Activity Trackers are Unreliable for Monitoring Sleep in Hospitalized Patients with Cognitive Disorders

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Introduction

Wearable technologies that track activity and sleep use an algorithm of wrist movement detection and heart rate monitoring to recognize sleep initiation and to detect periods of wakefulness. The reliability of wrist sleep trackers in patients with cognitive disorders such as dementia is unclear[1,2].

Objectives

We investigated the consistency of activity monitor data from study participants with a diagnosis of mild cognitive impairment (MCI), dementia, Parkinson's disease and those who developed delirium. This was done as part of a study investigating sleep duration and quality in older adults during post-operative recovery from hip fracture.

Methods

Wrist activity monitors (Fitbit®, Alta 2) were applied to consenting post-operative older adults with hip fractures and worn for the duration of their hospital stay (or up to 14 days). We conducted an exploratory analysis of the device data from participants with MCI, dementia, Parkinson's disease and those who developed postoperative delirium. The proportion of sleep data that failed to be recorded from participants with these conditions was compared to data from other participants in the study. If the activity monitor did not track any sleep for one or more nights, that data was categorized as failed to record.
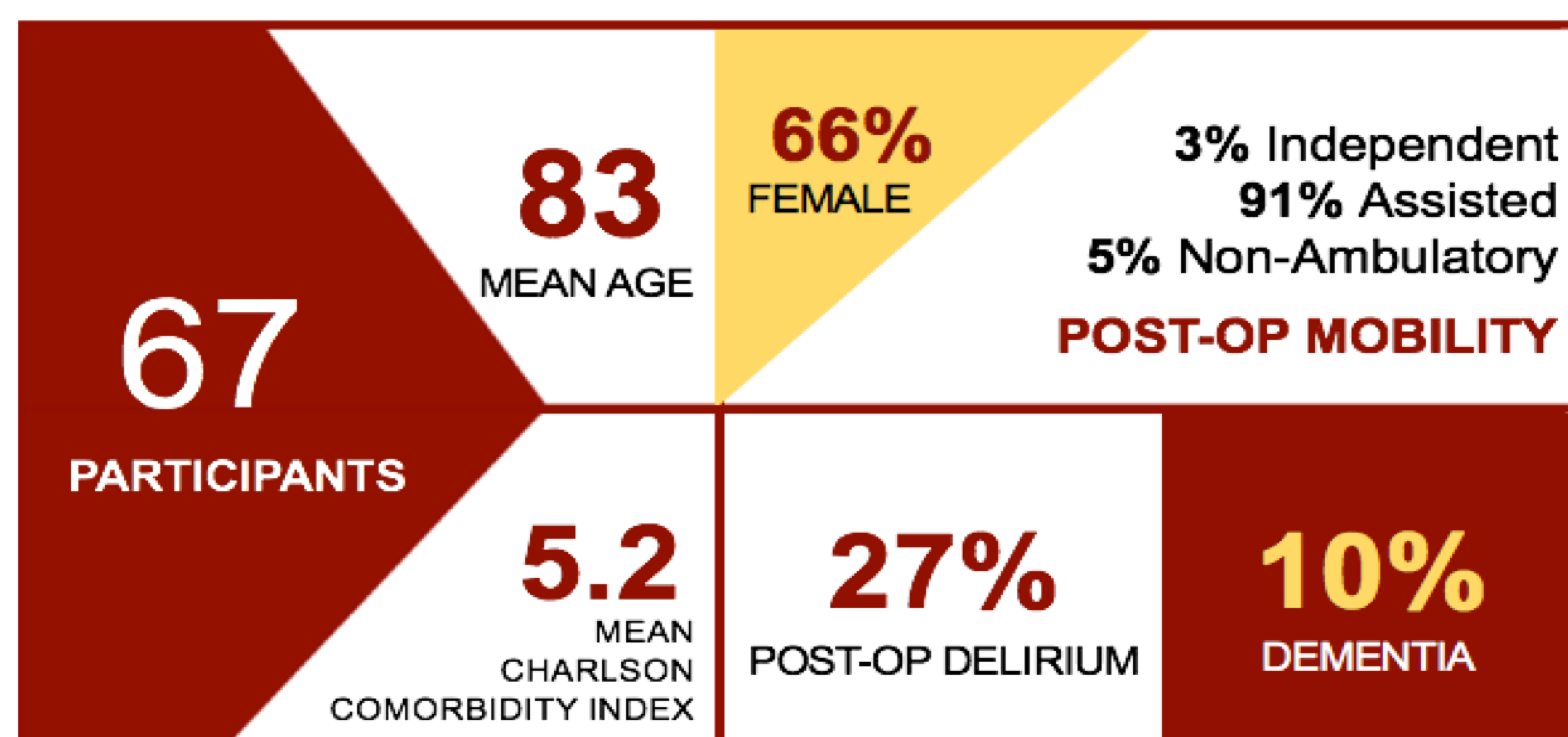
Study Demographics

67 PARTICIPANTS
83 MEAN AGE
66% FEMALE
91% Assisted
3% Independent
5% Non-Ambulatory
POST-OP MOBILITY
5.2 MEAN CHARLSON COMORBIDITY INDEX
27% POST-OP DELIRIUM
10% DEMENTIA

Figure 1. Participant Characteristics

Study Groups

Characteristic	Cognitive Disorder (n=22)	No Cognitive Disorder (n=45)
Age: mean (range)	86.1 (70-95)	81.2 (67-95)
Female: number (%)	15 (68.2)	29 (64.4)
Charlson Comorbidity Index: mean (range)	5.5 (3-8)	5.0 (2-11)
Post-operative delirium: number (%)	18 (81.8)	N/A
Major cognitive disorder (dementia): number (%)	7 (31.8)	N/A
Post-operative mobility: number (%)		
Independent	0 (0.0)	2 (4.4)
Assistance	19 (86.4)	42 (93.3)
Non-ambulatory	3 (13.6)	1 (2.2)
Unknown	0 (0.0)	0 (0.0)
Living situation: number (%)		
Community	1 (4.5)	7 (15.6)
LTC/Convalescent Care	6 (27.2)	2 (4.4)
Rehabilitation	12 (54.5)	34 (75.6)
Other	3 (13.6)	2 (4.4)

Table 1. Participant Characteristics by study group

Results

Cognitive Disorder | No Cognitive Disorder

■ Missing sleep data ■ Recorded sleep data
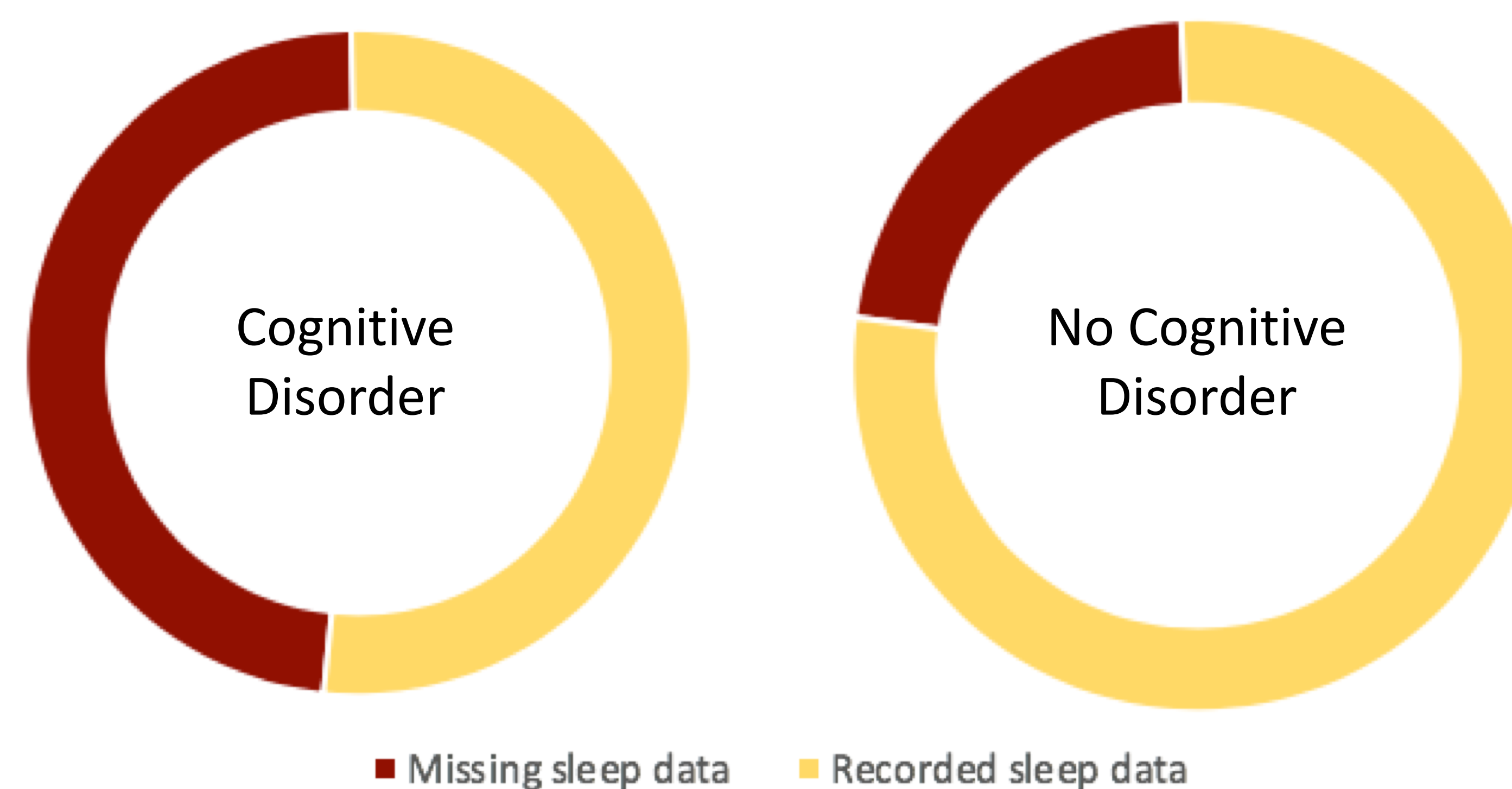
Data	Cognitive Disorder (n=22)	No Cognitive Disorder (n=45)
Total sleep data days (n)	151	310
Total missing sleep data (n)	73	67
% of missing sleep data	48%	22%

Table 2. Sleep Data Results

Discussion

Data analysis demonstrated a difference in the missing sleep data between patients with and without cognitive disorders. The activity monitors did not record data in 48% of nights (73 of 151) in the group with cognitive disorders compared to just 22% (67 of 310) in those without a cognitive diagnosis. Possible reasons for the discrepancy include agitation, tremors, excessive movements (e.g. REM sleep disorder, hyperactive delirium) or device removal. It is also possible that the devices measured sleep accurately and that participants were indeed awake all night. These devices were validated for sleep detection accuracy in young health adults[3,4].The reliability of these devices for research or lifestyle use in populations with dementia and other cognitive disorders is potentially questionable.

There are some limitations that are worth noting. These limitations may be patient-centered, such as uncertainty the participant wore the activity monitor for the entirety of the night or that the device fit properly. They may also be device dependent, which includes a possible technological shortcoming of the activity monitors causing a sleep recording failure.

Conclusions

Sleep data tracking using wrist monitors in our study of hospitalized older adults admitted with hip fracture was inconsistent in participants with cognitive disorders. This highlights the potential challenges of using devices that have been validated for healthy adults and applying them to older adults with various physical or cognitive impairments. Alternative methods may be required to reliably and accurately evaluate sleep in future research investigations involving this patient population[5].

References

1. Lewy H. Wearable technologies - future challenges for implementation in healthcare services. Healthc Technol Lett. 2015;2(1):2–5. Published 2015 Feb 16.
2. Maresova P, Tomsone S, Lameski P, et al. Technological Solutions for Older People with Alzheimer's Disease: Review. Curr Alzheimer Res. 2018;15(10):975–983.
3. Lee HA, Lee HJ, Moon JH, Lee T, Kim MG, In H, Cho CH, Kim L. Comparison of wearable activity tracker with actigraphy for sleep evaluation and circadian rest-activity rhythm measurement in healthy young adults. Psychiatry investigation. 2017 Mar;14(2):179.
4. Mantua J, Gravel N, Spencer R. Reliability of sleep measures from four personal health monitoring devices compared to research-based actigraphy and polysomnography. Sensors. 2016;16(5):646.
5. Teipel S, König A, Hoey J, et al. Use of nonintrusive sensor-based information and communication technology for real-world evidence for clinical trials in dementia. Alzheimers Dement. 2018;14(9):1216–1231