# Assessment of sedentary behaviour in individuals with COPD: how many days are necessary?

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**Any combination of 4 days is able to reliably assess the main outcomes related to sedentary behaviour in individuals with moderate to very severe COPD, regardless of patient sex, disease severity, day of the week, daylight time and daytime naps** https://bit.ly/443F9A7

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## Abstract

*Objective* The objective of the present study was to define the minimum number of monitoring days required for the adequate cross-sectional assessment of sedentary behaviour in individuals with chronic obstructive pulmonary disease (COPD).

*Methods* In this cross-sectional study, the sedentary behaviour of individuals with COPD was assessed using two physical activity monitors during awake time for seven consecutive days. Time spent per day in activities requiring ⩽1.5 metabolic equivalents (METs) and in sitting, lying and sitting+lying positions was calculated taking into account the average of 7 days (as a reference in all analyses) and of all 119 possible combinations of 2–6 days. Intraclass correlation coefficients (ICCs) and linear regression analyses were performed for all combinations.

*Results* 91 individuals were analysed (47 female, 66±9 years, forced expiratory volume in 1 s 50±15% predicted). For the variables time spent per day in activities ⩽1.5METs and sitting, the average of any combination of at least four assessment days was sufficient to adequately reflect the average of 7 days (adjusted $R^2$⩾0.929, ICC⩾0.962, p<0.0001 for all). For time spent per day lying and sitting+lying, only two assessment days were enough (adjusted $R^2$⩾0.937, ICC⩾0.968, p<0.0001 for all). Results were maintained independently of patient sex, disease severity, day of the week, daylight time or daytime naps.

*Conclusions* The average of 4 days of objective monitoring was sufficient to adequately reflect the results of a 1-week assessment of the main outcomes related to sedentary behaviour in individuals with moderate to very severe COPD, regardless of sex, disease severity, day of the week, daylight time and occurrence of daytime naps.

## Introduction

Previous evidence has shown that a large proportion of individuals with chronic obstructive pulmonary disease (COPD) are physically inactive in daily life [1–3]. It is known that physical activity level is an important predictor of all-cause mortality in this population [4], and physically inactive patients have higher risk of developing cancer, cardiovascular disease, type 2 diabetes and many other health conditions [5]. In addition to the relevance of assessing physical activity, more recently there has been growing interest in assessing sedentary behaviour in individuals with COPD [6–11]. A long time spent in sedentary behaviour is also an independent predictor of mortality in individuals with COPD, even after adjusting for time spent in moderate-to-vigorous physical activity and other factors [6].

It is always useful to clarify that physical inactivity and sedentary behaviour are distinct concepts. The Sedentary Behavior Research Network paper published in 2017 [12] recommends using the following

definitions: physical inactivity refers to a level of physical activity that is insufficient to meet current physical activity recommendations (not achieving 150 min·week$^{-1}$ of moderate-to-vigorous-intensity physical activity or 75 min·week$^{-1}$ of vigorous-intensity physical activity or an equivalent combination of moderate- and vigorous-intensity activity); sedentary behaviour is defined as any waking behaviour characterised by an energy expenditure ⩽1.5 metabolic equivalents (METs) while in a sitting, reclining or lying posture [12].

Based on the classic study by Watz *et al.* [2], international recommendations [5] have suggested that, from a cross-sectional perspective, two to three assessment days may provide a reliable evaluation of physical activity in individuals with very severe COPD (*i.e.* Global Initiative for Obstructive Lung Disease (GOLD) 4), whereas 5 days may be necessary for individuals with mild disease (*i.e.* GOLD 1). More recently, an international task force on physical activity recommended that 1 week of assessment is likely able to provide the necessary number of valid days [13]. However, it is crucial to highlight that all these recommendations apply to the assessment of physical (in)activity, and not sedentary behaviour. Using a variety of activity monitors, various studies have assessed sedentary behaviour either as a primary or secondary outcome in individuals with COPD, and in most of these studies the number of assessment days ranged between two and seven [6, 8–10, 14–20]. Nevertheless, there are currently no available recommendations concerning the necessary number of days to specifically assess such an important outcome as sedentary behaviour. Therefore, the main aim of this study was to define the minimum number of monitoring days required for the adequate cross-sectional assessment of sedentary behaviour in individuals with COPD. We also aimed to investigate whether sex, disease severity, day of the week and occurrence of daytime nap might impact the results.

## Materials and methods

This study was a retrospective analysis of baseline-only assessment data from all patients recruited for an unrelated and as yet unpublished interventional study performed in the same laboratory. Patients were recruited for admission in an outpatient-based pulmonary rehabilitation programme at the University Hospital of the State University of Londrina, Brazil, which involved physical training and education. Although there were no symptomatology requirements for referral to the programme, the predominant profile of the patients was GOLD 2–4 owing to the tertiary nature of the institution. Patients underwent routine medical consultation with a pulmonologist in the public health service and through this consultation and registry they were referred to the research team and invited to take part in the study. Data were collected from January 2012 to May 2018 in the Laboratory of Research in Respiratory Physiotherapy, State University of Londrina, Brazil. In brief, a cross-sectional analysis was performed in a convenience sample which involved patients with the following inclusion criteria: diagnosis of COPD according to GOLD criteria [21]; clinical stability (*i.e.* no infections and exacerbations within the previous 3 months before the study); not performing either pulmonary rehabilitation or any kind of high intensity regular exercise training in the last year; and absence of severe and/or unstable cardiac disease and musculoskeletal comorbidities that could interfere with the assessments. Exclusion criteria were: no availability of seven complete assessment days according to the pre-established valid day criterium (*i.e.* at least 8 h of wearing time·day$^{-1}$); occurrence of osteoneuromuscular complications or acute exacerbations during the assessment period. The study was approved by the ethics committee of the University (no. 123/09) and all patients provided informed consent prior to inclusion.

### *Assessments*

Spirometry was performed using the SpiroBank G (Medical International Research, Rome, Italy) according to the American Thoracic Society/European Respiratory Society guidelines [22] and reference values by Pereira *et al.* [23]. The 6-min walk test (6MWT) was performed according to international standards [24] and using reference values by Britto *et al.* [25]. Dyspnoea in daily life was assessed by the modified Medical Research Council scale [26]. Physical activity in daily life was objectively assessed using two validated physical activity monitors, the SenseWear Pro 2 Armband (BodyMedia, Pittsburgh, PA, USA) and the DynaPort MoveMonitor (McRoberts, The Hague, The Netherlands) [27, 28]. Patients were instructed to wear the monitors simultaneously during awake time of seven consecutive routine days. In accordance with the existing literature, a valid assessment day consisted of at least 8 h of on-body measurement [29].

The variables analysed by the SenseWear Armband were time spent per day in sedentary behaviour, *i.e.* demanding <1.5 MET (in minutes); number of steps per day; time spent per day in light and in moderate-to-vigorous activities; wearing time (in minutes); and duration of daytime naps (in minutes). The variables analysed by the DynaPort MoveMonitor were time spent per day in walking, sitting, lying and sitting+lying (in minutes). The outcomes of sedentary behaviour were calculated for the 7 days (criterion),

for each day, and for all 119 combinations of 2–6 days (*i.e.* each and all combinations of 2 days, 3 days, 4 days, *etc*.). A combination without repetition, in combinatorial analysis [30], indicates how many variations of different elements exist in a set. It is only used when there is no repeating of elements within the set. In the simple combination, the order of the elements in the grouping does not interfere. The used formula reads as follows:

$$C_{n,p} = n!/p!(n-p)!$$

where C=combination without repetition, n=number of elements belonging to the set, p=natural number less than or equivalent to "n" and !=factorial.

There were 21 combinations of 2 days, 35 combinations of 3 days, 35 combinations of 4 days, 21 combinations of 5 days and seven combinations of 6 days. That is:

$C_{7,7}$=7!/7!=1 (one combination of 7 days)

$C_{7,6}$=7!/6!1!=7 (seven combinations of 6 days)

$C_{7,5}$=7!/5!2!=21 (21 combinations of 5 days)

$C_{7,4}$=7!/4!3!=35 (35 combinations of 4 days)

$C_{7,3}$=7!/3!4!=35 (35 combinations of 3 days)

$C_{7,2}$=7!/2!5!=21 (21 combinations of 2 days)

Information on daylight time concerning the respective assessment period of each patient was gathered by accessing a website of the USA government (https://aa.usno.navy.mil/data/Dur_OneYear), which provides daylight time retrospectively for any day in any region of the world.

### *Statistical analysis*

Data distribution was analysed using the Shapiro–Wilk test and continuous variables were described as mean±SD or median (IQR) depending on the normality of the data.

Intraclass correlation coefficients (ICCs) and simple linear regressions were performed to determine the minimal number of days required to achieve an ICC>0.90 and adjusted $R^2 \geqslant 0.90$ [31]. Simple regression analyses were used to estimate both how many and what types of days were necessary to predict sedentary behaviour in individuals with COPD. A manual (direct) input method was used in simple linear regressions, so that the dependent variable was always the average of the 7 days of the week, with all other combinations analysed as simple independent variables. Daylight time was also analysed as an adjustment factor in the models. The average of 7 days was used as a reference in all analyses. For comparisons between males and females, a t-test for independent samples or Mann–Whitney test were used, depending on the normality of data distribution. The Mann–Whitney test was used to compare sedentary behaviour variables across GOLD stages. For the combinatorial analysis of 119 combinations without repeating elements of the set, the simple combination Excel (Microsoft Corporation, Redmond, WA, USA) formula was used.

Statistical analyses were carried out using SPSS 22.0 (IBM Corp., Armonk, NY, USA) and GraphPad Prism 6.0 (GraphPad Software, La Jolla, CA, USA), and the statistical significance was set at $p<0.05$.

## Results

### *Baseline characteristics*

A total of 94 patients with COPD were included; three of them were excluded for not reaching seven valid assessment days in the activity monitoring. Therefore, 91 patients with COPD were studied (47 women, 66±9 years old, body mass index 27±5 $kg \cdot m^{-2}$, forced expiratory volume in 1 s ($FEV_1$) 50±15% predicted). Demographic and clinical characteristics of the individuals are described in table 1, as well as the comparison between male and female baseline characteristics. In general, men were slightly older and had higher values of $FEV_1$, forced vital capacity and 6MWT in absolute values, although these differences were not found when values were compared as percentages of the predicted values.

**TABLE 1** Baseline characteristics and comparison between males and females

| Characteristics | Total | Male | Female | p-value |
|---|---|---|---|---|
| **Patients** | 91 (100%) | 44 (48%) | 47 (52%) | |
| **Age, years** | 66±9 | 68±8 | 64±8 | **0.012** |
| **BMI, kg·m$^{-2}$** | 27±5 | 27±5 | 26±6 | 0.301 |
| **$FEV_1$, L** | 1.22 (0.90–1.69) | 1.66 (1.23–1.84) | 1.04 (0.74–1.28) | **<0.0001** |
| **$FEV_1$, % pred** | 50±23 | 52±17 | 48±14 | 0.289 |
| **FVC, L** | 2.50 (1.72–3.10) | 3.08 (2.57–3.46) | 2.01 (1.65–2.54) | **<0.0001** |
| **FVC, % pred** | 79 (63–87) | 79 (67–89) | 80 (60–86) | 0.194 |
| **$FEV_1$/FVC %** | 52 (43–62) | 51 (47–62) | 52 (43–62) | 0.828 |
| **GOLD 1/2/3/4** | 2/53/23/13 | 1/28/8/5 | 1/24/14/8 | 0.193 |
| **6MWT, m** | 473±74 | 493±74 | 456±70 | **0.021** |
| **6MWT, % pred** | 89±14 | 89±14 | 88±14 | 0.747 |

Values are presented as mean±SD, median (IQR) or n (%) according to the normality in data distribution. Bold text indicates statistically significant values. BMI: body mass index; $FEV_1$: forced expiratory volume in 1 s; FVC: forced vital capacity; GOLD: Global Initiative for Chronic Obstructive Lung Disease; 6MWT: 6-min walk test.

### *Outcomes of sedentary behaviour, light activities and moderate-to-vigorous physical activity*

Variables of physical activity in daily life and sedentary behaviour, as well as a comparison between men and women, are described in table 2. The table shows low values for variables reflecting physical activity, and high values for variables reflecting sedentary behaviour. There was no difference between men and women for these variables.

Comparisons of sedentary behaviour characteristics when analysing with and without daytime naps are described in supplementary table S1. There were no differences in any variable when analysing with and without daytime naps.

Linear regressions involving each combination of days and the 7-day assessment (criterion) for the variables of sedentary behaviour (not including naptime during the day in the analysis) are shown in table 3. Values of $R^2$>0.90 were found for any four combined days (adjusted $R^2 \geqslant 0.929$, ICC$\geqslant$0.962, p<0.0001 for all) for the variables time spent per day in activities $\leqslant$1.5 METs and sitting time. For the variables lying and sitting+lying time, values of $R^2$>0.90 were found for any two combined days (adjusted $R^2 \geqslant 0.937$, ICC$\geqslant$0.968, p<0.0001 for all). Results were similar when weekend days were excluded and only weekdays were analysed (supplementary table S2). Further, linear regressions of combinations of days including naptime during the day are described in supplementary table S3, and results were similar to those in table 3.

The combination of days was also analysed separated by disease severity according to GOLD stage. Once again, results for each of the GOLD stages mimicked those from the entire sample (supplementary tables S4, S5 and S6). Further, no significant differences were found when comparing sedentary behaviour across

**TABLE 2** Physical activity in daily life, sedentary behaviour and comparison between males and females

| Variables | Total sample | Male | Female | p-value |
|---|---|---|---|---|
| **Patients, n** | 91 | 44 | 47 | |
| **Steps·day$^{-1}$** | 5417 (3399–8569) | 5484 (3351–8562) | 5376 (3368–8649) | 0.846 |
| **Sedentary behaviour, min·day$^{-1}$** | 549±150 | 542±155 | 555±145 | 0.673 |
| **Light activities, min·day$^{-1}$** | 258±137 | 266±132 | 249±144 | 0.577 |
| **MVPA, min·day$^{-1}$** | 32 (14–76) | 41 (17–76) | 30 (11–76) | 0.766 |
| **Walking, min·day$^{-1}$** | 34±16 | 37±14 | 31±11 | 0.376 |
| **Sitting, min·day$^{-1}$** | 443±122 | 448±132 | 436±114 | 0.671 |
| **Lying, min·day$^{-1}$** | 494 (144–617) | 509 (144–668) | 471 (135–570) | 0.286 |
| **Sitting+lying, min·day$^{-1}$** | 969 (544–1096) | 1014 (646–1101) | 957 (505–1083) | 0.274 |
| **Wearing time, min·day$^{-1}$** | 961±111 | 963±117 | 958±106 | 0.826 |

Values are presented as mean±SD or median (IQR) according to the normality in data distribution, unless otherwise indicated. MVPA: moderate-to-vigorous physical activity.

**TABLE 3** Linear regressions and ICCs of all combinations of days for assessment of variables of sedentary behaviour

| Variables/combinations | $R^2$ adjusted | p-value | ICC | p-value |
|---|---|---|---|---|
| **Time spent per day in sedentary behaviour** | | | | |
| 1 day | 0.652–0.763 | <0.0001 | 0.828–0.920 | <0.0001 |
| 2 days | 0.809–0.886 | <0.0001 | 0.895–0.937 | <0.0001 |
| 3 days | 0.883–0.938 | <0.0001 | 0.940–0.969 | <0.0001 |
| **4 days** | **0.934–0.964** | **<0.0001** | **0.967–0.982** | **<0.0001** |
| 5 days | 0.964–0.978 | <0.0001 | 0.982–0.989 | <0.0001 |
| 6 days | 0.986–0.990 | <0.0001 | 0.993–0.995 | <0.0001 |
| 7 days | 1.00 | <0.0001 | 1.00 | <0.0001 |
| **Sitting time** | | | | |
| 1 day | 0.524–0.776 | <0.0001 | 0.833–0.914 | <0.0001 |
| 2 days | 0.753–0.869 | <0.0001 | 0.865–0.929 | <0.0001 |
| 3 days | 0.862–0.938 | <0.0001 | 0.929–0.968 | <0.0001 |
| **4 days** | **0.929–0.931** | **<0.0001** | **0.962–0.980** | **<0.0001** |
| 5 days | 0.955–0.976 | <0.0001 | 0.977–0.988 | <0.0001 |
| 6 days | 0.980–0.991 | <0.0001 | 0.990–0.996 | <0.0001 |
| 7 days | 1.00 | <0.0001 | 1.00 | <0.0001 |
| **Lying time** | | | | |
| 1 day | 0.864–0.934 | <0.0001 | 0.963–0.982 | <0.0001 |
| **2 days** | **0.948–0.950** | **<0.0001** | **0.972–0.984** | **<0.0001** |
| 3 days | 0.964–0.979 | <0.0001 | 0.982–0.990 | <0.0001 |
| 4 days | 0.980–0.987 | <0.0001 | 0.990–0.994 | <0.0001 |
| 5 days | 0.990–0.995 | <0.0001 | 0.995–0.998 | <0.0001 |
| 6 days | 0.997–0.998 | <0.0001 | 0.998–0.999 | <0.0001 |
| 7 days | 1.00 | <0.0001 | 1.00 | <0.0001 |
| **Sitting+lying time** | | | | |
| 1 day | 0.874–0.931 | <0.0001 | 0.966–0.981 | <0.0001 |
| **2 days** | **0.937–0.973** | **<0.0001** | **0.968–0.986** | **<0.0001** |
| 3 days | 0.960–0.984 | <0.0001 | 0.980–0.992 | <0.0001 |
| 4 days | 0.975–0.991 | <0.0001 | 0.988–0.996 | <0.0001 |
| 5 days | 0.993–0.995 | <0.0001 | 0.992–0.998 | <0.0001 |
| 6 days | 0.996–0.998 | <0.0001 | 0.998–0.999 | <0.0001 |
| 7 days | 1.00 | <0.0001 | 1.00 | <0.0001 |

Bold indicates the number of days in which values are all >0.90. The intervals in the table refer to the lowest and highest values of the ICCs and regressions. ICC: intraclass correlation coefficient.

GOLD stages (supplementary table S7). When daylight time was considered as an adjustment factor in the regression analyses, no difference was found in the number of days required for assessing variables of sedentary behaviour (supplementary table S8).

Table 4 shows the proportion of time spent in sedentary behaviour (analysed through different variables) for each day as a percentage of the total wearing time. Results show that patients with COPD spend most of their time in sedentary behaviour regardless of the day, including weekdays and weekend days ($p>0.586$ for all).

In addition, variables of sedentary behaviour separated by each day of the week are described in supplementary table S9. Results show that even when comparing each single day of the week, there were no differences between men and women regarding the pattern of sedentary behaviour ($p>0.116$ for all). Furthermore, supplementary table S9 shows that Sundays presented significantly higher sitting+lying time than Fridays across the whole group (corresponding to ~6.5% difference). No other between-day significant differences were found for any other variable.

## Discussion

This is the first study to propose a standardisation of the minimum number of days needed to cross-sectionally evaluate sedentary behaviour in individuals with COPD. Results showed that the evaluation of sedentary behaviour in this population depends on the variable used, so that any combination of 4 days is required to assess time spent per day in activities ⩽1.5 METs and sitting time, and any

**TABLE 4** Proportion of time spent in sedentary behaviour (analysed through different variables) as a percentage of the total wearing time

| | Time spent per day in sedentary behaviour | Sitting time per day | Lying time per day | Lying+sitting time per day |
|---|---|---|---|---|
| **Monday** | 67±12 | 31±15 | 42±10 | 73±15 |
| **Tuesday** | 65±14 | 32±12 | 40±11 | 72±10 |
| **Wednesday** | 66±15 | 31±17 | 37±13 | 68±16 |
| **Thursday** | 63±12 | 31±14 | 38±16 | 69±15 |
| **Friday** | 61±11 | 39±13 | 38±15 | 77±16 |
| **Saturday** | 63±12 | 31±15 | 40±14 | 71±14 |
| **Sunday** | 69±13 | 35±16 | 35±12 | 70±14 |
| **Mean of all days** | 65±14 | 33±16 | 37±15 | 74±15 |

Values are presented as the mean±SD of the percentage of wearing time. $p>0.586$ for all variables when comparing all days (Monday to Sunday).

combination of 2 days is required to assess lying time and lying+sitting time. Taking these results into account, four assessment days can be recommended in general to reliably measure all main outcomes related to sedentary behaviour in this population. Moreover, these results are independent of sex, disease severity, day of the week, daylight time and/or the occurrence of daytime naps.

Previous literature has shown a wide variety of number of assessment days for quantifying the level of physical (in)activity [5, 31]. Most studies evaluating sedentary behaviour were cross-sectional and the focus period ranged between two and seven assessment days [6, 8–10, 14–20]. Concerning a longitudinal approach, Demeyer *et al.* [29] suggested that changes in the level of physical activity of individuals with COPD following pulmonary rehabilitation are best measured for at least 4 weekdays, including only days with at least 8 h of wearing time (during waking hours) and considering the difference in duration of daylight time as a covariate in the analysis. In that study [29], however, no such information was provided concerning variables of sedentary behaviour.

Because the present study provides solely a cross-sectional approach, the number of days necessary to capture longitudinal changes in sedentary behaviour remains to be defined. However, interesting information can be drawn from the study by Demeyer *et al.* [29] in view of the present study. In that study, including weekend days increased the variability of the analysis, possibly leading to the requirement of a higher number of assessment days. Others have also suggested that including more assessment days of physical activity in a longitudinal design enhances the robustness of the findings [32]. Interestingly, this was not observed in the present study, because weekend days or weekdays showed no influence on the definition of the number of days for cross-sectional assessment of sedentary behaviour. This reflects the fact that physical inactivity and sedentary behaviour are clearly different concepts and should therefore be considered separately. In other words, while moderate-to-vigorous physical activity may decrease in the weekends, sedentary time may tend to remain stable throughout the whole week, with no marked changes between weekdays and weekend days. The understanding of these differences is beyond the context of the present study and certainly deserves further investigation in the future.

In agreement with the present results, Pitta *et al.* [1] showed that most individuals with COPD spend a considerably high time sitting and lying in daily life. In addition, it has also been suggested that elderly individuals in general spend a large part of the day in the sitting position, which seems to be a characteristic of these subjects, regardless of whether or not they have a chronic disease [33]. It is known that the number of days needed for assessing physical (in)activity variables may be different according to the severity of COPD [2]. However, the present study identified that when assessing sedentary behaviour, the required number of assessment days was the same, regardless of disease severity (*i.e.* GOLD 2, 3 and 4). Future studies considering the assessment of longitudinal changes in sedentary behaviour, as well as in-depth differences in sedentary behaviour according to degrees of disease severity, are very welcome in order to complement the present results.

Previous evidence shows that healthy adults spend ∼46–59% of the day in sedentary behaviour [34]. In line with these results, the present study showed that individuals with COPD spend on average ∼65% of the day in sedentary activities (table 4). Therefore, part of the current challenge in this field is to lead

individuals to break sedentary bouts and turn this into an increase in moderate-to-vigorous physical activity bouts or even in bouts of light activities. Because a greater quantity of low intensity physical activity already leads to lower risk of COPD hospitalisations [35], detailed results pertaining to a reduction in sedentary behaviour and an increase in the frequency and duration of bouts of physical activity become even more relevant.

Given that sedentary behaviour and worse physical activity level have been independently associated with worse prognosis in individuals with COPD [4, 6, 36], an ideal goal would be to have as many patients as possible being physically active and non-sedentary. However, as a first step, patients may benefit from presenting at least one of these positive characteristics, avoiding the worse profile (*i.e.* physically inactive and sedentary). An intermediate goal that focuses on reducing time spent in sedentary behaviour and increasing participation in light intensity physical activity is a more realistic goal in this population and may offer a gateway to higher intensity physical activity. For all these reasons, knowing how to assess sedentary behaviour in this population is extremely important because the degree of sedentary behaviour can influence the patient's clinical condition, evolution and prognosis.

Results of the present study show that there was a difference between sitting+lying time per day between Sundays and Fridays (supplementary table S9). However, this concerned only one variable and only one between-days comparison, and values represent a difference of only 6.5%. Although a word of caution is required concerning this very specific result, it brings little practical implication and does not seem to be enough to interfere in the general message that the present results are not influenced by the day of the week.

Standardising the evaluation of sedentary behaviour has not yet been proposed; nevertheless, owing to the timely relevance of this outcome, this should be a goal of the research community. Assessment methods, whether subjective or objective, should be developed, validated, standardised, popularised and compared in free-living conditions. Objective measures are important for decreasing measurement error and providing detailed and individually reliable information on patterns of sedentarism and physical activity.

Although the SenseWear activity monitor has been widely used, including in individuals with COPD [2, 37], it is currently no longer commercialised, and the research field has moved on to other monitors. A systematic review identified that a limitation of the SenseWear is that it is difficult to properly detect walking speed in individuals who walk slowly and who need auxiliary devices and/or portable oxygen during ambulation [38]. By contrast, the ActiGraph GT3X activity monitor (ActiGraph, Pensacola, FL, USA), for example, appears to be a suitable option for assessment because it has moderate to good criterion validity and high correlations with energy expenditure [27] and is able to detect changes in energy expenditure with changing walking speed [39].

We hope this study may be one of the initial steps towards this necessary standardisation. Moreover, the present findings may have implications for study design and data processing in the future. Finally, they may potentially be cost saving for researchers and clinicians, and may reduce unnecessary burden on patients.

### *Study limitations*

The present study involves essentially individuals with moderate to very severe COPD, and therefore future studies may confirm or refute these findings in subjects with mild disease. In addition, caution is necessary in the generalisation of the present results because one of the accelerometers used is no longer commercially available, and future research may confirm whether these results are equally applicable to other physical activity monitors.

### *Conclusions*

An average of 4 days of objective monitoring is sufficient to adequately reflect the results of a 1-week assessment of all main outcomes related to sedentary behaviour in individuals with moderate to very severe COPD. These results were independent of sex, severity of disease, day of the week, daylight time and occurrence of daytime naps.

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