Physiotherapy UK Abstracts

Title
Accuracy of physical activity recognition from a wrist-worn sensor

Presenter & co-authors
Cooper, K; Sani S; Corrigan L; MacDonald H; Prentice C; Vareta R; Massie S; Wiratunga N

Contact details authors
TBC

Conference theme
Our Digital Movement

Brief biography presenting author
TBC

Presentations or publications of work made prior to conference
None

Ethical review
RGU SHS/16/10

Purpose
The EU-funded project “selfBACK” (http://www.selfback.net/) will utilise continuous objective monitoring of physical activity (PA) by a wrist-mounted wearable, combined with self-monitoring of symptoms and case-based reasoning. Together these will provide personalised self-management plans to people with low back pain via a novel digital health intervention. The purpose of this study was to determine the accuracy of PA recognition via wrist-mounted sensors compared to thigh-mounted sensors. Thigh or hip-mounted sensors have previously been shown to be the most accurate placement for single sensor-based PA monitoring. However, long-term adherence may be greatly enhanced with a less obtrusive wrist-worn sensor. It was therefore important to compare both locations.

Methods
Thirty-four healthy university staff and students (mean age 26±4) undertook 5 supervised PA protocols in a random order on one occasion whilst wearing an Axivity AX3 accelerometer (Axivity, Newcastle Upon Tyne, UK) in standardised locations on both the right wrist and mid-thigh. The 5 protocols were (i) overground walking, (ii) stair climbing and descending, (iii) sedentary activities (lying, sitting), (iv) standing, and (v) treadmill running. For activity prediction, a supervised machine learning approach was used where a classifier was trained on labelled accelerometer data to predict user activities. To train the classifier, three processing steps were applied: (i) windowing (partitioning the data stream into time lengths), (ii) labelling (each window by activity), and (iii) feature extraction (producing characteristic descriptors from the raw accelerometer signal). The accuracy of the classifier was measured using the F1 score; a measure of accuracy which is computed as the harmonic

mean of precision and recall. F1 scores have a value between 0-1, with higher scores representing better accuracy. Paired t-tests were used to identify significant differences between F1 scores for the wrist and thigh sensor placements for each protocol.

Results

F1 scores obtained from our evaluation ranged from 0.71 (wrist: stair protocol) to 0.991 (thigh: sedentary protocol), with 8 of the 10 F1 scores greater than 0.9. Wrist-mounted monitoring of stairs (F1=0.71) and standing activities (F1=0.792) were the least accurate. There was no statistically significant difference between F1 scores for the running protocol (wrist=0.955, thigh=0.957, p=0.854). All other protocols demonstrated small but statistically significant differences with thigh F1 greater than wrist F1 throughout.

Conclusions

Placing the Axivity AX3 sensor on the thigh was consistently more accurate than placing it on the wrist for PA recognition, with the exception of running where there was no difference in accuracy. The differences are however small for both sedentary activities and walking. These findings suggest that wrist-mounted PA recognition may be acceptable for differentiating between ambulatory and sedentary activities.

Implications

The use of wrist-mounted PA monitoring in the selfBACK study is a suitable compromise between accuracy and predicted compliance. Such PA monitoring, which overcomes the limitations of self-reporting, has great potential as part of innovative digital self-management interventions for a range of health conditions routinely managed by physiotherapists. Further work needs to be conducted to enhance the accuracy of wrist-mounted PA monitoring, particularly for activities such as standing and stair climbing/descending.

3 key words

Physical activity; digital health; monitoring

Funding acknowledgements

This project has received funding from the European Union Horizon 2020 research and innovation programme under grant agreement No 689043.