a moderate intensity to increase survival for people of all ages. The subjects that reached this minimum in our study had indeed a better (i.e., lower) BODE-index (table 1). The BODE has been shown to be

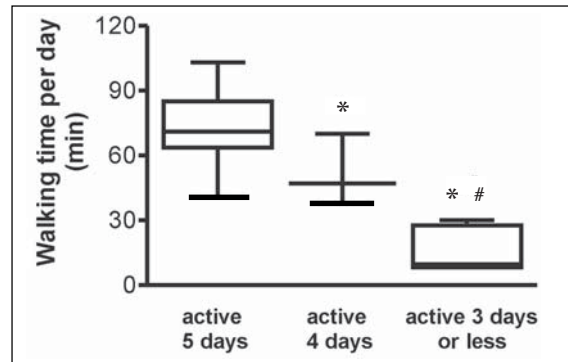


Figure 1 - Box plots of walking time in daily life in subjects reaching the minimum daily physical activity recommendations according to the American College of Sports Medicine in 5 days (n=12), 4 days (n=5) and 3 or less days (n=6) during the 5 days of activity monitoring
* p<0.05 versus active 5 days; # p<0.05 versus active 4 days.

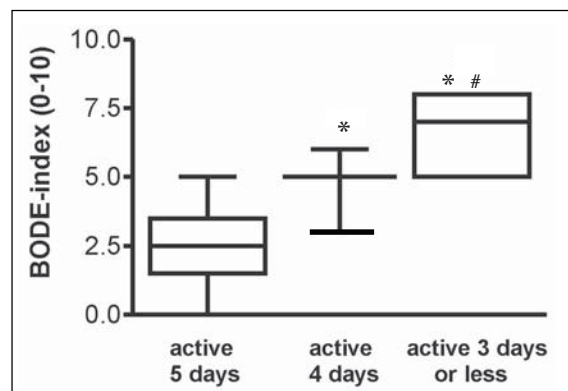


Figure 2 - Box plots of the BODE-index in subjects reaching the minimum daily physical activity recommendations according to the American College of Sports Medicine in 5 days (n=12), 4 days (n=5) and 3 or less days (n=6) during the 5 days of activity monitoring
* p<0.05 versus active 5 days; # p<0.05 versus active 4 days.

the best predictor of mortality in COPD patients so far. In addition, walking slower (as seen in the inactive group) may by itself be a predictor of mortality.⁽²⁰⁾ Furthermore, subjects classified as inactive according to the ACSM guidelines, besides walking less and slower than the active subjects, had also worse exercise capacity, more dyspnea and a trend for worse functional status. This can lead patients into a vicious circle of dyspnea, inactivity and further deconditioning.

In the current study, 52% of the COPD patients reached 30 minutes of walking time every day. In a study by Rafferty et al., only 21% of the subjects included in a group of healthy individuals met these minimum recommendations of the ACSM.⁽²¹⁾ This discrepancy is likely to be caused by the fact that, in the current study, every minute of walking was added up, whereas the study by Rafferty et al. referred to one bout of 30 consecutive minutes of walking. A recent study performed by Garcia-Aymerich et al., concerning physical activity in daily life in COPD patients was also based on the sum of minutes spent in activity.⁽²²⁾ One third of the subjects in that study had a physical activity level lower than walking less than 15 minutes a day, while one third was active for at least 60 minutes a day. Patients who walk less than 30 minutes every day even in an interspersed manner are surely not compliant to the ACSM guidelines, but patients who walk more than 30 minutes per day are not necessarily compliant if the criteria used is 30 minutes of continuous walking. To investigate this, we analyzed in more detail the 5 days of measurement of the most active patient in our sample (mean of 95 minutes of walking time per day). This detailed analysis was not performed in the whole group since it is extremely time-consuming. According to the analysis, even this patient did not reach 30 minutes of continuous walking in any day, despite being classified as active. Therefore, in case the same criteria as Rafferty et al. were used in the current study, possibly none of the patients in our sample would be classified as compliant with the guideline. Furthermore, the intensity at which COPD patients walk is lower than healthy subjects,⁽⁸⁾ and might not be enough to be qualified as moderate.

Other less strict recommendations of minimum physical activity have been suggested, such as 150 minutes of moderate physical activity per week

independently of reaching 30 minutes every day.⁽²¹⁾ Our results showed that COPD patients who are not active every day generally do not compensate this by walking more on active days (Figure 1). If this was the case, walking time per day in patients with 4 or less active days per week (box plots in the center and right) would be similar to patients active every day (box plot in the left). Further analysis showed that being inactive for only 1 out of 5 days doubled the BODE score, and therefore decreased considerably the probability of survival. More inactive days result in an even higher BODE score and therefore an even lower probability of survival (Figure 2). These results suggest that, as seen in other populations, the recommendation of at least 30 minutes of activity every day offers a reasonable cut-off to determine increased death risk also in COPD patients. Pulmonary rehabilitation programs currently aim at having patients exercising at high intensity at least 3 days per week.⁽²³⁾ However, the results of the present study suggest that asking patients to be active in daily life every single day is recommended. For patients with cardiovascular disease, for instance, Thompson et al. suggested efforts to adapt the environment and to encourage people to be more active, like taking the stairs instead of the elevator.⁽²⁴⁾

Currently, lung function is the most frequently used indicator of severity in COPD, as determined by the GOLD classification. In this study, MRC and BODE turned out to be superior predictors of physical activity in daily life than the GOLD. This suggests that lung function alone is not able to provide reliable estimate of physical activity level in daily life. On the other hand, a multicomponent index such as the BODE seems to be more adequate than the FEV₁ alone in order to estimate physical activity level in COPD. Interestingly, the MRC had good sensitivity and specificity to predict active and inactive patients as well, reinforcing the validity of this simple unidimensional scale.

Unfortunately, the sample size of the present study may be too small to allow further sub-analysis and may be considered a limitation of the study. Another limitation of the study was the fact that death risk was indirectly assessed through an index. Therefore, although the BODE-index has been reported as a strong predictor of survival, patients were not prospectively followed up in order to confirm the findings. In addition, limitations of

the BODE-index include the fact that generalization of results from the index might be limited by two factors: the proportion of women included in the validation study by Celli et al. was relatively low; and the grading system is universal, which means that it does not take into consideration differences observed in patients from different countries and races.⁽¹³⁾ Furthermore, concerning the sub-classification of the three severity indexes used in the present study, it is worthy to remember that it was not based on previously published criteria but on a simple differentiation in scores which denote more severity (highest values) or less severity (lowest values). For the GOLD, it has been shown that the transition between classes II and III (FEV₁ higher or lower than 49% predicted, as used in the present study) is a clear threshold differentiating patients with better or worse health status, respectively.⁽²⁵⁾ Therefore, according to the literature, splitting groups of COPD patients according to better or worse GOLD classes is reasonable. In the present study, we assumed that correspondent division could be valid for the MRC and the BODE. However, this is speculative and needs further confirmation.

CONCLUSION

In conclusion, almost half of the COPD patients included in this study do not walk more than 30 minutes per day and hence can not be compliant with the minimum recommended daily physical activity. The inactive group is characterized by worse exercise capacity, lung function and functional status. Each day of inactivity per week increases the risk of death. To predict whether a patient is capable of reaching the ACSM guidelines, both BODE and MRC may be more useful than the GOLD.

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