activAnalyzer: An R Shiny app to analyse ActiGraph accelerometer data and to implement the use of the PROactive Physical Activity in COPD instruments

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Statement of need

ActiGraph devices (ActiGraph LLC, Pensacola, FL) have been the most used accelerometers in scientific literature to measure physical activity (Bassett et al. 2015; Migueles et al. 2017). These devices, along with their software companion ActiLife (ActiGraph LLC, Pensacola, FL), allow to get movement data expressed in either *activity counts* or *G-force* units. Activity counts represent the amount of acceleration produced over a given epoch of time at the wearing position of the device. While analytic methods based on G-force data are developing, using activity counts to assess physical activity and sedentary behaviours remains common (Migueles et al. 2017). Interestingly, ActiGraph devices have been validated to implement the framework related to the use of the PROactive Physical Activity in COPD (chronic obstructive pulmonary disease) instruments (Dobbels et al. 2014; Gimeno-Santos et al. 2015; Garcia-Aymerich et al. 2021). Such a framework requires combining scores relating to answers of questionnaire items and scores relating to accelerometer metrics obtained from a week of measurement.

Due to the large size of data files to analyse when using accelerometry and due to the relative complexity of the implementation of some algorithms, a simple spreadsheet does not appear to be a feasible tool to complete all the accelerometer data analysis workflow from the same place. The 'Full' version of ActiLife software allows completing all the general steps of the data analysis workflow with activity counts but the cost of this ActiLife version may prevent teaching a wide audience to implement such a workflow and may also prevent working with large teams on recorded data ('Lite' versions of ActiLife software, that are at a lower cost than 'Full' versions, allow device initialisation and data downloading only). Moreover, there is no solution in ActiLife software to fully implement the PROactive framework for COPD patients described above.

Other ways than ActiLife software to analyse activity counts include using programming languages. R (R Core Team 2022) and Python (Python Software Foundation 2022) have been programming languages commonly used by scientists to build tools aiming at fostering physical activity data analysis. In R, the 'accelerometry' and 'nhanesaccel' packages by Van Domelen and Pittard (2014), the 'actigraph.sleepr' package by Petkova (2021), and the 'pawacc' package by Geraci (2017), provide several functions to perform analyses of interest with activity counts. In Python, the 'pyActigraphy' library by Hammad and Reyt (2020) also allows, among various other features, to handle ActiGraph activity counts. While useful for research settings, these ressources may be of a little interest for other settings where people have no programming skills, because they do not propose a GUI (graphical user interface) to help people who do not code and who have no time to learn this skill. Beyond the lack of a free and simple interface to analyse ActiGraph activity counts data, there is, to our knowledge, no app that allows an easy implementation of the PROactive framework with COPD patients that would be based on an analysis of ActiGraph activity counts. This is why we have developed the 'activAnalyzer' app. For now, a first main interest of this app is to allow teaching large groups of students or professionnals, who have no programming skills, to analyse activity counts for assessing physical behaviour. A second main interest is to allow an easy implementation of the PROactive framework with COPD patients when working with an ActiGraph accelerometer, this by clinicians, healthcare providers and/or researchers, either in clinical routine or in research setting.

Functionality and purpose of the software

'activAnalyzer' is an app built as a package using R programming language. The app can be used in three different ways as explained elsewhere (https://pydemull.github.io/activAnalyzer/), including (i) a standalone desktop application for Windows machines only thanks to the DesktopDeployR framework developed by Lee Pang; (ii) using R and RStudio software along with the CRAN version of the 'activAnalyzer' package (v1.0.4) or its development version from GitHub; (iii) using a shinyapps.io plateform. If used with R and RStudio, the app will require the installation of the TinyTeX distribution to generate .pdf reports, as explained on the app website.

When the user opens the app, they has to deal with four ordered sections. The first section allows the user to complete information related to the measurement setup (patient's characteristics, device position, etc.). In the second section, the user must upload an .agd data file ('.agd' being the extension of the initial file generated by ActiLife software when the user wants to work with activity counts data). Then, the user has to configure the app to detect nonwear time. The results from this first analysis can be visualised by the user, as shown in Figure 1.
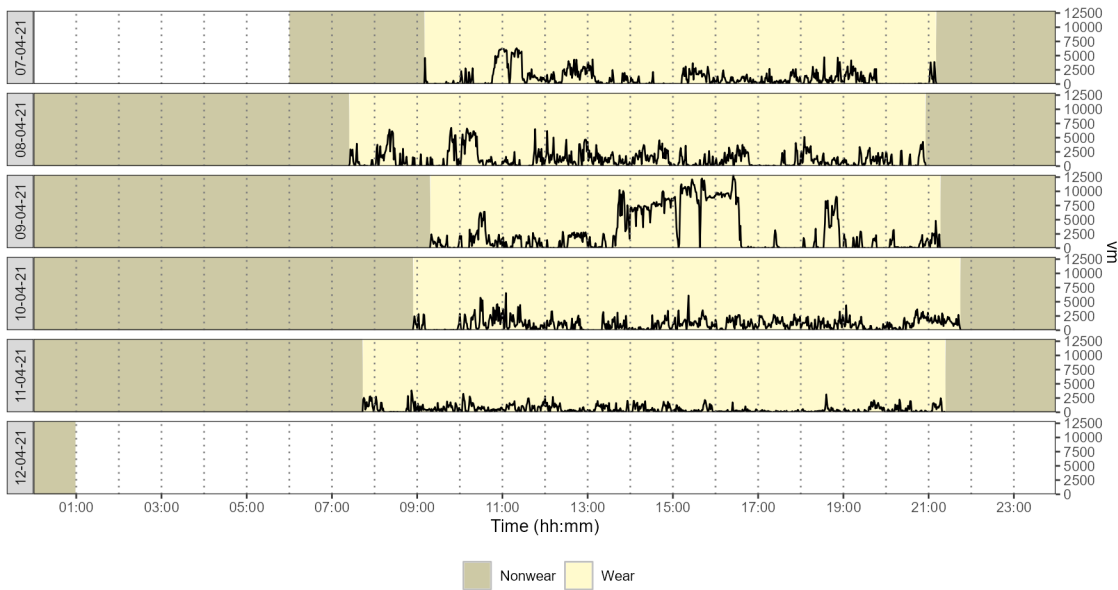

Figure 1: Example of analysis for nonwear time detection.

In a third section, the user has to select an equation to estimate energy expenditure and values to define cut-points in counts/min. Cut-points are the values below or above which one can be classified as being in sedentary behaviour or in light, moderate, or vigourous physical activity. Once the user has completed the configuration for intensity analysis, they can run analysis. Then, the user can see a figure showing time spent in the different categories of activity intensity (Figure 2), a table showing the results of the measurement for each day (Figure 3), and tables with daily means and daily medians, respectively, showing metrics summarised from valid days (e.g., Figure 4 for means).

Once analysis is finished, the user can generate a report of the measurement, download .csv files containing data produced by the app, or go to the questionnaires related to the PROactive framework. This last part consists of completing the chosen questionnaire, and downloading a report once analysis is completed.
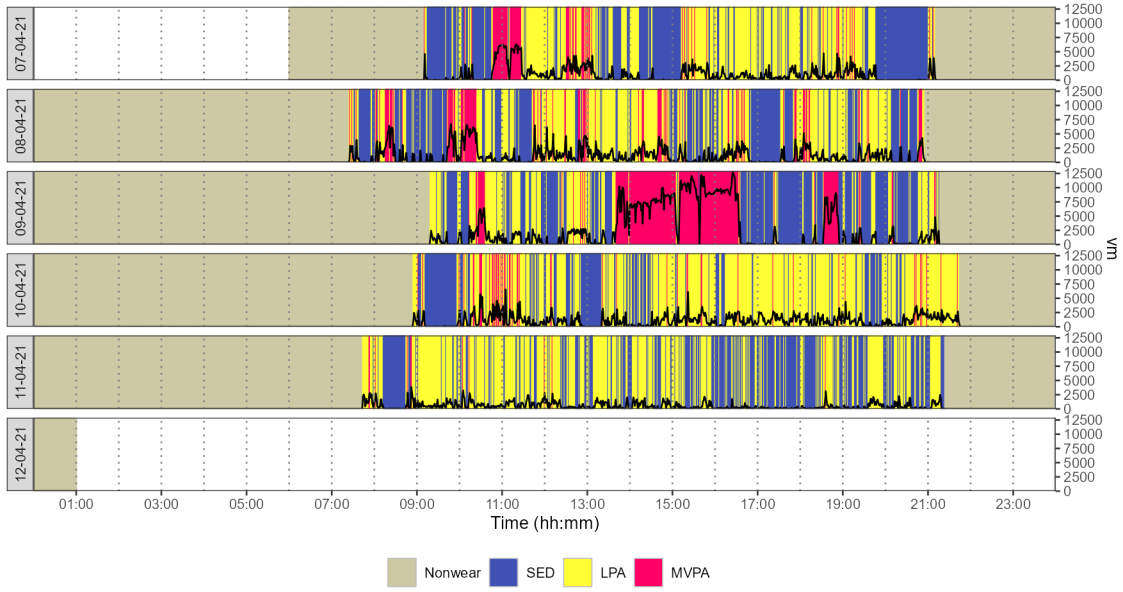
Figure 2: Example of analysis for intensity of physical behaviour.

	date	wear_time	total_counts_axis1	total_counts_vm	axis1_per_min	vm_per_min	total_steps	total_kcal
1	2021-04-07	720	359125	721645.8	498.78	1002.29	14056	2090.04
2	2021-04-08	811	495257	946481.6	610.67	1167.06	14595	2273.94
3	2021-04-09	718	1222315	1945733.9	1702.39	2709.94	21635	3273.24
4	2021-04-10	770	320847	806592.1	416.68	1047.52	13744	2128.08
5	2021-04-11	820	167999	431269.6	204.88	525.94	10315	1780.67
6	2021-04-12	0	0	0.0	NA	NA	0	1544.40

Figure 3: Example of table of results with the metrics for each day (first columns).

	valid_days	wear_time	total_counts_axis1	total_counts_vm	axis1_per_min	vm_per_min	total_steps	total_kcal
1	5	767.8	513108.6	970344.61	686.68	1290.55	14869	2309.19

Figure 4: Example of table of results with the means of the metrics from valid days (first columns).

Acknowledgements

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