Data Article

Data acquisition of timed-up and go test with older adults: accelerometer, magnetometer, electrocardiography and electroencephalography sensors’ data

Vasco Ponciano\textsuperscript{1,2}, Ivan Miguel Pires\textsuperscript{3,4,*}, Fernando Reinaldo Ribeiro\textsuperscript{1}, Nuno M. Garcia\textsuperscript{3}

\textsuperscript{1} R&D Unit in Digital Services, Applications and Content, Polytechnic Institute of Castelo Branco, 6000-767 Castelo Branco, Portugal
\textsuperscript{2} Altranportugal, 1990-096 Lisbon, Portugal
\textsuperscript{3} Instituto de Telecomunicações, Universidade da Beira Interior, 6200-001 Covilhã, Portugal
\textsuperscript{4} Department of Computer Science, Polytechnic Institute of Viseu, 3504-510 Viseu, Portugal

\begin{abstract}
We present a dataset related to the acquisition of different sensors data during the performance of the Timed-Up and Go test with the mobile device positioned in a waistband for the acquisition of accelerometer and magnetometer data, and a BITalino device positioned in a chest band for the acquisition of Electrocardiography and Electroencephalography for further processing. The data acquired from the BITalino device is acquired simultaneously by a Bluetooth connection with the same mobile application. The data was acquired in five institutions, including Centro Comunitário das Lameiras, Lar Nossa Senhora de Fátima, Centro Comunitário das Minas da Panasqueira, Lar da Misericórdia da Santa Casa da Misericórdia do Fundão, and Lar da Aldeia de Joanes da Santa Casa da Misericórdia do Fundão from Fundão and Covilhã municipalities (Portugal). This article describes the data acquired from a several subjects from the different institutions for the acquisition of accelerometer and magnetometer data, where each person performed the Timed-Up and
\end{abstract}

\* Corresponding author.

\textit{E-mail address:} impires@it.ubi.pt (I.M. Pires).

Social media: \texttt{Twitter} (I.M. Pires), \texttt{Twitter} (N.M. Garcia)

https://doi.org/10.1016/j.dib.2020.106306

2352-3409/© 2020 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Go test three times, where each output from the sensors was acquired with a sampling rate of 100 Hz. Related to the data acquired by the sensors connected to the BITalino device, 31 persons performed the different experiments related to the Timed-Up and Go Test. Following the data acquired from Electroencephalography and Electrocardiography sensors, only the data acquired from 14 individuals was considered valid. The data acquired by a BITalino device has a sampling rate of 100 Hz. These data can be reused for testing machine learning methods for the evaluation of the performance of the Timed-Up and Go test with older adults.

© 2020 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

### Specifications Table

| Subject                     | Electrical and Electronic Engineering Biomedical Engineering Health |
|----------------------------|-----------------------------------------------|
| Specific subject area      | Timed-Up and Go test Physical therapy Elderly |
| Type of data               | Table; Chart                                   |
| How data were acquired     | Accelerometer and magnetometer data were acquired with an Android application installed in a Smartphone XIAOMI MI 6 in a wristband. Electrocardiography and Electroencephalography were acquired with a BITalino device in a chest band. |
| Data format                | Raw text files                                 |
| Parameters for data collection | Older adults were instrumented with one waistband with the mobile device, and one chest band for the BITalino device. The participants were also instrumented with the Electrocardiography and Electroencephalography sensors connected to the BITalino device. The equipment is not intrusive, and the older adults were familiarized with the equipment before recording. The experimental procedure was explained before the data acquisition. |
| Description of data collection | After the instrumentation, the Timed-Up and Go test was performed three times by the participants involved in the study. The accelerometer and magnetometer data during the performance of the Timed-Up and Go test were concurrently collected by the mobile device and stored in text files for further analysis. The sensors of the mobile device have tree axis. Firstly, the accelerometer model embedded in the mobile device is the Bosch BMI160, and the frequencies of data acquisition are 200 Hz/400 Hz for specific forces, and 100 Hz/400 Hz for angular velocities. Secondly, the magnetometer model embedded in the mobile device is the AK09911, and the frequencies of data acquisition are in the range 50 Hz-200 Hz. At the same time, the mobile device is connected by Bluetooth to the BITalino device for the acquisition of Electrocardiography and Electroencephalography sensors’ data. The sample rate of 100 Hz was used for the different sensors connected to BITalino device. |
| Data source location       | Primary data sources: Institution: Centro Comunitário das Lameiras City/Town/Region: Silvares Country: Portugal Latitude and longitude for collected samples/data: 40° 8’ 31.003” N 7° 40’ 13.543” W Institution: Lar Nossa Senhora de Fátima City/Town/Region: Fundão Country: Portugal Latitude and longitude for collected samples/data: 40° 8’ 12.827” N 7° 30’ 4.3” W Institution: Centro Comunitário das Minas da Panasqueira City/Town/Region: Minas da Panasqueira Country: Portugal Latitude and longitude for collected samples/data: 40° 9’ 5.45” N 7° 44’ 33.599” W Institution: Lar da Misericórdia da Santa Casa da Misericórdia do Fundão City/Town/Region: Fundão Country: Portugal Latitude and longitude for collected samples/data: 40° 8’ 8.893” N 7° 30’ 28.702” W Institution: Lar da Aldeia de Joanes da Santa Casa da Misericórdia do Fundão City/Town/Region: Aldeia de Joanes Country: Portugal Latitude and longitude for collected samples/data: 40° 8’ 9.179” N 7° 31’ 6.825” W |
| Data accessibility         | Repository name: Timed-Up and Go Data retrieved from Centre of Portugal Data identification number: 10.17632/dv8xt3t3b3.3 Direct URL to data: https://data.mendeley.com/datasets/dv8xt3t3b3/ |
| Related research article   | V. Ponciano, I.M. Pires, F.R. Ribeiro, M.V. Villasana, R. Crisóstomo, M.C. Teixeira, E. Zdravevski, Mobile Computing Technologies for Health and Mobility Assessment: Research Design and Results of the Timed Up and Go Test in Older Adults, Sensors 2020. 20 (2020), 3481. https://doi.org/10.3390/s20123481 V. Ponciano, I.M. Pires, F.R. Ribeiro, N.M. Garcia, M.V. Villasana, P. Lameski, and E. Zdravevski, Machine Learning Techniques with ECG and EEG Data: An Exploratory Study, Computers 2020. 9, 55. https://doi.org/10.3390/computers9030055 |
Value of the Data

- The data provide a set of data acquired during the performance of the Timed-Up and Go test [1–3] with the sensors available in a mobile [4,5] and a BITalino devices [6], including accelerometer, magnetometer, Electroencephalography and Electrocardiography sensors;
- The data is important for the creation of solutions for automatic validation of Timed-Up and Go test, and, as we acquired Electroencephalography and Electrocardiography data, it will allows to the creation of patterns of different diseases [7–10] for further developments;
- The acquired data may be used for the recognition of different stages and activities during the Timed-Up and Go test, as well as the identification of diseases with machine learning techniques [10–12];
- The data are valid for the creation of disease patterns associated with movement, cardiac and brain frequency, and other problems related to walking activity, applying different techniques to reduce the artefacts [13–15].
- It also allows further research with the sensors available in off-the-shelf mobile devices for further creation of Mobile Health solutions [16,17].

1. Data Description

The dataset presented in this paper includes relevant information related to the performance of the Timed-Up and Go test. The data were acquired with a smartphone named XIAOMI MI 6, and a BITalino device with the Electrocardiography and Electroencephalography sensors.

The dataset is composed by a repository with two folders, including one named as “accelerometer_magnetometer” that contains the data acquired by the sensors embedded in the off-the-shelf mobile device, and another folder named “ecg_eeg” that contains the data acquired by the Electrocardiography and Electroencephalography connected to the BITalino device. These folders contain one folder for each institution of data collection. Next, each folder related to the different institutions includes one folder for each individual. Finally, each folder related to everyone contains folders for each data capture or repetition of the Timed-Up and Go test. The dataset contains a total of 89 files related to accelerometer and magnetometer sensors, and 72 files related to Electrocardiography and Electroencephalography captures. The data acquired from the mobile device are collected in m/s², and the data acquired from the BITalino device is acquired in millivolts.

The files related to the accelerometer sensor includes the following columns:

- First column: Timestamp of each data acquired in milliseconds (ms);
- Second column: Value of the x-axis of the accelerometer (m/s²);
- Third column: Value of the y-axis of the accelerometer (m/s²);
- Fourth column: Value of the z-axis of the accelerometer (m/s²).

Next, the files related to the magnetometer sensor includes the following columns:

- First column: Timestamp of each data acquired (ms);
- Second column: Value of the x-axis of the magnetometer (m/s²);
- Third column: Value of the y-axis of the magnetometer (m/s²);
- Fourth column: Value of the z-axis of the magnetometer (m/s²).

Finally, the files acquired from the BITalino device, including the Electroencephalography and Electrocardiography sensors, include the following columns:

- First column: Sequence number from BITalino device related to the frequency of the capture;
- Second column: Values of Electrocardiography sensor (mV);
- Third column: Values of Electroencephalography sensor (mV).

Magnetometer data, presented in Fig. 1, can be used to measure the instants for the changing of the direction. Thus, we studied two options for the detection of the changing of the direction. These are:
Fig. 1. Example of data acquisition of magnetometer for Timed-Up and Go Test.

Fig. 2. Average of data acquired by Magnetometer sensor by each person.

- By magnitude of vector: Corresponds to the minimum value of the acceleration of the data captured;
- By value of z axis: Corresponds to the first instant of the change of the signal of value of z axis.

Considering the data acquired from the magnetometer sensor during the performance of the Timed-Up and Go test, Table 1 and Fig. 2 present the dataset that contains data acquired from 31 individuals from the different institutions. The data presented in Table 1 are:

- Total test time (ms) → Total duration of the test in milliseconds;
- Turn around instant by the magnitude of vector (ms) → Number of milliseconds after the start of the data acquisition, where the individual changed the direction of the movement calculated by the magnitude of vector;
- Turn around instant by value of z axis (ms) → Number of milliseconds after the start of the data acquisition, where the individual changed the direction of the movement calculated by absolute value of z axis.

Accelerometer data, presented in Fig. 3, can be used to measure the reaction time, going time, turn around instant, and going time. These are:
### Table 1

Data collected from the Magnetometer sensor.

| #  | Institution                                         | Person ID | Total test time (ms) | Turn around instant by the magnitude of vector (ms) | Turn around instant by absolute of z axis (ms) |
|----|-----------------------------------------------------|-----------|----------------------|-----------------------------------------------------|-----------------------------------------------|
| 1  | Centro Comunitário Das Lameiras                     | 10        | 22190                | 13271                                               | 8433                                          |
| 2  | Centro Comunitário Das Lameiras                      | 12        | 27332                | 6964                                                | 15424                                         |
| 3  | Centro Comunitário Das Lameiras                      | 3         | 28937                | 20776                                               | 14157                                         |
| 4  | Centro Comunitário Das Lameiras                      | 5         | 21651                | 7988                                                | 11338                                         |
| 5  | Centro Comunitário Das Lameiras                      | 6         | 40410                | 19750                                               | 19590                                         |
| 6  | Centro Comunitário Das Lameiras                      | 8         | 31495                | 18123                                               | 25683                                         |
| 7  | Centro Comunitário Das Lameiras                      | 9         | 22457                | 5696                                                | 18577                                         |
| 8  | Lar da Aldeia de Joanés da Santa Casa da Misericórdia do Fundão | 1         | 74053                | 30070                                               | 23034                                         |
| 9  | Centro Comunitário das Minas da Panasqueira          | 1         | 74053                | 30070                                               | 23034                                         |
| 10 | Centro Comunitário das Minas da Panasqueira          | 4         | 30107                | 27487                                               | 19308                                         |
| 11 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 10       | 38305                | 42285                                               | 27844                                         |
| 12 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 12       | 22105                | 9727                                                | 19205                                         |
| 13 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 13       | 20755                | 2591                                                | 15875                                         |
| 14 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 14       | 34990                | 3966                                                | 25648                                         |
| 15 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 15       | 37584                | 30805                                               | 30731                                         |
| 16 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 18       | 66947                | 3836                                                | 8704                                          |
| 17 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 20       | 46608                | 51742                                               | 23762                                         |
| 18 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 3        | 29397                | 26044                                               | 25931                                         |
| 19 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 5        | 32318                | 18447                                               | 13908                                         |
| 20 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 6        | 21157                | 3967                                                | 16266                                         |
| 21 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 8        | 19819                | 10344                                               | 16509                                         |
| 22 | Lar Nossa Senhora de Fátima                         | 1         | 40706                | 28895                                               | 33206                                         |
| 23 | Lar Nossa Senhora de Fátima                         | 10        | 52377                | 22804                                               | 39465                                         |
| 24 | Lar Nossa Senhora de Fátima                         | 11        | 37737                | 13757                                               | 27056                                         |
| 25 | Lar Nossa Senhora de Fátima                         | 13        | 44071                | 38031                                               | 39649                                         |
| 26 | Lar Nossa Senhora de Fátima                         | 16        | 30923                | 16989                                               | 23555                                         |
| 27 | Lar Nossa Senhora de Fátima                         | 17        | 38345                | 31644                                               | 27205                                         |
| 28 | Lar Nossa Senhora de Fátima                         | 7         | 28835                | 16996                                               | 24543                                         |
| 29 | Lar Nossa Senhora de Fátima                         | 8         | 30663                | 12223                                               | 30643                                         |
| 30 | Lar Nossa Senhora de Fátima                         | 9         | 29504                | 4336                                                | 25740                                         |
| 31 | Lar Nossa Senhora de Fátima                         | 2         | 26930                | 11310                                               | 17570                                         |

- Reaction time: Corresponds to the time where the data is 9.81 +/- 1 m/s²;
- Turn around instant: Corresponds to the instant where the data is 9.81 +/- 1 m/s², after the reaction time;
- Going time: Corresponds to the time between the reaction time, and the Turn around instant;
- Return time: Corresponds to the time between the Turn around instant, and the end of the capture.
Fig. 3. Example of data acquisition of accelerometer for Timed-Up and Go Test.

Fig. 4. Average of data acquired by Accelerometer sensor by each person.

Considering the data acquired from the accelerometer sensor during the performance of the Timed-Up and Go test, Table 2, and Fig. 4 present the dataset that contains data acquired from 16 individuals from the different institutions. The values related to acceleration or magnitude of vector were calculated by the Euclidean norm of each vector acquired. The data presented in Table 2 are:

- Total test time (ms) ➔ Total duration of the test in milliseconds;
- Duration of turn around (ms) ➔ Duration of the movement related with the changing of the direction;
- Turn around instant (ms) ➔ Number of milliseconds after the start of the data acquisition, where the individual changed the direction of the movement calculated by the magnitude of vector;
- Going time (ms) ➔ Number of milliseconds elapsed before the changing of the direction;
- Return time (ms) ➔ Number of milliseconds elapsed after the changing of the direction;
- Average of acceleration during going time (m/s²) ➔ Average of the values calculated with the Euclidean norm until the changing of the direction;
Table 2
Data collected from the Accelerometer sensor related to the acceleration.

| #  | Institution                                    | Person ID | Reaction time (ms) | Total test time (ms) | Duration of turn around (ms) | Turn around Instant (ms) | Going time (ms) | Return time (ms) | Average of acceleration during going time (m/s²) | Average of acceleration during return time (m/s²) |
|----|------------------------------------------------|-----------|--------------------|----------------------|-----------------------------|--------------------------|----------------|----------------|-----------------------------------------------|-----------------------------------------------|
| 1  | Centro Comunitário Das Lameiras                | 10        | 8970               | 23169                | 402                         | 10417                    | 1447           | 12752          | 10.05                                         | 10.09                                         |
| 2  | Centro Comunitário Das Lameiras                | 12        | 8265               | 23036                | 408                         | 9628                     | 1363           | 13408          | 9.86                                          | 9.89                                          |
| 3  | Centro Comunitário Das Lameiras                | 3         | 14369              | 28854                | 408                         | 19858                    | 5489           | 8996           | 9.80                                          | 9.85                                          |
| 4  | Centro Comunitário Das Lameiras                | 5         | 9018               | 23689                | 406                         | 12356                    | 3338           | 11333          | 9.85                                          | 9.92                                          |
| 5  | Centro Comunitário Das Lameiras                | 9         | 7552               | 22909                | 401                         | 15798                    | 8237           | 7120           | 10.05                                         | 10.05                                         |
| 6  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 12 | 9728               | 22590                | 405                         | 12664                    | 2936           | 11926          | 10.05                                         | 10.06                                         |
| 7  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 13 | 6618               | 22295                | 401                         | 7407                     | 789            | 14888          | 10.05                                         | 10.04                                         |
| 8  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 14 | 9773               | 40083                | 408                         | 10949                    | 1176           | 29134          | 9.82                                          | 9.83                                          |
| 9  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 15 | 12595              | 45978                | 401                         | 14602                    | 2007           | 31376          | 10.04                                         | 10.01                                         |
| 10 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 6  | 6203               | 25254                | 409                         | 7575                     | 1372           | 17679          | 10.04                                         | 10.05                                         |
| 11 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 8  | 8383               | 22286                | 401                         | 14668                    | 6285           | 7618           | 9.85                                          | 9.88                                          |
| 12 | Lar Nossa Senhora de Fátima                    | 1         | 14639              | 30044                | 409                         | 15458                    | 819            | 24586          | 9.82                                          | 9.85                                          |
| 13 | Lar Nossa Senhora de Fátima                    | 13        | 9195               | 44724                | 407                         | 9985                     | 790            | 34739          | 9.99                                          | 10.03                                         |
| 14 | Lar Nossa Senhora de Fátima                    | 16        | 7272               | 42296                | 408                         | 8000                     | 728            | 34296          | 9.93                                          | 10.02                                         |
| 15 | Lar Nossa Senhora de Fátima                    | 17        | 14639              | 40044                | 409                         | 15458                    | 819            | 24586          | 9.82                                          | 9.85                                          |
| 16 | Lar Nossa Senhora de Fátima                    | 7         | 19986              | 37853                | 407                         | 21133                    | 1147           | 16720          | 10.03                                         | 10.05                                         |
### Table 3
Data collected from the Electrocardiography sensor.

| #  | Institution                                                      | Person ID | Heart Rate (bps) | Heart Rate Variability (%) | Average of QRS interval (ms) | Average of R-R interval (ms) | Average of R-S interval (ms) |
|----|------------------------------------------------------------------|-----------|------------------|----------------------------|------------------------------|-----------------------------|------------------------------|
| 1  | Centro Comunitário das Lameiras                                  | 3         | 107              | 58.0                       | 598.5                        | 899                         | 396                         |
| 2  | Centro Comunitário das Minas da Panasqueira                      | 2         | 86               | 116.0                      | 614.1                        | 1651                        | 321                         |
| 3  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão      | 12        | 99               | 97.5                       | 627.0                        | 1693                        | 279                         |
| 4  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão      | 13        | 86               | 95.5                       | 762.8                        | 2013                        | 279                         |
| 5  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão      | 14        | 100              | 89.3                       | 617.3                        | 1678                        | 343                         |
| 6  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão      | 17        | 86               | 115.6                      | 642.6                        | 1302                        | 334                         |
| 7  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão      | 18        | 94               | 120.0                      | 619.0                        | 1018                        | 683                         |
| 8  | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão      | 20        | 84               | 120.7                      | 675.2                        | 1198                        | 15.77                       |
| 9  | Lar da nossa senhora de Fátima                                   | 10        | 94               | 87.3                       | 656.4                        | 1725                        | 348                         |
| 10 | Lar da Nossa Senhora de Fátima                                   | 15        | 97               | 122.0                      | 620.0                        | 1265                        | 277                         |
| 11 | Lar da Nossa Senhora de Fátima                                   | 17        | 97               | 110.0                      | 713.5                        | 2169                        | 255                         |
| 12 | Lar da nossa senhora de Fátima                                   | 5         | 89               | 73.0                       | 686.1                        | 1663                        | 390                         |
| 13 | Lar da nossa senhora de Fátima                                   | 7         | 99               | 97.3                       | 579.6                        | 1574                        | 295                         |
| 14 | Lar da Nossa Senhora de Fátima                                   | 9         | 87               | 84.0                       | 674.1                        | 1363                        | 351                         |

**Fig. 5.** Average of data acquired by Electrocardiography sensor by each person.

- Average of acceleration during return time (m/s²) → Average of the values calculated with the Euclidean norm after the changing of the direction.

Considering the data acquired from the Electrocardiography sensor during the performance of the Timed-Up and Go test, Table 3 and Fig. 5 present the dataset that contains data acquired from 14 individuals from the different institutions.

Considering the data acquired from the Electroencephalography sensor during the performance of the Timed-Up and Go test, Table 4 and Fig. 6 present the dataset that contains data acquired from 14 individuals from the different institutions.
Table 4
Data collected from the Electroencephalography sensor.

| # | Institution                                                 | Person ID | Frequency | Variability (%) |
|---|-------------------------------------------------------------|-----------|-----------|-----------------|
| 1 | Centro Comunitário das Lameiras                             | 3         | 151       | 31              |
| 2 | Centro Comunitário das Minas da Panasqueira                 | 2         | 243       | 110             |
| 3 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 12        | 157       | 118             |
| 4 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 13        | 122       | 64              |
| 5 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 14        | 313       | 85              |
| 6 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 17        | 277       | 109             |
| 7 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 18        | 434       | 89              |
| 8 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 20        | 272       | 122             |
| 9 | Lar da nossa senhora de Fátima                              | 10        | 328       | 79              |
| 10| Lar da Nossa Senhora de Fátima                              | 15        | 284       | 112             |
| 11| Lar da Nossa Senhora de Fátima                              | 17        | 299       | 111             |
| 12| Lar da nossa senhora de Fátima                              | 5         | 111       | 85              |
| 13| Lar da nossa senhora de Fátima                              | 7         | 218       | 71              |
| 14| Lar da Nossa Senhora de Fátima                              | 9         | 208       | 77              |

Fig. 6. Average of data acquired by Electroencephalography sensor by each person.

2. Experimental Design, Materials and Methods

The Timed-Up and Go test was implemented according an experimental protocol that includes the following steps:

- Several older adults from the different institutions were instrumented with the mobile device, and Electrocardiography and Electroencephalography sensors connected to a BITalino device;
- Each subject performed the Timed-Up and Go test three consecutive times. The test included the following activities:
  - Sit down on the chair;
  - Stand up from the chair;
  - Walk three meters;
  - Turn around;
  - Walk another three meters;
  - Sit down on the chair again.
3. Participants

A total of 37 individuals with different types of diseases aged between 73 and 92 years old were selected for participation as reported in Table 5. Between them, some experiments were invalidated, and some individuals were not considered as presented in Tables 1 to 4. The different diseases identified in Table 5 were indicated by the responsible persons of the institutionalized older adults. In Lar da Aldeia de Joanes da Santa Casa da Misericórdia do Fundão, Centro Comunitário das Minas da Panasqueira, and Lar da Misericórdia da Santa Casa da Misericórdia do Fundão, the participants used a chair with armrests that helped in the movement for standing up from the chair. The test conditions are also reported in Table 5 because they influence the results of the data acquisition.

• Age = 84.5625 ± 6.9093 years old

4. Procedure

The different sensors data were recorded during the voluntary performance of the Timed-Up and Go test by institutionalized individuals with the smartphone on a waistband, and a Bitalino device with the Electrocardiography and Electroencephalography sensors attached to the individuals positioned in a chest band.

Initially, the individuals were instrumented as presented in Fig. 7. Then, they performed the test procedure three times.

There is high importance to the results related to the positioning of the sensors. Thus, there are different rules to instrument the different individuals during the experiments. These are:

i) Put the smartphone in a waistband in the horizontal orientation;
ii) Attach the waistband to the individual;
iii) Put the Electrocardiography and the Electroencephalography sensors on the individuals as presented in Fig. 5;

![Fig. 7. Sensors placement.](image-url)
Table 5
Population of the study.

| #  | Institution                                           | Person ID | Diseases                                      | Age (years old) | Availability of Armrests | Physical conditions                                      | Mobile network coverage | Presence of physical therapist |
|----|-------------------------------------------------------|-----------|-----------------------------------------------|-----------------|-------------------------|----------------------------------------------------------|-------------------------|--------------------------------|
| 1  | Centro Comunitário das Lameiras                       | 10        | Arthrosis                                     | 85              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 2  | Centro Comunitário das Lameiras                       | 12        | Gastroenteritis                               | 92              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 3  | Centro Comunitário das Lameiras                       | 3         | Arterial hypertension; Arthrosis              | 85              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 4  | Centro Comunitário das Lameiras                       | 5         | Arterial hypertension; Cardiac arrhythmia     | 92              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 5  | Centro Comunitário das Lameiras                       | 6         | Arterial hypertension; Cardiac arrhythmia; Diabetes mellitus Type II; Scoliosis | 92  | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 6  | Centro Comunitário das Lameiras                       | 7         | Scoliosis                                     | 85              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 7  | Centro Comunitário das Lameiras                       | 8         | Osteoporosis                                  | 83              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 8  | Centro Comunitário das Lameiras                       | 9         | Arthrosis                                     | 87              | No                      | Spacious place. Floor with the right conditions.         | Available              | Yes                            |
| 9  | Lar da Aldeia de Joanes da Santa Casa da Misericórdia do Fundão | 1         | N/D                                           | N/D             | Yes                     | Floor with the right conditions.                         | Weak                   | No                             |
| 10 | Centro Comunitário das Minas da Panasqueira           | 1         | Arterial hypertension                         | 88              | Yes                     | Floor with the right conditions.                         | No                      | No                             |
| 11 | Centro Comunitário das Minas da Panasqueira           | 2         | Arterial hypertension; Cardiac arrhythmia; Arteriosclerotic coronary disease; Heart failure | 84  | Yes                     | Floor with the right conditions.                         | No                      | No                             |
| 12 | Centro Comunitário das Minas da Panasqueira           | 4         | N/D                                           | 65              | Yes                     | Floor with the right conditions.                         | No                      | No                             |
| 13 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 3         | N/D                                           | 91              | Yes                     | Flat ground with a slight slope.                        | Weak                   | No                             |
| 14 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 5         | N/D                                           | 84              | Yes                     | Flat ground with a slight slope.                        | Weak                   | No                             |

(continued on next page)
| #  | Institution                                      | Person ID | Diseases                                                                 | Age (years old) | Availability of Armrests | Physical conditions                                      | Mobile network coverage | Presence of physical therapist |
|----|--------------------------------------------------|-----------|--------------------------------------------------------------------------|-----------------|--------------------------|----------------------------------------------------------|-------------------------|--------------------------------|
| 15 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 6         | Hernioplasty in 2010; Sarcoidosis                                         | 87              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 16 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 8         | Chronic obstructive pulmonary disease; Chronic bronchitis; Osteoarthritis | 73              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 17 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 10        | Cirrhosis; Anemia; Chronic kidney disease; Umbilical hernia; Inginal hernia | 79              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 18 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 12        | Right leg amputation; Umbilical hernia; Arterial hypertension             | 88              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 19 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 13        | Prostate Cancer; Parkinson’s disease; Post-traumatic stress               | 76              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 20 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 14        | Arterial hypertension; Diabetes mellitus Type II                          | 86              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 21 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 15        | Prostate Cancer; Osteoporosis; Chronic Venous Insufficiency of the lower limbs; Chronic bronchitis | 92              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 22 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 17        | Diabetes mellitus Type II; Arterial hypertension; Depression; Sequelae of surgery to brain injury | 83              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 23 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 18        | Diabetes mellitus Type II; Vertigo syndrome; Chronic headaches; Osteoarthrosis; Prosthesis in the right humeral; Osteoporosis; Arterial hypertension | 81              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 24 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 19        | Arterial hypertension; Anemia                                             | 91              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 25 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 20        | Osteoarthritis; Depression; Heart failure; Arterial hypertension; Osteoporosis | 89              | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 26 | Lar da Misericórdia da Santa Casa da Misericórdia do Fundão | 1         | N/D                                                                      | N/D             | Yes                      | Flat ground with a slight slope.                        | Weak                    | No                             |
| 27 | Lar da Nossa Senhora de Fátima                      | 10        | Diabetes mellitus Type II                                                 | 86              | No                       | Narrow location. The floor and width of the test site were very tight. | Good                    | No                             |
### Table 5 (continued)

| #   | Institution                                      | Person ID | Diseases                                                                 | Age (years old) | Availability of Armrests | Physical conditions                                                                 | Mobile network coverage | Presence of physical therapist |
|-----|--------------------------------------------------|-----------|---------------------------------------------------------------------------|-----------------|--------------------------|---------------------------------------------------------------------------------------|--------------------------|-------------------------------|
| 28  | Lar da nossa senhora de Fátima                   | 11        | Dementia of vascular etiology; Prostate cancer; Arterial hypertension; Vertigo syndrome Depression; Osteoporosis | N/D             | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 29  | Lar da nossa senhora de Fátima                   | 13        | Depression; Osteoporosis                                                  | 83              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 30  | Lar da Nossa Senhora de Fátima                   | 15        | Diabetes mellitus Type II; Osteoarthritis                                 | 87              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 31  | Lar da Nossa Senhora de Fátima                   | 16        | Diabetes mellitus Type II; Arterial hypertension; Heart failure; Hyperuricemia; Depression; Bilateral gonarthritis | N/D             | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 32  | Lar da nossa senhora de Fátima                   | 17        | Prostate cancer                                                           | 88              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 33  | Lar da Nossa Senhora de Fátima                   | 5         | Heart failure; Chronic obstructive pulmonary disease; Bilateral gonarthritis | 97              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 34  | Lar da nossa senhora de Fátima                   | 7         | Diabetes mellitus Type II; Arterial hypertension                          | 71              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 35  | Lar da nossa senhora de Fátima                   | 8         | Arterial hypertension                                                     | 74              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 36  | Lar da Nossa Senhora de Fátima                   | 9         | Osteoarthritis; Lumbar hernias; Depression; Gastric ulcer                 | 82              | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
| 37  | Lar da Nossa Senhora de Fátima                   | 2         | Heart failure; Arterial hypertension; Pulmonary fibrosis; Hyperuricemia; Anemia; Chronic kidney disease; Cardiac arrhythmia; Acute myocardial infarction; Hypocoagulated | N/D             | No                       | Narrow location. The floor and width of the test site were very tight.                | Good                     | No                            |
iv) Connect the Electrocardiography and the Electroencephalography sensors to the BITalino device;

v) Put the BITalino device in a chest band;

vi) Attach the chest band to the individual;

vii) Open the mobile application used for data acquisition;

viii) Connect the BITalino device to the mobile application;

ix) Start the data acquisition, and the individual performs the test;

x) After the performance of the test, stop the data acquisition.

The signals are collected and stored in text readable files for further analysis. As the smartphone is in the horizontal orientation, the different axes of the sensors are represented in Fig. 8.

**Ethics Statement**

The participants signed an ethical agreement to allow us to share the results of the tests in an anonymous form. The agreement also provided the participants’ informed consent considering the risks and the objective of the study. Ethics Committee from Escola Superior de Saúde Dr. Lopes Dias at Polytechnic Institute of Castelo Branco approved the study with the number 114/CE-ESALD/2019.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Acknowledgments**

This work is funded by FCT/MEC through national funds and, when applicable, co-funded by the FEDER-PT2020 partnership agreement under the project UIDB/50008/2020. (Este trabalho é financiado pela FCT/MEC através de fundos nacionais e cofinanciado pelo FEDER, no âmbito do Acordo de Parceria PT2020 no âmbito do projeto UIDB/50008/2020).

This article is based upon work from COST Action IC1303-AAPELE—Architectures, Algorithms, and Protocols for Enhanced Living Environments and COST Action CA16226—SHELD-ON—Indoor living space improvement: Smart Habitat for the Elderly, supported by COST (European Cooperation in Science and Technology). COST is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their
ideas by sharing them with their peers. It boosts their research, career, and innovation. More information in www.cost.eu.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi: 10.1016/j.dib.2020.106306.

References

[1] M. Milosevic, E. Jovanov, A. Milenkovic, Quantifying timed-up-and-go test: a smartphone implementation, in: 2013 IEEE International Conference on Body Sensor Networks, Cambridge, MA, USA, May 2013, pp. 1–6, doi: 10.1109/BSN.2013.6575478.

[2] V. Ponciano, et al., Smartphone-based automatic measurement of the results of the Timed-Up and Go test, in: Proceedings of the 5th EAI International Conference on Smart Objects and Technologies for Social Good, 2019, pp. 239–242.

[3] D. Vervoort, N. Vuillerme, N. Kosse, T. Hortobágyi, C.J.C. Lamothe, Multivariate analyses and classification of inertial sensor data to identify aging effects on the timed-up-and-go test, PLOS ONE 11 (6) (Jun. 2016) e0155984, doi: 10.1371/journal.pone.0155984.

[4] P. Sousa, D. Sabugueiro, V. Felizardo, R. Couto, I. Pires, N. Garcia, Health sensors and applications for personal aid, in: Mobile Health, Springer, Cham, 2015, pp. 265–281.

[5] V. Felizardo, et al., E-Health: current status and future trends, in: Handbook of Research on Democratic Strategies and Citizen-Centered E-Government Services, IGI Global, 2015, pp. 302–326.

[6] D. Batista, H. Silva, A. Fred, Experimental characterization and analysis of the BiTalino platforms against a reference device, in: 2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Seogwipo, 2017, pp. 2418–2421, doi: 10.1109/EMBC.2017.8037344.

[7] I.M. Pires, et al., Pattern recognition techniques for the identification of activities of daily living using a mobile device accelerometer, Electronics 9 (3) (2020) 509, doi: 10.3390/electronics9030509.

[8] P Broderick J, J Phillips S, M O’Fallon W, L Frye R, P Whisnant J, Relationship of cardiac disease to stroke occurrence, recurrence, and mortality, Stroke 23 (9) (1992) 1250–1256, doi: 10.1161/01.STR.23.9.1250.

[9] A. Suppa, et al., l-DOPA and freezing of gait in parkinson’s disease: objective assessment through a wearable wireless system, Front. Neurol. 8 (2017) 406, doi: 10.3389/fneur.2017.00406.

[10] M. De Vos, J. Prince, T. Buchanan, J.J. FitzGerald, C.A. Antoniades, Discriminating progressive supranuclear palsy from Parkinson’s disease using wearable technology and machine learning, Gait & Posture 77 (2020) 257–263, doi: 10.1016/j.gaitpost.2020.02.007.

[11] K. Sasani, et al., Gait speed and survival of older surgical patient with cancer: prediction after machine learning. J. Geriatric Oncol. 10 (1) (2019) 120–125, doi: 10.1016/j.jgo.2018.06.012.

[12] I. M. Pires et al., “Android library for recognition of activities of daily living: implementation considerations, challenges, and solutions.” 2018.

[13] S.E.P. Costa, J.P.C. Rodrigues, B.M.C. Silva, J.N. Isento, J.M. Corchado, Integration of wearable solutions in AAL environments with mobility support, J Med Syst 39 (12) (2015) 184, doi: 10.1007/s10916-015-0342-z.

[14] P. Madhushri, A.A. Dzhagaryan, E. Jovanov, A. Milenkovic, A Smartphone application suite for assessing mobility, in: 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Orlando, FL, USA, 2016, pp. 3117–3120, doi: 10.1109/EMBC.2016.7591389.

[15] D. Podsiało, S. Richardson, The timed ‘up & go’: a test of basic functional mobility for frail elderly persons, J. American Geriatrics Soc. 39 (2) (1991) 142–148, doi: 10.1111/j.1532-5415.1991.tb01616.x.

[16] I.M. Pires, N.M. Garcia, N. Pombo, F. Flórez-Revuelta, N.D. Rodríguez, Validation techniques for sensor data in mobile health applications. J. Sensors 2016 (2016).

[17] I.M. Pires, G. Marques, N.M. Garcia, F. Flórez-Revuelta, V. Ponciano, S. Oniani, A Research on the classification and applicability of the mobile health applications, JPM 10 (1) (2020) 11, doi: 10.3390/jpm10010011.