Seasonal variation in the indoor lighting and temperature environment and the impact on sleep timing, continuity and duration in people living with dementia

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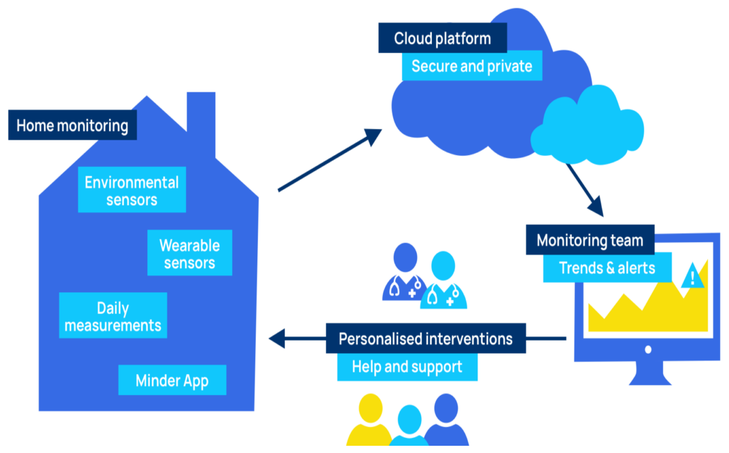
Goal: Use Minder data to understand how environmental factors influence sleep disturbances in people living with dementia

Population studies have shown:

- Cognitive functions improve in summer [1].
- Diagnoses of dementia are highest in winter [1].
- Sleep duration varies across seasons [2].

Understand seasonal variation in the indoor light and temperature environment → **Understand correlations between the environment and sleep** → **Design interventions to improve sleep**

Minder (UK DRI CR&T)



We used data from Minder, a smart home platform that supports people living with dementia to live in their own homes for longer.

How are environmental variables measured?

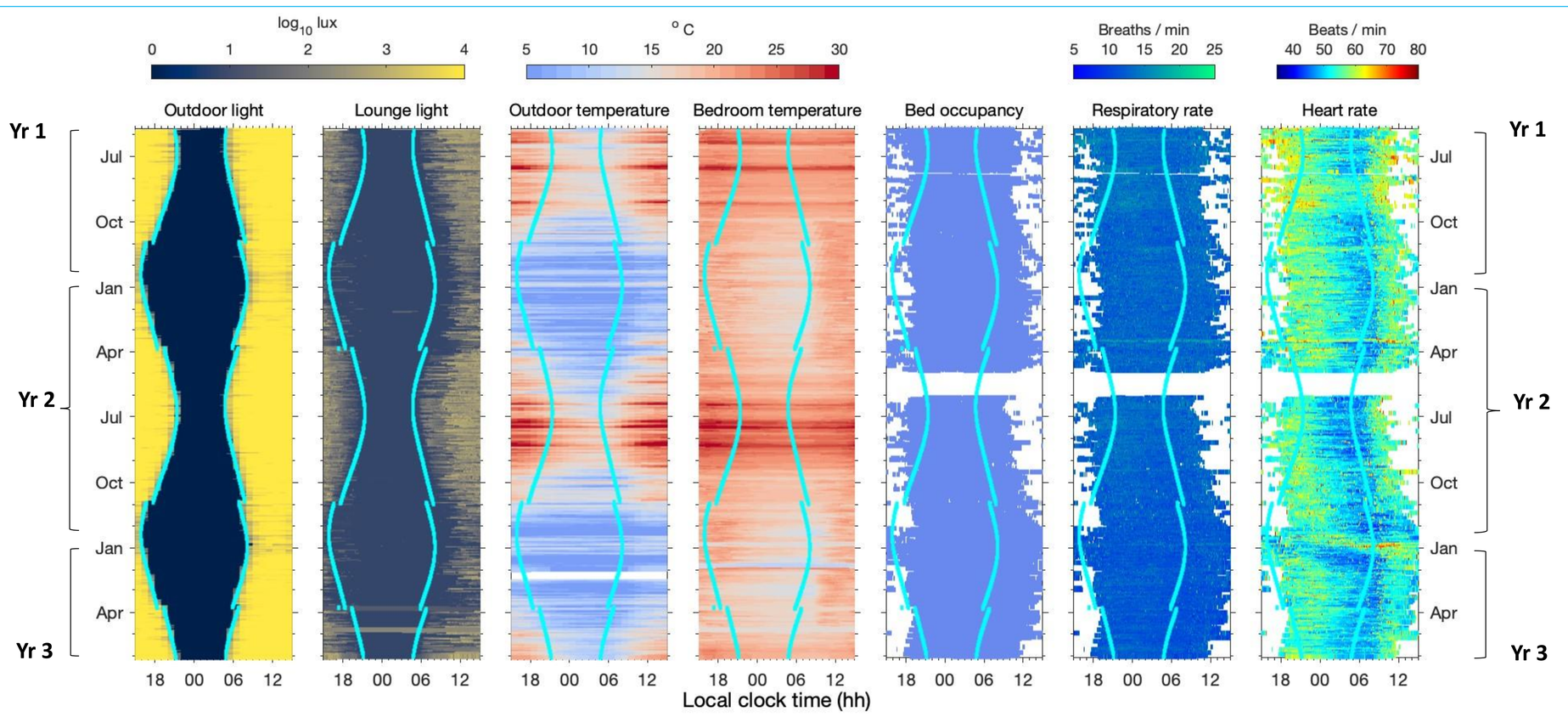
Multisensors with a light sensor (range 3-70000 lux) and temperature sensor (range 0-50 ^{o}C) are placed in homes.

How is sleep measured?

An under-mattress device measures bed occupancy and physiological information from which sleep is inferred.

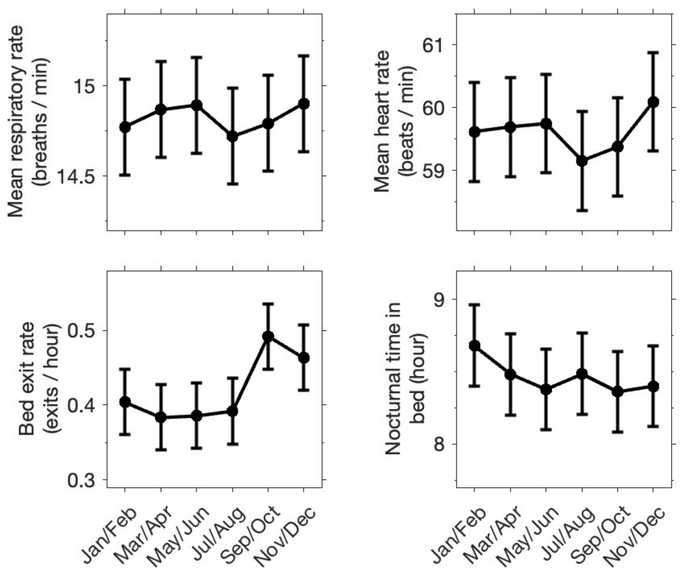
Methods

- We analysed ~26,600 days and nights of data from 70 people living with dementia.
- We computed 35 metrics that describe daily bed occupancy, sleep timing, continuity, duration, heart rate and breathing rate.
- We calculated metrics quantifying daily amount and timing of light and temperature.
- We employed linear mixed-effects models to investigate the effect of season on measures of sleep and physiology, with environmental factors and other independent variables as co-variates.



Example of data collected for one participant. Indoor and outdoor light and temperature were associated.

Results



Seasonal variation (LSMEANS estimates in the full model).

- Multiple physiological and behavioural measures varied with season including heart rate and respiratory rate during time in bed, bed exit rate and nocturnal time in bed ($p<0.001$ in each case) even when controlling for environmental factors and other co-variates.

	Bimonth		Hours of bright light (lounge)		Mean temperature during nocturnal time in bed		Age at date of metric		Gender	
	F	p	F	p	F	p	F	p	F	p
Mean respiratory rate	25.06	<.0001	1.42	0.2338	226.51	<.0001	1.18	0.2798	0.19	0.6653
Mean heart rate	28.92	<.0001	6.34	0.0118	158.27	<.0001	5.28	0.0245	0.46	0.5005
Bed exit rate	22.77	<.0001	4.8	0.0285	2.66	0.1026	0.08	0.776	6.9	0.0106
Nocturnal time in bed	8.76	<.0001	2.38	0.1232	4.25	0.0394	0.08	0.7813	0.05	0.8209
Sleep onset	2.08	0.0642	2.1	0.1476	617.98	<.0001	0.61	0.4364	0.33	0.5677
Sleep offset	4.96	0.0002	2.06	0.1508	423.95	<.0001	0.09	0.7682	0	0.9965
Wake after sleep onset	3.66	0.0026	3.88	0.0488	7.53	0.0061	2.49	0.1191	0.62	0.4334

Linear mixed-effect model results.

Analysis of the co-variates demonstrated:

- Increased nocturnal bedroom temperature was associated with the mattress recording earlier sleep onset and offset, even when controlling for season.
- More hours of bright light (light >500 lux) was associated with the mattress recording less disrupted sleep including a reduced bed exit rate and fewer minutes awake after sleep onset, even when controlling for season.

Conclusion

In people living with dementia:

- Measures of sleep and physiology varied with season.
- The indoor light and temperature environment affected multiple aspects of sleep physiology, sleep timing, continuity and duration independent of season.

Tuning indoor light and temperature maybe a pragmatic way to improve sleep in those living with dementia.

Acknowledgments

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References

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[2] Allebrandt et al. Chronotype and sleep duration: the influence of season of assessment. *Chronobiol Int*. 2014; 31:731-40.

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