

Night-time activity measured by passive sensors is associated with increased fall risk in dementia

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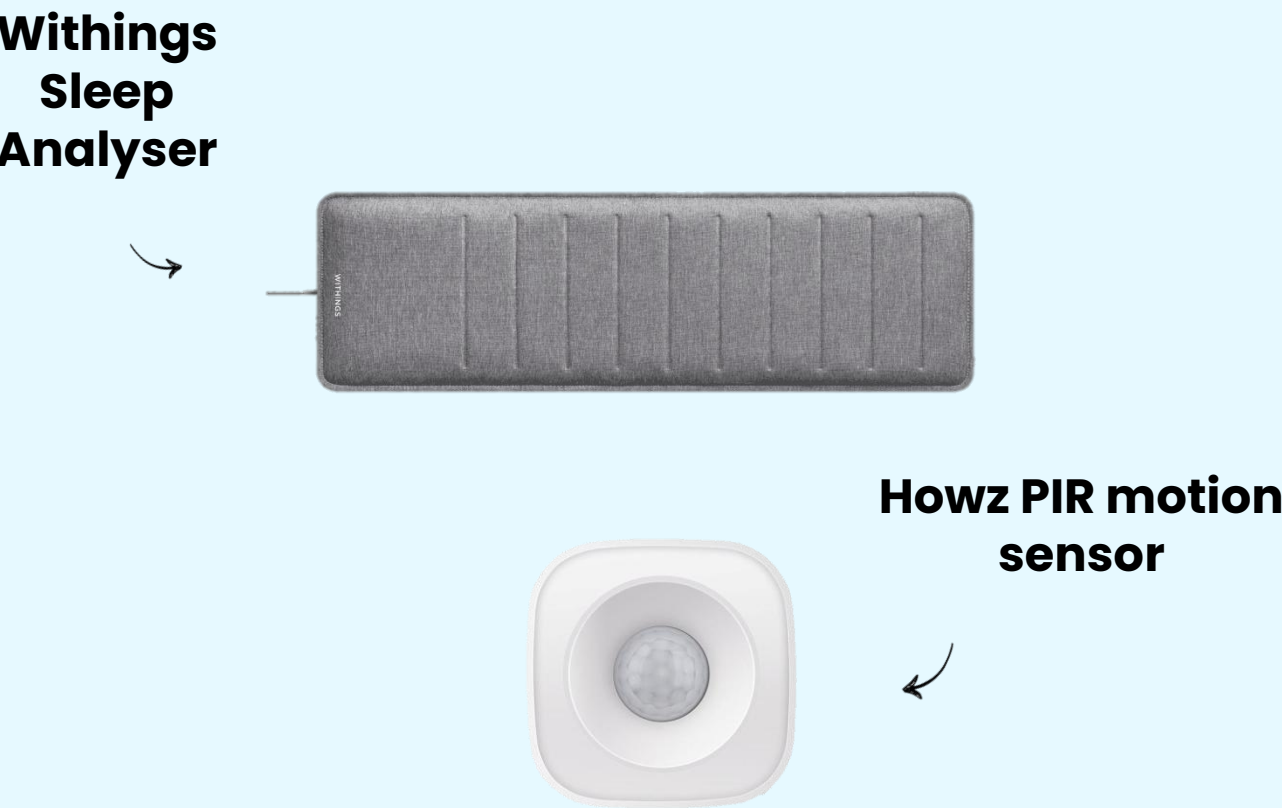
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BACKGROUND

- Disturbed night-time activity is common among people living with dementia (PLWD)
- Using contactless digital technologies, we quantified nighttime activity in PLWD and examined its association with falls
- Clinician friendly reports were developed to summarise both short term and long-term patterns of night-time behavior

METHODS

PLWD in the Minder and MinderCare studies were monitored using a Withings Sleep Analyzer (WSA) and in-home motion sensors. Nighttime activity was quantified using a rule-based algorithm summarizing out-of-bed activity. Group differences were examined between participants with and without disturbed night-time activity. Average night-time activity was calculated over rolling 30-day windows and classified as low or high. Within-person associations with falls in the subsequent 30 days were then assessed using mixed effects logistic regression. A high activity threshold was then applied to both cohorts and alerts generated over 12 months. Clinician friendly reports were developed to visualized activity patterns.



PLWD WITH DISTURBED SLEEP SHOW HIGHER NIGHT-TIME ACTIVITY

Night-time activity was significantly higher among PLWD reporting sleep disturbance in the neuropsychiatric index (N=22, Median=19.3 min/night vs N=60, Median = 1.5 min/night U=997.5, p<0.0001, Fig 1)

The algorithm combining PIR sensors with the WSA performed better at discriminating sleep groups than a single device (AUC = 0.81 (95% CI 0.65-0.94), Fig 2)

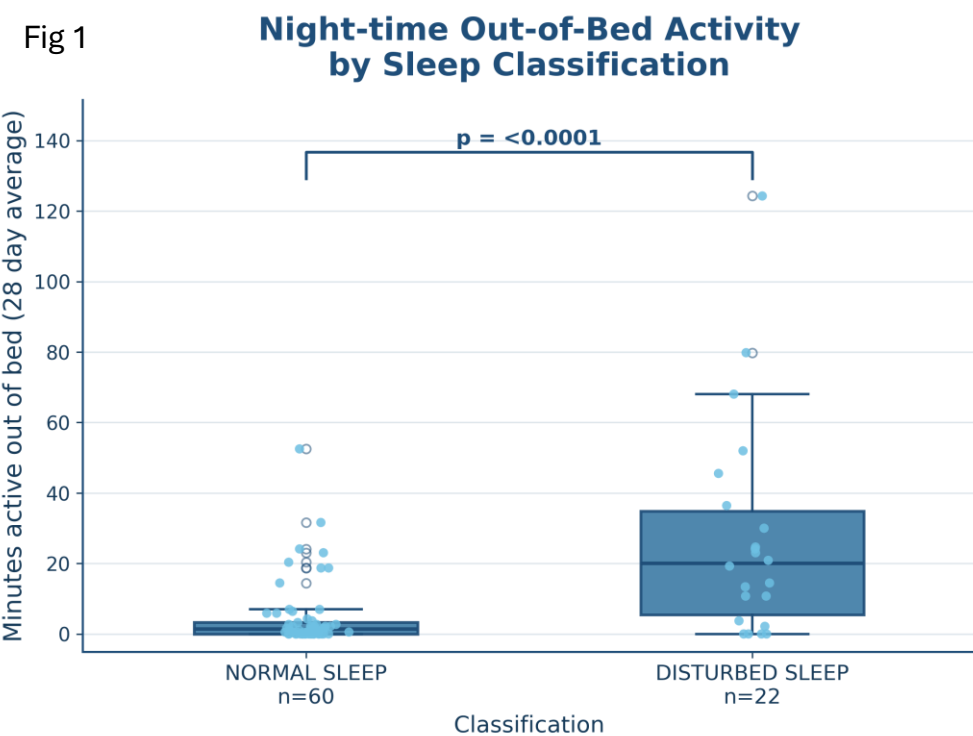


Figure 1: Average nightly out-of-bed activity (28-day average) according to sleep classification. Participants with disturbed sleep (n = 22) spent significantly longer out of bed overnight than those with normal sleep.

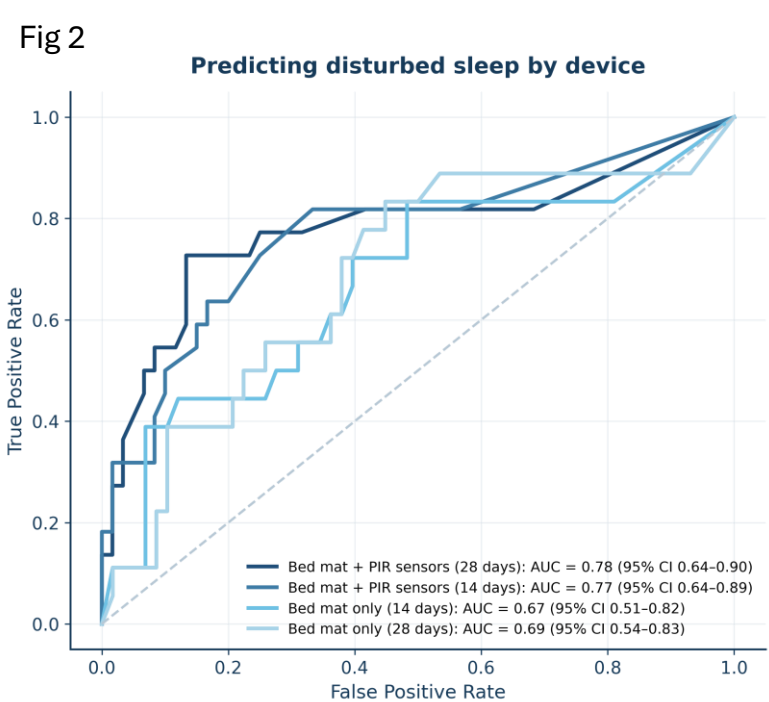


Figure 2: Receiver operating characteristic (ROC) curves show that the sleep mat in combination with PIR sensors is best at predicting disturbed sleep.

HIGH NIGHT-TIME ACTIVITY INCREASES FALL RISK IN PLWD

Longitudinal monitoring of 158 PLWD over 3720 person months identified 247 falls between July 2021 and November 2025. Elevated night-time activity, defined as the higher quartile (>12 min/night), was associated with increased odds of falling in the subsequent 30 days (OR, 95% CI 1.15-2.75, p=0.032)

Night-time activity was also modelled as a continuous measure. Each additional 6 minutes spent active and out of bed was associated with a 10% increase in fall risk (OR 1.10, 95% CI 1.01-1.20, p=0.038, Fig 3).

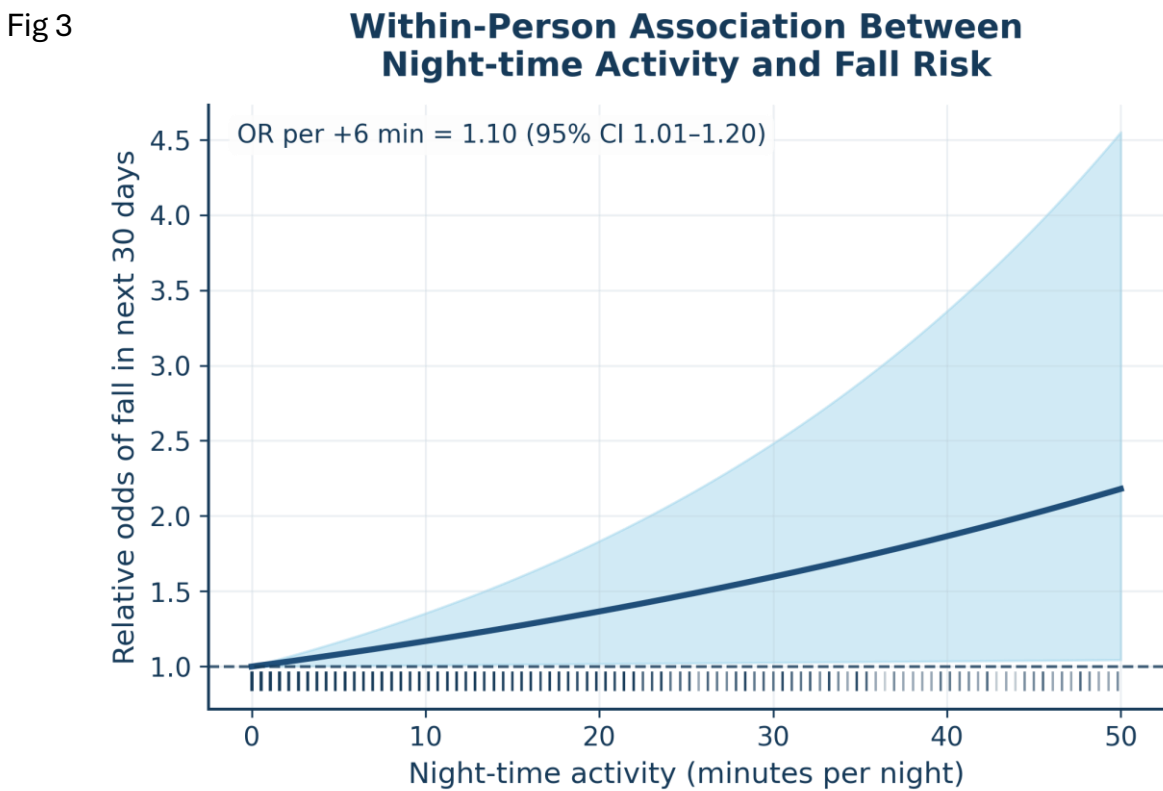
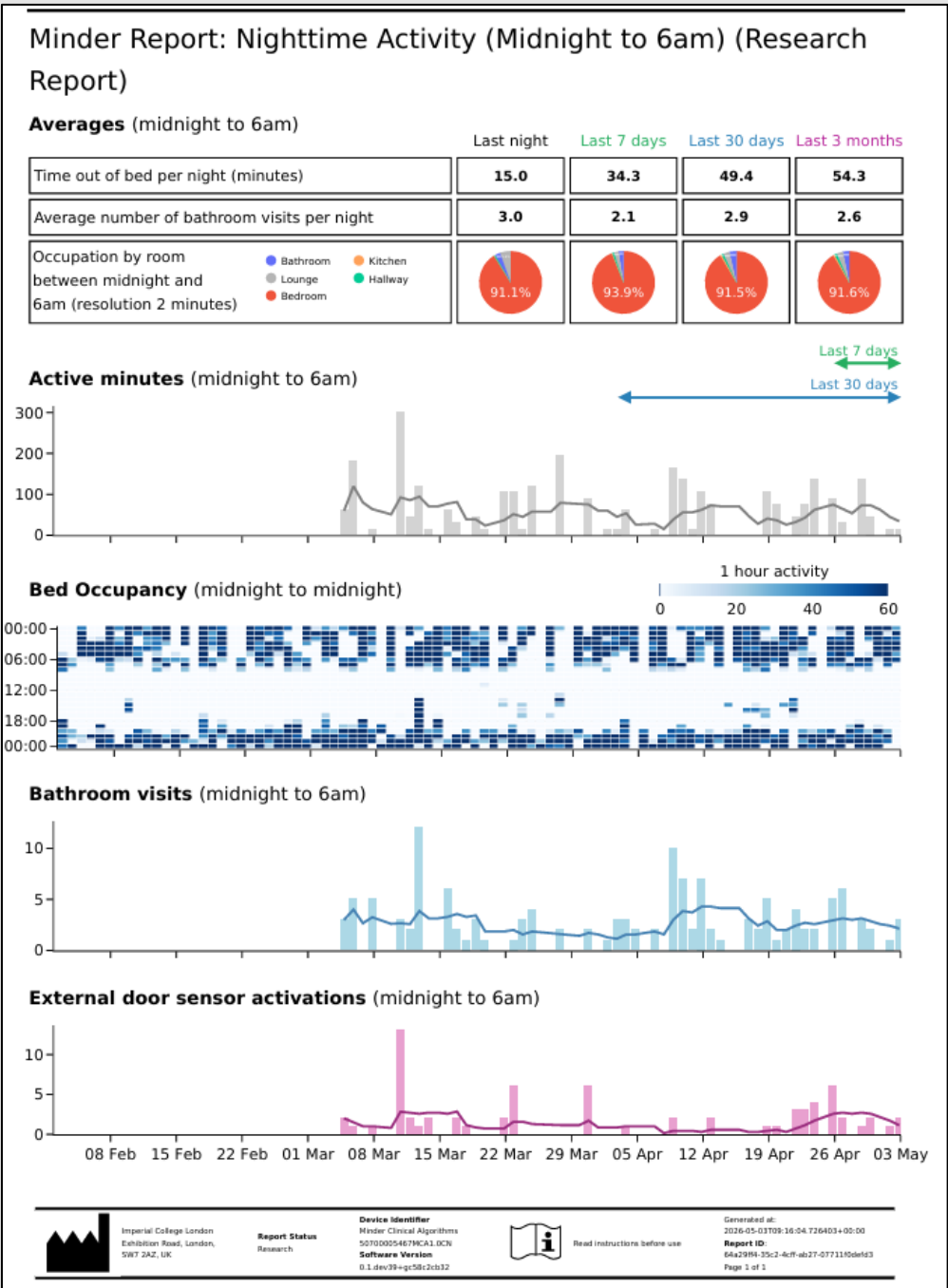
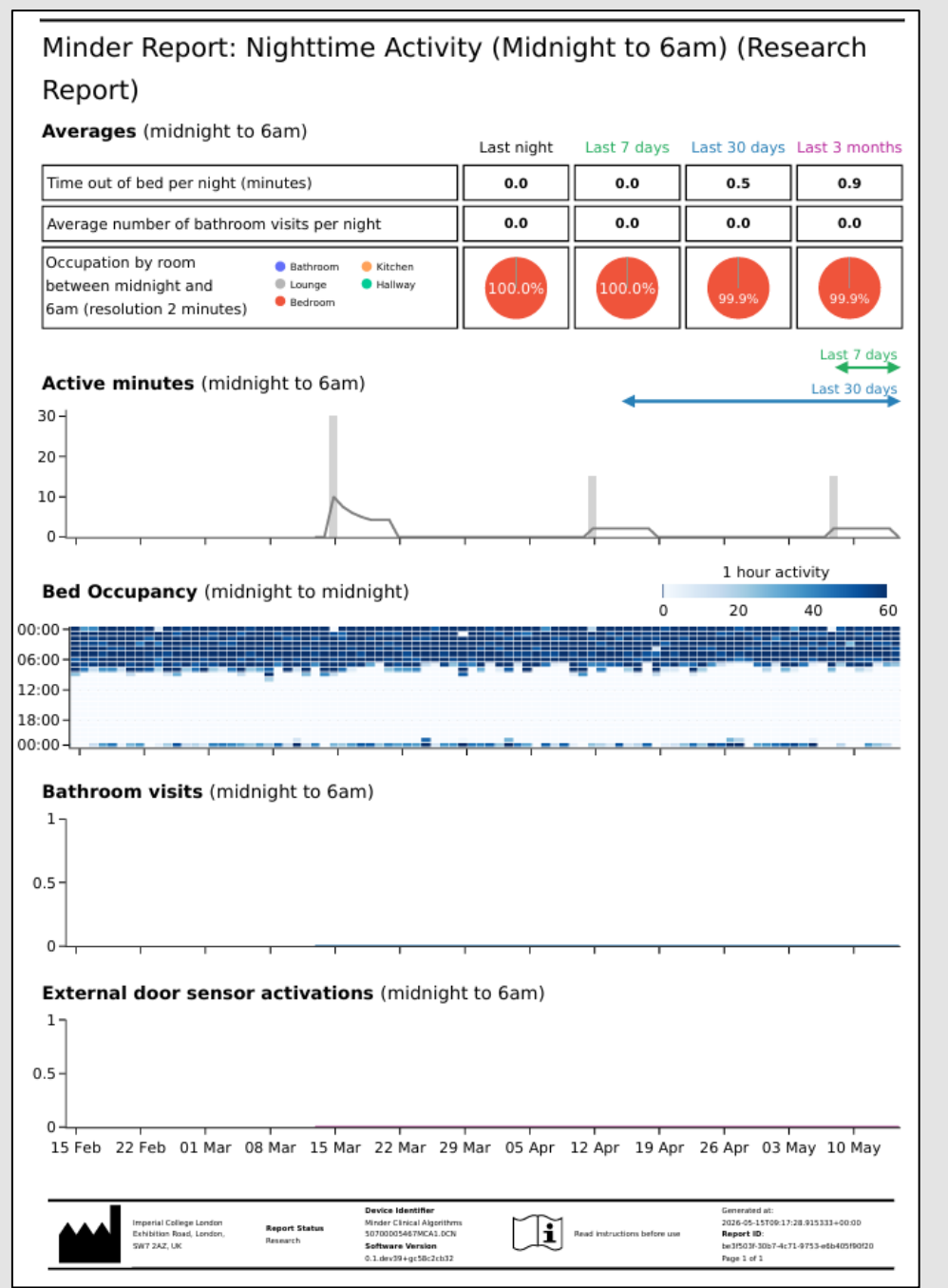


Figure 3: Increasing night-time out of bed activity within individuals is associated with a higher risk of falling in the subsequent 30 days. Each additional 6 minutes of nightly activity increases the odds of falling by 10% (OR 1.10, 95% CI 1.01-1.20). The shaded area represents the 95% confidence interval



Case A



Case B

CLINICIAN FRIENDLY REPORTS

We created clinician friendly reports that summarise night-time behaviors. These are shown in the case examples above. Case A demonstrates minimal nocturnal activity in a participant with mixed dementia. Case B demonstrates frequent night-time activity and wandering behaviours. These reports aim to support clinical decision making, care planning, risk assessment and best interest discussions.