Associations between Residential Indoor Temperatures and Self-Reported Sleep Disturbances in UK Adults: A Cross-Sectional Study

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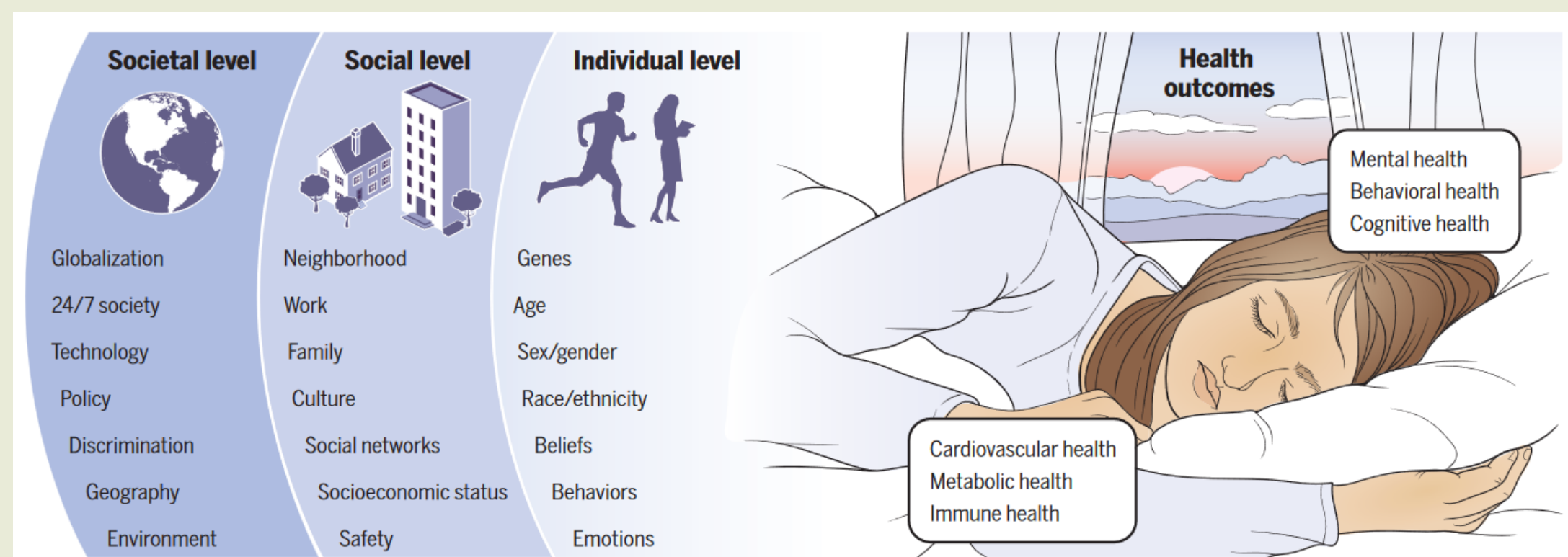
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Figure.1 Social-ecological model of sleep health, adapted from (1)

BACKGROUND. Sleep is fundamental to human physical and mental health. It is influenced by complex interrelationships between individuals and their physical and social environments. Thermal environment is an important while relatively neglected factor affecting sleep. Excessively high or low temperature can disrupt sleep in adults without sleep disorders.

AIM. Examine the associations between residential indoor temperature and self-reported sleep disturbances in UK adults, using data from the NSHD (National Survey of Health and Development) birth cohort .
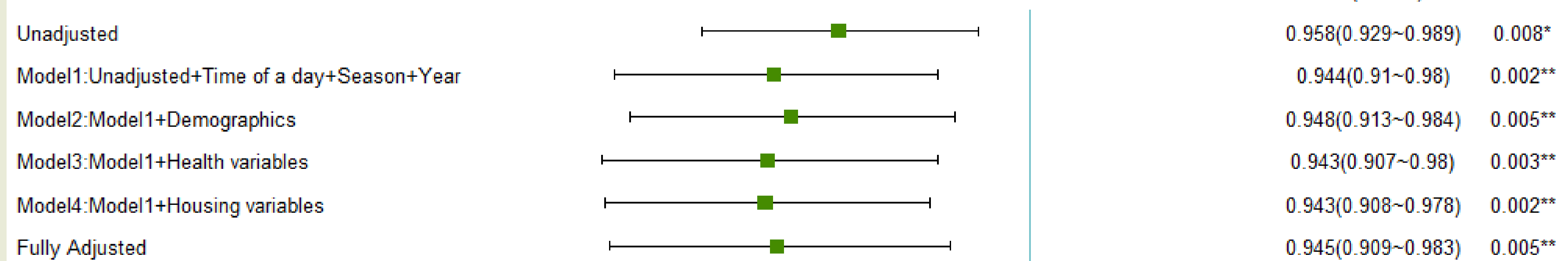
METHOD. A cross-sectional analysis was conducted with a sample of 2481 subjects derived from the NSHD (aged 43 years). Data was collected between 1989 and1990. Logistic regression analysis was conducted to investigate the associations between sleep disturbances (outcomes), room temperature (main exposure) and outdoor temperature, controlling for different potential confounders. Also, logistic regression models were created between sleep disturbances and room temperature groups with cuts-off (18/26) determined by WHO housing and health guidelines (2) and CIBSE TM59 (3) respectively.

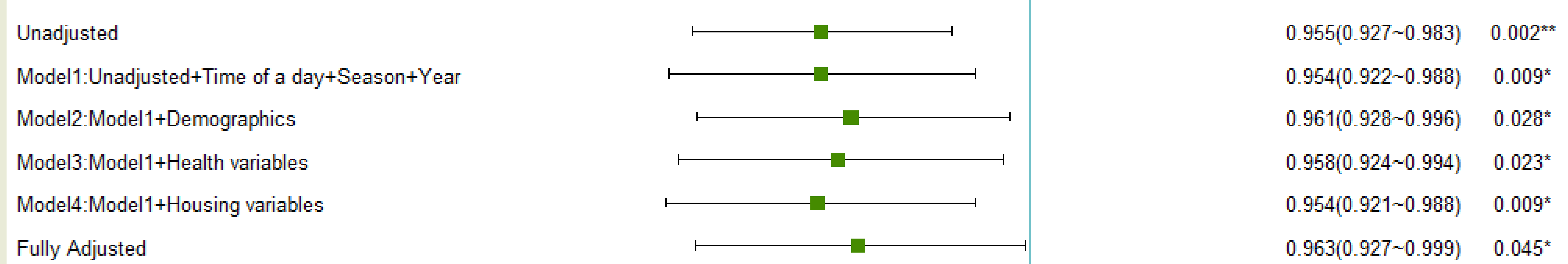**CONCLUSION.** There were strong associations between residential indoor temperatures and self-reported sleep disturbances in UK adults. Within the range of room temperature in this sample [15°C-30°C; mean: 21.77°C; SD: 2.81], each one degree increase in room temperature was associated with lower odds of having difficulty in initiating and maintaining sleep. Room temperature, rather than outdoor temperature, was a superior predictor of sleep disturbances.
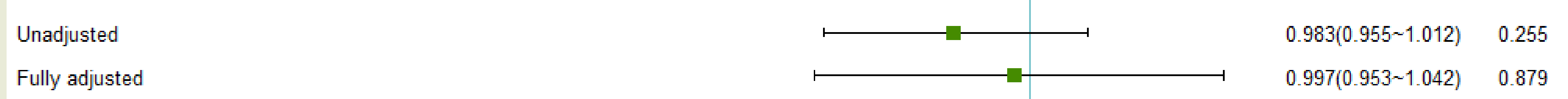
RESULTS

|	OR(95%CI)	P VALUE
ROOM TEMPERATURE & DIFFICULTY INITIATING SLEEP		
Unadjusted	0.958(0.929~0.989)	0.008*
Model1:Unadjusted+Time of a day+Season+Year	0.944(0.91~0.98)	0.002**
Model2:Model1+Demographics	0.948(0.913~0.984)	0.005**
Model3:Model1+Health variables	0.943(0.907~0.98)	0.003**
Model4:Model1+Housing variables	0.943(0.908~0.978)	0.002**
Fully Adjusted	0.945(0.909~0.983)	0.005**
ROOM TEMPERATURE & DIFFICULTY MAINTAINING SLEEP		
Unadjusted	0.955(0.927~0.983)	0.002**
Model1:Unadjusted+Time of a day+Season+Year	0.954(0.922~0.988)	0.009*
Model2:Model1+Demographics	0.961(0.928~0.996)	0.028*
Model3:Model1+Health variables	0.958(0.924~0.994)	0.023*
Model4:Model1+Housing variables	0.954(0.921~0.988)	0.009*
Fully Adjusted	0.963(0.927~0.999)	0.045*
OUTDOOR TEMPERATURE & DIFFICULTY INITIATING SLEEP		
Unadjusted	0.983(0.955~1.012)	0.255
Fully adjusted	0.997(0.953~1.042)	0.879
OUTDOOR TEMPERATURE & DIFFICULTY MAINTAINING SLEEP		
Unadjusted	0.992(0.965~1.02)	0.552
Fully adjusted	1.001(0.959~1.045)	0.955

| Room Temperature Group	Low Room Temperature (<18°C, n=333)	Neutral Room Temperature (18°C-26°C, n=1875)	High Room Temperature (>26°C, n=250)
Fully-adjusted model for DIS aOR(95%CI)	**1.32 (1.01-1.72)***	1.00	0.93 (0.68-1.26)
Fully-adjusted model for DMS aOR (95%CI)	1.10 (0.84-1.42)	1.00	0.83 (0.61-1.11)

Abbreviations: aOR, adjusted odds ratio; 95%CI, 95% confidence interval.
Significant differences were marked as · P < 0.1, *P < .05, **P < .01, and ***P < .001.

Table.1 Fully-adjusted models showing the ORs of room temperature groups, difficulty initiating & maintaining sleep

Compared with neutral room temperatures, each unit increase in low room temperatures was associated with 32% higher odds of having difficulty initiating sleep. No significant association was found between high room temperatures and sleep disturbances, possibly due to the fact that room temperature dropped at night and may be lower than 26°C.

EXPOSURES & OUTCOMES
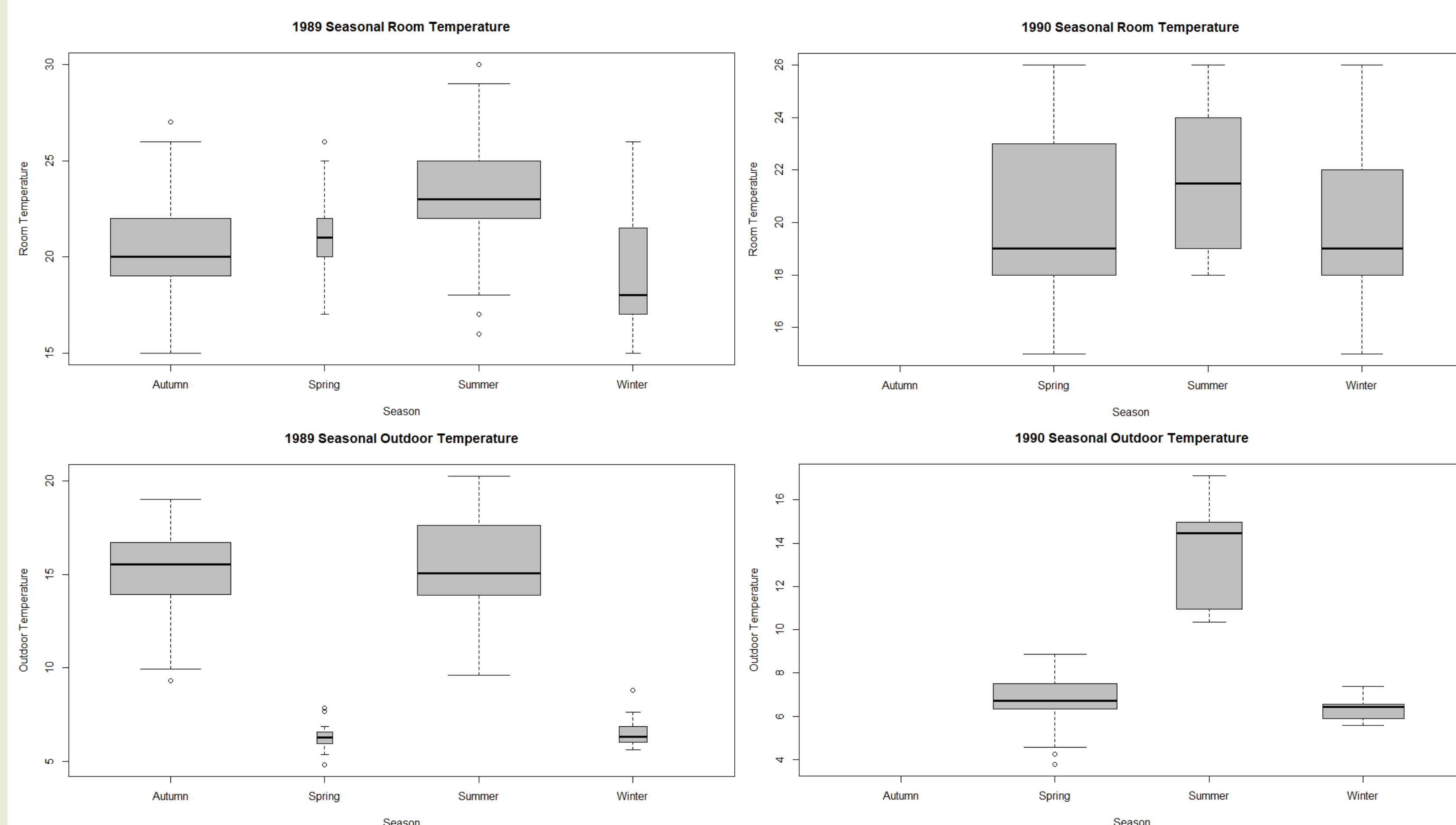
Room temperature was objectively measured by a nurse using a thermometer on the specific day. This single time point temperature reading may not fully represent the actual night-time temperature. Outdoor temperature was monthly average (mean: 14.8°C; SD: 3.0) and data was publicly available obtained from the MET Office.
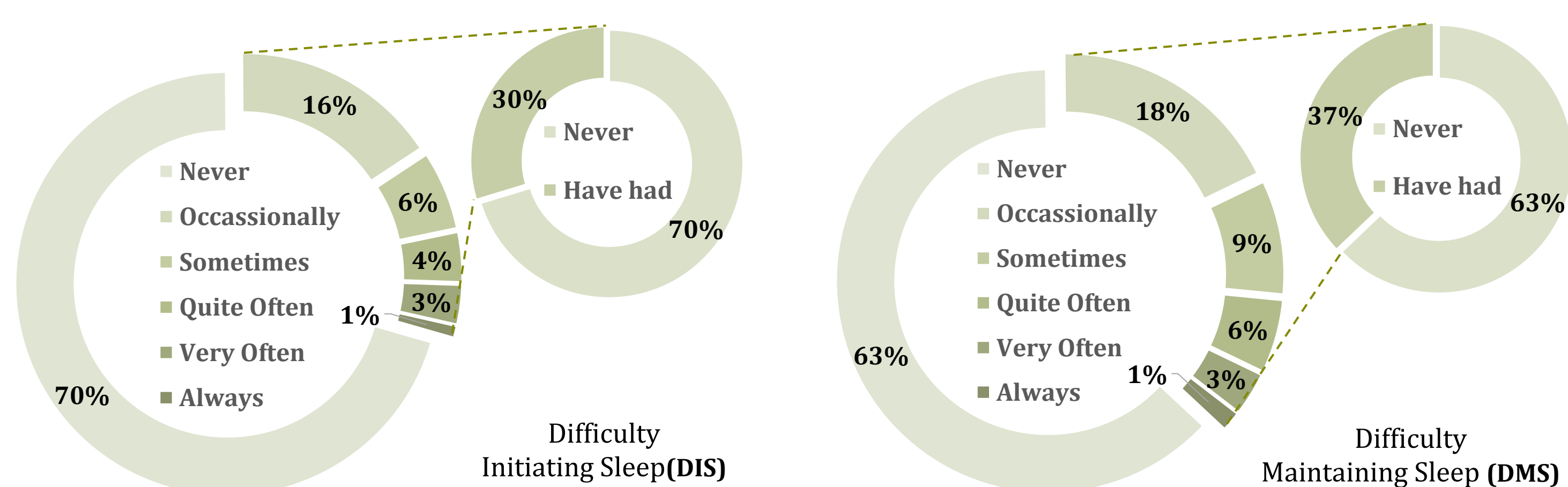
Difficulty initiating sleep**(DIS)**: how often have you had trouble in getting off to sleep in the last year?
Difficulty maintaining sleep**(DMS)**: have you had trouble with waking up & not being able to get back to sleep in the last year?

CONFOUNDERS

Demographics	Mean(SD)/%
Gender	
Female (%)	47.3%
Male (%)	52.7%
Social Class	
No job in 1989	1.0%
I Professional etc.	7.3%
II Intermediate	38.0%
IIINM Skilled (Non-Manual)	21.9%
IIIM Skilled (Manual)	17.8%
IV Partly skilled	10.5%
V Unskilled	3.5%
Health Variables	**Mean(SD)/%**
BMI	25.5 (5.9)
Alcohol Consumption grams/day	15.8 (23.1)
Smoking Status	
Yes	70.9%
No	29.1%
Exercise: Sports/Recreational Activity	
None	50.5%
< once/week	24.1%
1-2 times/week	17.9%
>=3 times/week	7.5%
Physical Effort From Work	
Often	17.5%
Sometimes	32.2%
Seldom/Never	50.3%

Temperature-related Variables	Mean(SD)/%
Year of Temperature Recording	
1989	96.5%
1990	3.5%
Season of Temperature Recording	
Spring	2.8%
Summer	48.7%
Autumn	45.1%
Winter	3.4%
Time of A Day of Temperature Recording	
Morning	26.6%
Afternoon	28.6%
Evening	44.8%
Housing Variables	**Mean(SD)/%**
Heating Types	
Fully centrally heated	82.0%
Partially centrally heated	4.0%
Heated with storage heaters	3.5%
Gas fire	6.9%
Open fires	2.2%
Others	1.4%
Number of Bedroom	3.4 (3.1)

Table.2 Demographics and health variables controlled (Individual-Level Factors)

Table.3 Temperature-related and housing variables controlled (Social-Level Factors)

STRENGTHS
• The large sample size with participants in the same age provided sufficient power to identify the effect of room temperature on sleep disturbances.
• Room temperature data was reliable, since it was objectively measured by the thermometer using the same protocol among individuals during nurse visit.

LIMITATIONS
• Different temporal resolutions of exposure & outcome.
• Room temperatures recorded in living rooms or kitchens, not bedrooms.
• Self-reported sleep outcomes are subject to recall bias.

REFERENCES
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(2) World Health Organization. (2018). WHO Housing and Health Guidelines. Retrieved from https://www-ncbi-nlm-nih-gov.libproxy.ucl.ac.uk/books/NBK535298/
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