Validation of technology to monitor sleep and bed occupancy in older men and women

Supplementary Material - Poster #56018

Kiran Kumar Guruswamy Ravindran, PhD[1,2], Ciro della Monica, PhD[1,2], Giuseppe Atzori, MSc[1], Shirin Enshaeifar, PhD[1], Sara Mahvash-Mohammadi, MSc, MRes[1], Derk-Jan Dijk, PhD[1,2] and Victoria Revell, PhD [1,2]

[1] *University of Surrey, Guildford, United Kingdom*
[2] *UK Dementia Research Institute, Care Research and Technology Centre at Imperial College, London and the University of Surrey, Guildford, United Kingdom*

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1 Background

Nocturnal disturbance is frequently observed in dementia and is a major contributor to institutionalisation. Interruptions of sleep and nocturnal wandering are among the neuropsychiatric symptoms that are most disturbing to the caregivers [1]. Unobtrusive technology that can quantify sleep/wake and determine bed occupancy during the major nocturnal sleep episode may be beneficial for long-term clinical monitoring and the carer. Such technologies have, however, not been validated in older people. Here we assessed the performance of the Withings Sleep Mattress (WSM, Figure 1) in a heterogeneous older population to ensure external validity.

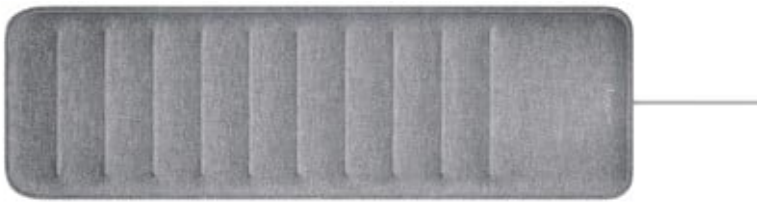

Figure 1: The Withings Sleep Mattress

2 Method

Eighteen participants (65 – 80 years, 10M:8F) completed 7-12 days of sleep/wake monitoring at home prior to an overnight laboratory session. The participants had several pre-existing conditions such as Type-2 diabetes, Hypertension, Arthritis, Sleep apnoea, etc. WSM performance was compared to gold-standard (laboratory polysomnography [PSG] with video) and silver standard (actiwatch [AWS] and sleep diary at home). WSM data were downloaded from a third-party API and the minute-to-minute sleep/wake timeseries extracted and time-ordered to create a sleep profile. Discontinuities in the timeseries were labelled as 'missing data' events.

Figure 2: The Actiwatch Spectrum

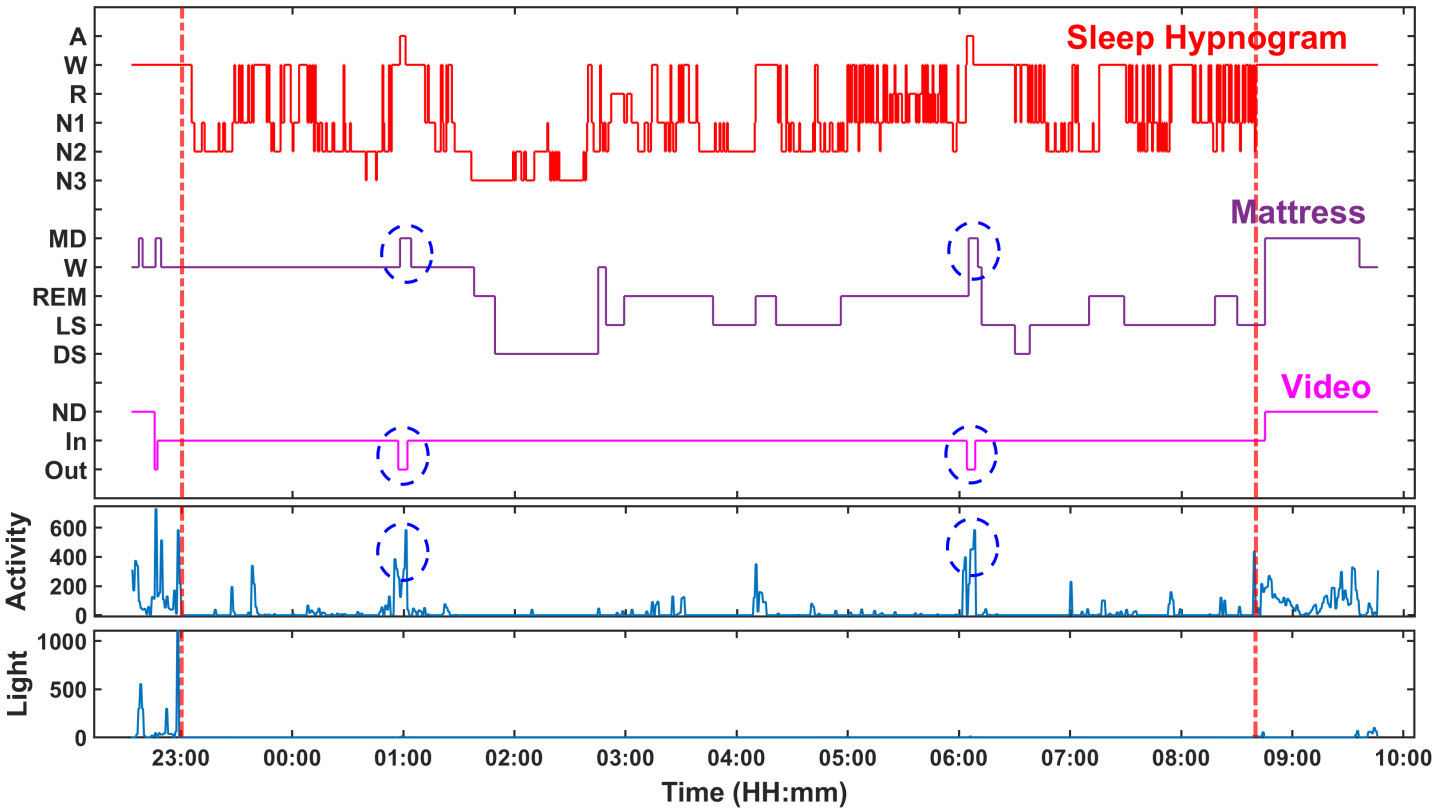

Figure 3: Example In Lab data with out of bed events marked

3 Results

Participants contributed 107 nights with WSM and PSG or AWS data. In the laboratory, the overall epoch to epoch agreement (accuracy) of sleep/wake detection of WSM compared to PSG was 0.71 (sensitivity 0.8; specificity 0.45) and to AWS was 0.74 (sensitivity 0.77; specificity 0.53). Through the inspection of the multimodal data we collected, we found that the missing data events in the mattress timeseries coincides accurately with the increase in activity. This can be seen in 3. Through PSG video inspection in-bed (IB) and out of bed (OoB) events were determined and a bed occupancy time line was created. This approach demonstrated that 20 of 21 'missing data' events were true 'out of bed' events 4. These events were always associated with an increase in activity (AWS).

In the home data collected, we can also found that there is a marked increase in activity and light levels during the out of bed events. This is depicted in 5 for one of the participants. At home, all 97 WSM 'missing data' events (across the 18 participants) that occurred within the major nocturnal sleep episode defined by sleep diary data, were associated with an increase in activity levels in the AWS data and 36 of these events were also associated with an increase in light levels, indicating that the participant had left the bed. In several participants, data recorded by the WSM during daytime coincided with reported naps in the sleep diary.(Fig. 5)

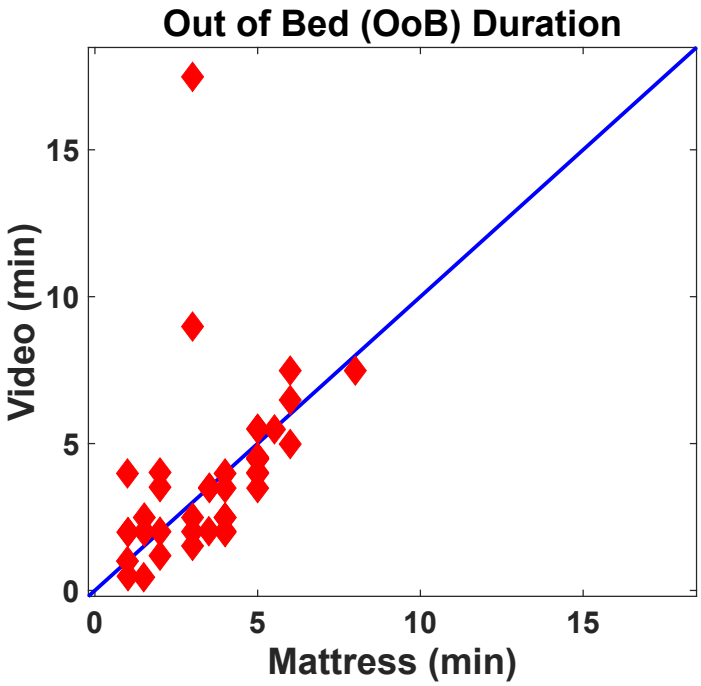

Figure 4: Mattress vs Video OoB correlation

4 Conclusion

Although WSM cannot reliably distinguish between sleep and wake, the presence/absence of data in WSM seem to be an accurate representation of whether older people are in or out of bed (bed occupancy). Thus, in dementia, this contactless, low-burden technology may be able to provide information about nocturnal disturbances and daytime naps in bed.

References

[1] D. Wilfling, M. N. Dichter, D. Trutschel, and S. Köpke, "Nurses' burden caused by sleep disturbances of nursing home residents with dementia: multicenter cross-sectional study," *BMC Nursing*, vol. 19, sep 2020.

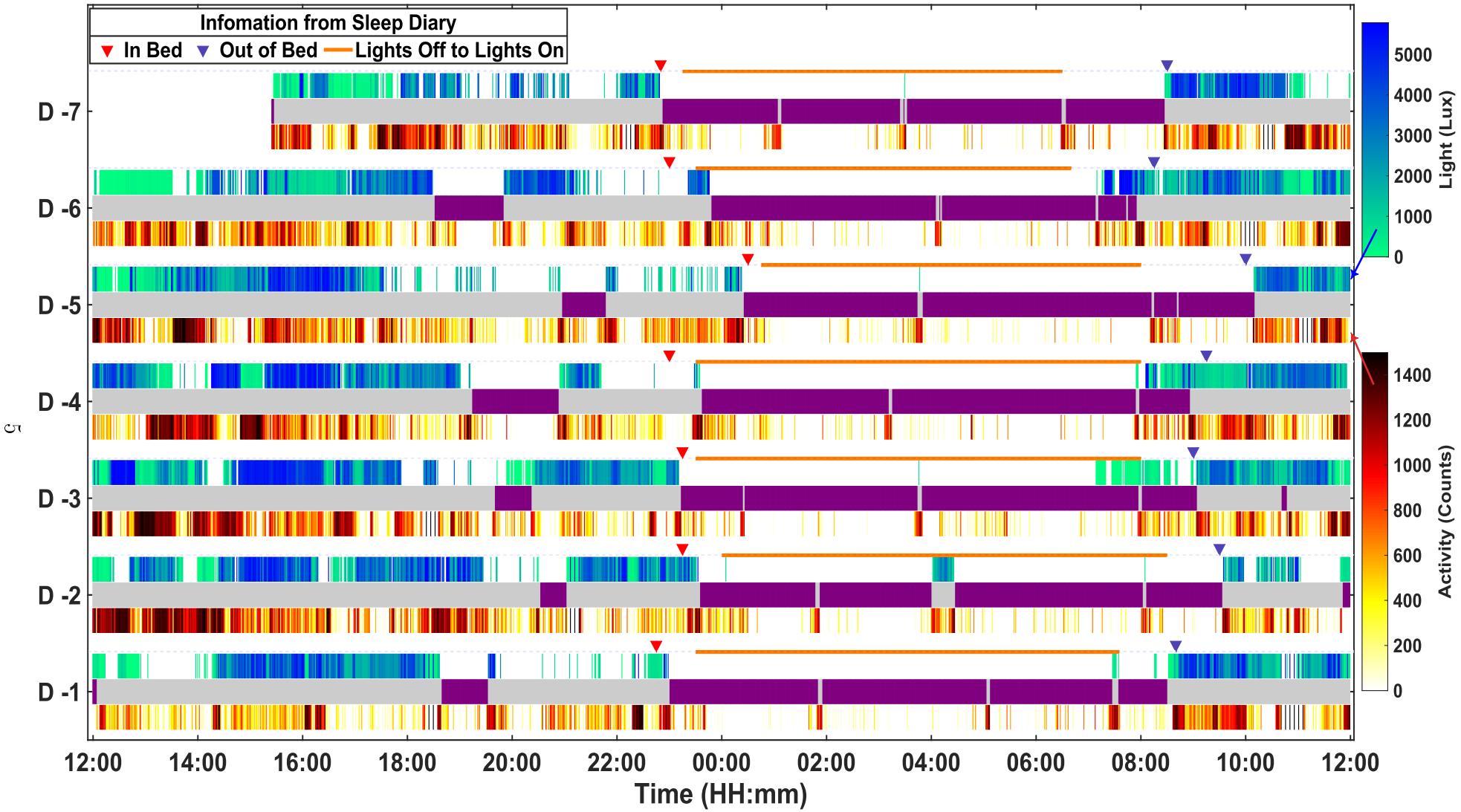

Figure 5: Example with bed occupancy, Actiwatch light and activity at home.