Can Real-World Measures of Activity, Sleep, and Cardiorespiratory Function Stratify Primary Sjogren's Syndrome Participants with Persistent Fatigue?

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Introduction

- Individuals with chronic disease often experience abnormal fatigue.
- Questionaries (PROs) are subjective and only provide a snapshot.
- Wearable devices can provide reliable estimates of activity and cardiorespiratory function, and therefore may provide objective, cheap, and continuous evidence of abnormal fatigue.

This Study:

- Measured time spent walking, sitting, and standing, HR, and RR with a digital wearable within the participants' home environment.
- Used statistical and machine learning techniques to explore the relationships between these measures and patient reported fatigue.
- Separated PSS participants based on the persistency of their fatigue.

Aims & Objectives

To test if focusing on persistency of fatigue, rather than overall fatigue, will reveal more relationships with measures of activity and cardiorespiratory function in participants with PSS, as a part of the BRC Tools study [1].

Data

- **Participants**: 72 PSS participants wore a chest-sensor for 2 continuous 7-day periods at home.
- **Devices**: Chest-worn VitalConnect's VitalPatch, containing ECG, a triaxial accelerometer, and a thermistor. Wrist-worn Actigraph, containing an IMU (triaxial accelerometer and gyroscope).
  - From VitalPatch [2]: **HR**, **RR**, and activity types (**sitting**, **standing**, and **walking**) estimated by the sensor's built-in software.
  - From Actigraph (processed by GGIR [3]): activity intensities (**inactive**, **light**, **moderate**, and **vigorous**) and **sleep quality** (time of sleep onset, the time of wake up, duration in bed, duration asleep, sleep efficiency, number of awakenings, and activity intensities in bed).
- 25 features per participant: the mean, SD, minimum, and maximum of the HR and RR (8 features), duration in each activity type (3 features), the mean daily duration in each activity intensity (4 features) and mean nightly sleep quality measures (10 features).
- **Fatigue**: Participants self-reported their fatigue (PROs with a scale 0-10) 4 times a day.

Analysis

- Participants were classified into "more fatigue" and "less fatigue" groups:
  - **Persistent fatigue**: Classed as **persistent fatigue** (vs. non-persistent) if their minimum fatigue rating was > threshold. Thresholds tested: 2, 3, 4, and 5.
  - **Overall fatigue**: Classed as **higher fatigue** (vs. lower) if their mean fatigue rating was > threshold. Thresholds tested: 4, 5, 6, and 7.
- Shapiro-Wilk tested both classes for normality. Welch's t-test used if normally distributed, otherwise Mann-Whitney U test, to compare distributions between the classes for each feature.

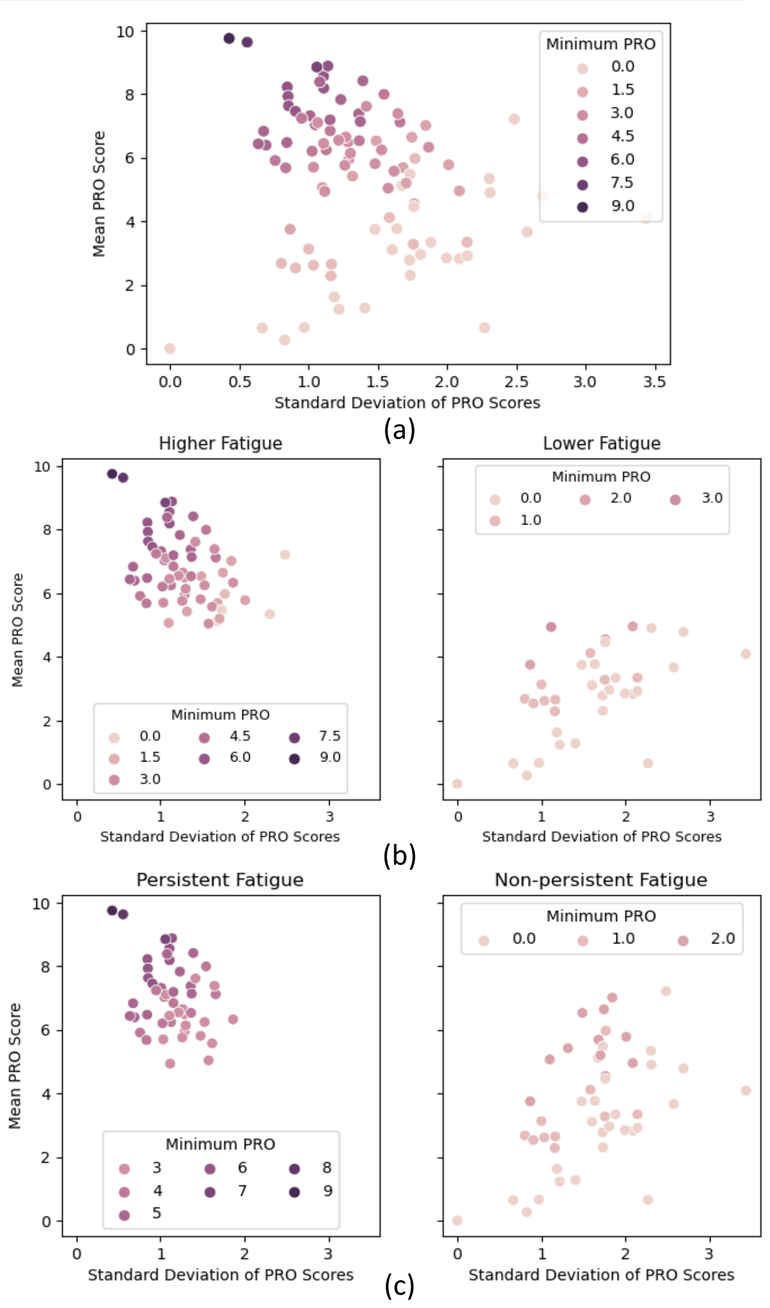

Fig. 1. Scatter plots of each participant's mean fatigue PRO score against the SD of their PRO scores. Colour of markers refer to the participants' minimum PRO score. (a) shows all participants used in the analysis and (b) shows an example of overall fatigue (threshold of 5) and (c) shows an example of a persistent fatigue (threshold of 2), with more fatigue group on the left and less fatigue group on the right.

Results

Overall Fatigue: Higher vs. Lower

- Mean: 1
- Moderate activity: 2
- Time in bed: 1

Persistent Fatigue: Persistent vs. non-persistent

- Inactive: 1
- Light: 2
- Mean: 3
- Min.: 1
- Awakenings: 1
- Inactive: 2
- Time in bed: 1
- Efficiency: 1

Number of thresholds with p<0.05 (4 max.): X

People with **more fatigue** had a **higher** average:

People with **more fatigue** had a **lower** average:

Figure 1: All features that were statistically significant (p<0.05), with the number of thresholds that were significant and the trends of the means.

Future Work

- Include a healthy control group, as well as other chronic diseases
- Explore within-subject changes in addition to between-subject changes
- Further exploration of how to define participants' fatigue as "persistent"

Conclusions

- 8 measures were significant (p<0.05) for persistent fatigue, compared to only 3 for overall fatigue.
- HR was higher, sleep quality was reduced, and activity intensity was reduced in individuals with increased levels of fatigue (both persistent and overall).

Abbreviations

HR: Heart rate, RR: Respiratory rate, PSS: Primary Sjogren's syndrome, ECG: Electrocardiogram, IMU: Inertial measurement unit, PRO: Patient reported outcome, SD: standard deviation.

Citations

[1] "ISRCTN - ISRCTN12062123: Finding a new way to measure fatigue in clinical studies."
[2] Chan et al. Annu Int Conf IEEE Eng Med Biol Soc, 2013.
[3] Migueles et al. JMPB, 2019.