

Increasing Ambient Temperature Disrupts Sleep and Impairs Cognitive Function among Older Adults

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Introduction

- Globally, exposure to extreme climatic conditions is estimated to cause over 5 million deaths annually accounting for 9.43% of all deaths.
- Extreme temperatures, particularly those above the absolute threshold of 35°C can have direct (e.g., heat stroke, cardiovascular disease) and indirect (e.g., reduced access to health care) health effects¹.
- Recent data show increases in extreme temperature, with a 6 to 25% increase in the prevalence of cognitive decline and a 9% increase in sleep disorders in sub-Saharan Africa (SSA).²
- Existing studies show disparate evidence for the direct effect of exposure to extreme temperature on reduced cognitive function and sleep disorders among older adults.³
- However, limited studies exist on the indirect relationship between exposure to extreme temperature and cognitive function through sleep disorders.
- Therefore, we examined the indirect relationship between exposure to extreme temperature and cognitive function among older adults in Ghana.

Hypotheses

- H₁.** Increasing ambient temperature will reduce sleep quality.
- H₂.** Increasing ambient temperature will increase the risk of cognitive impairment.
- H₃.** Sleep quality mediates the relationship between ambient temperature and cognitive impairment.

Methods

Study Setting

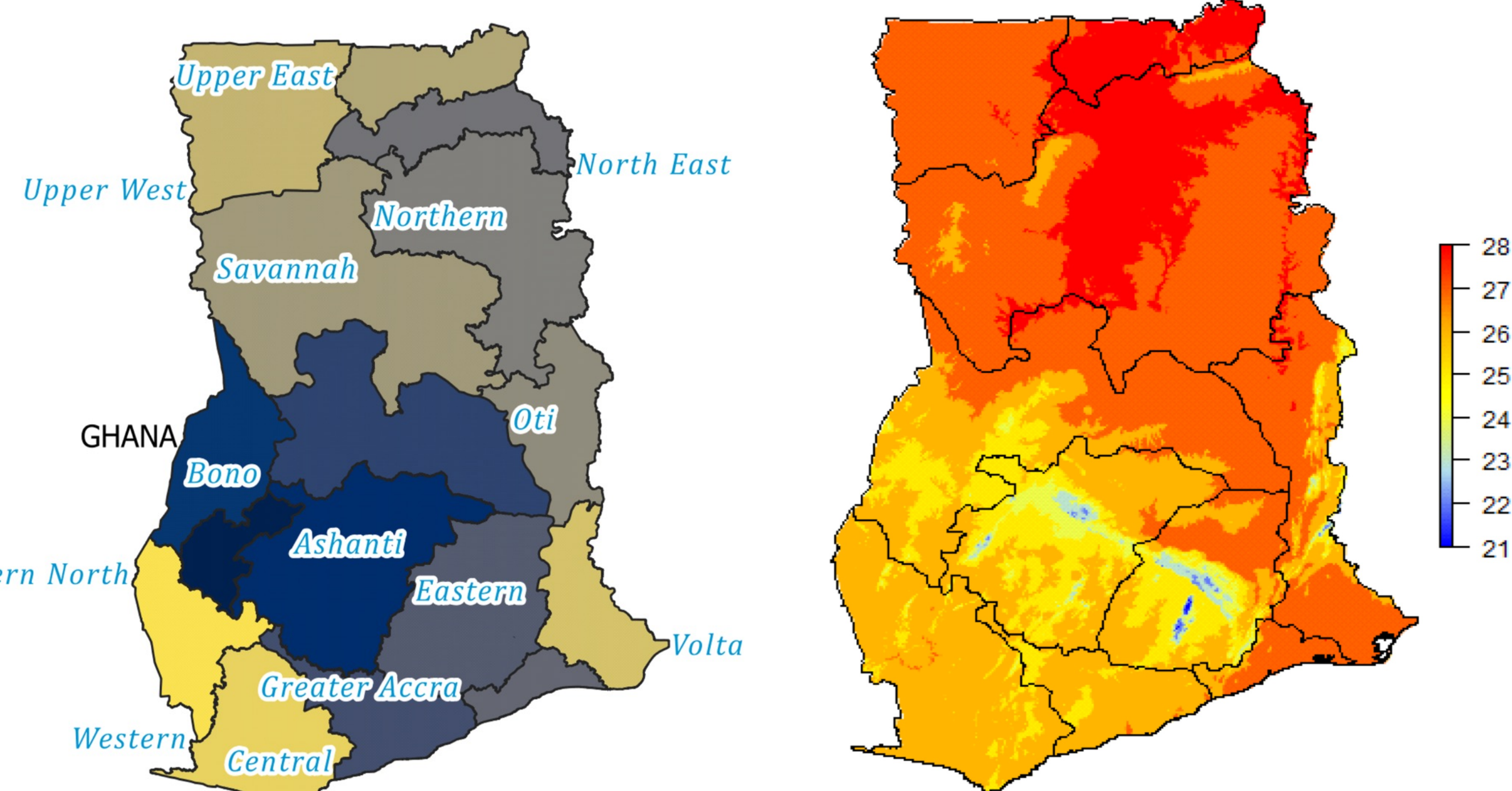


Fig. 1. Study area map showing the 16 administrative regions of Ghana for the SAGE data

Fig. 2. A map of Ghana showing variability in temperature ranges, with northern regions exhibiting the highest temperature

Data Source

- Population-based data: Study on Global AGEing and Adult Health (SAGE) – Wave 2 Ghana data (2014/2015) – (N=3,342 ~ 3,303,626)
- Telemetry Data: Climatic Research Unit (University of East Anglia) gridded Time Series (CRU TS v.4.07)

Outcome Variable

- Cognitive Impairment – Composite score from four tests of cognition
- Immediate verbal recall
 - Delayed verbal recall
 - Verbal fluency
 - Forward and backward digit span tests
 - Composite z-score derived for standardization
 - Rescaled to 0-100 range
 - Lower scores are indicative of greater cognitive impairment.

Methods

Mediating Variable

- Perceived Severity of Sleep Difficulties (Sleep Quality)
 - Problems with falling asleep, waking up frequently during the night, or waking up too early in the morning in the last 30 days.
 - Problems with not feeling rested and refreshed during the day.
 - Two-item scale with similarity to the Insomnia Severity Index.

Control Variables

- Lifestyle Factors
 - Smoking status
 - Physical health (BMI)
- Socio-Demography
 - Sex & Age (Biosocial)
 - Marital Status, Rural-Urban Residence, Level of Education

Data Analysis

- Descriptive:** We assessed the sample distribution for all outcome and control variables.
- Bivariate & Multivariate:**
 - Used multiple linear regression models to assess the relationship between mean past-year temperature and cognitive function and perceived sleep difficulties.
 - Examined the interaction effect of sleep disorder and temperature on cognitive function, while adjusting for covariates.
 - Structural equation models on the mediation effect of sleep difficulty on the relationship between mean temperature and cognitive function.

Results

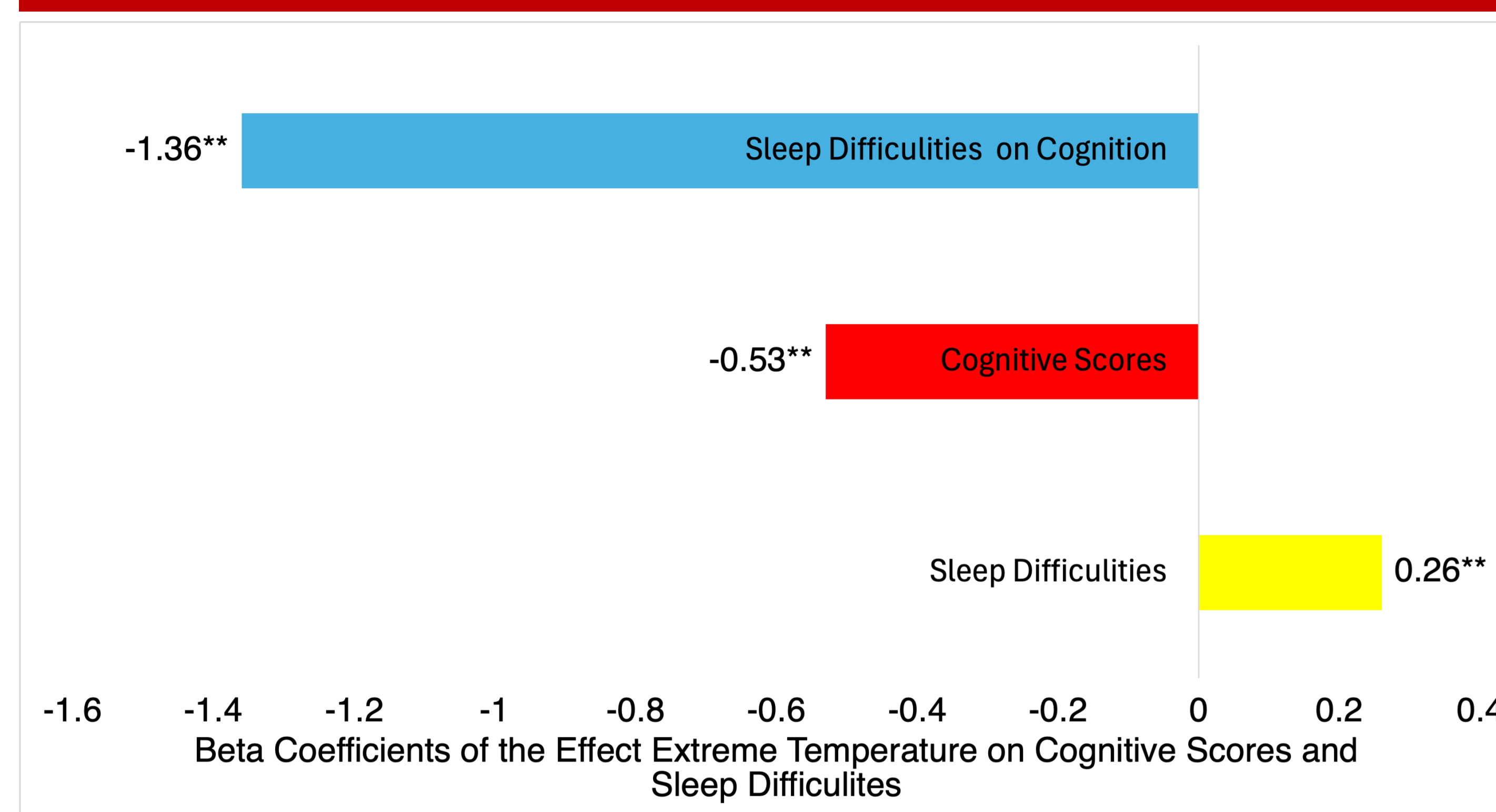


Fig. 3. Beta Coefficients showing the effect of the past year's mean ambient temperature on cognitive scores and sleep difficulties and the effect of sleep difficulties on cognitive scores.

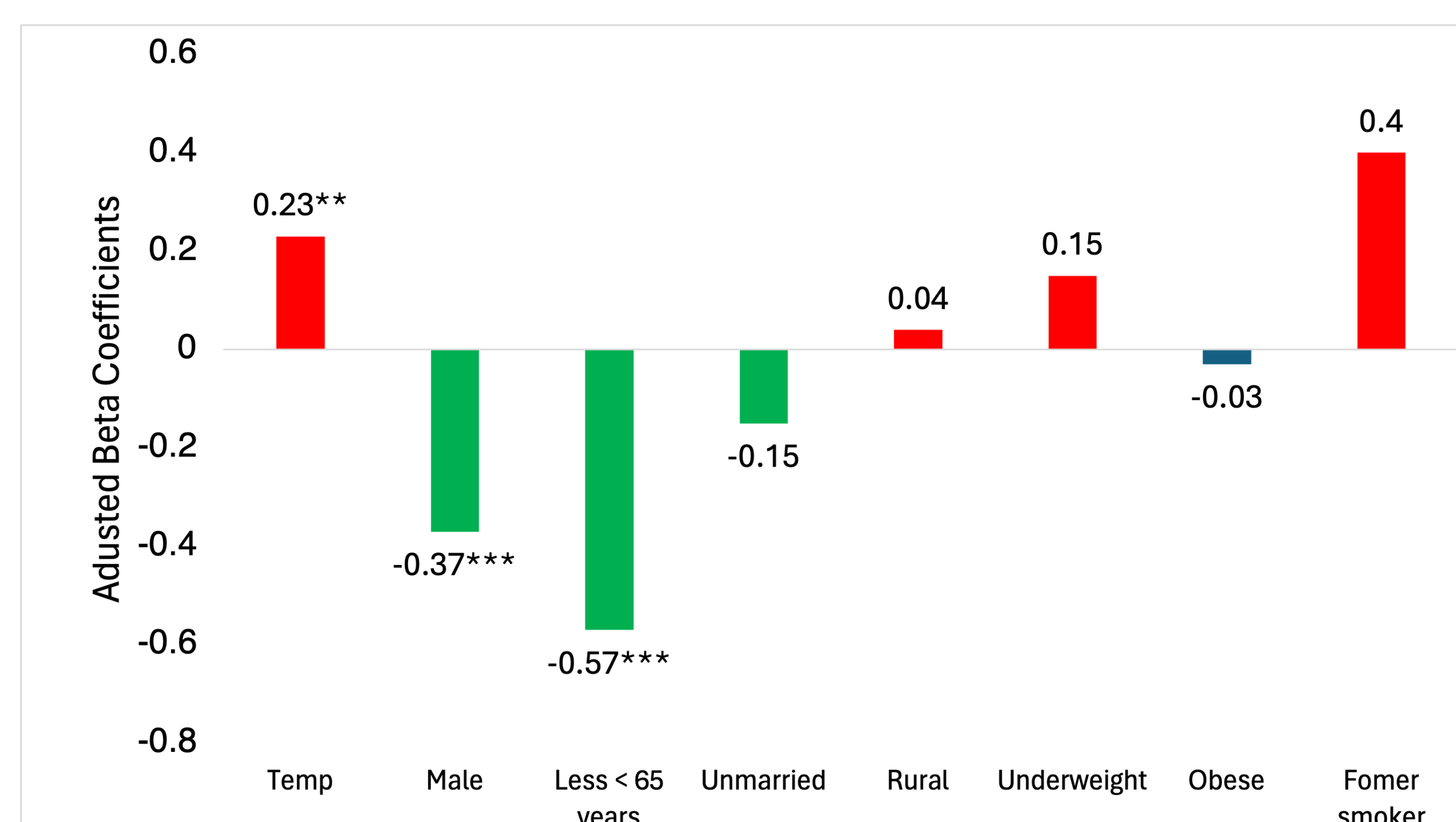


Fig. 4. Adjusted Beta Coefficients showing the effect of the past year's mean ambient temperature on sleep difficulties. (**H₁**)

Results

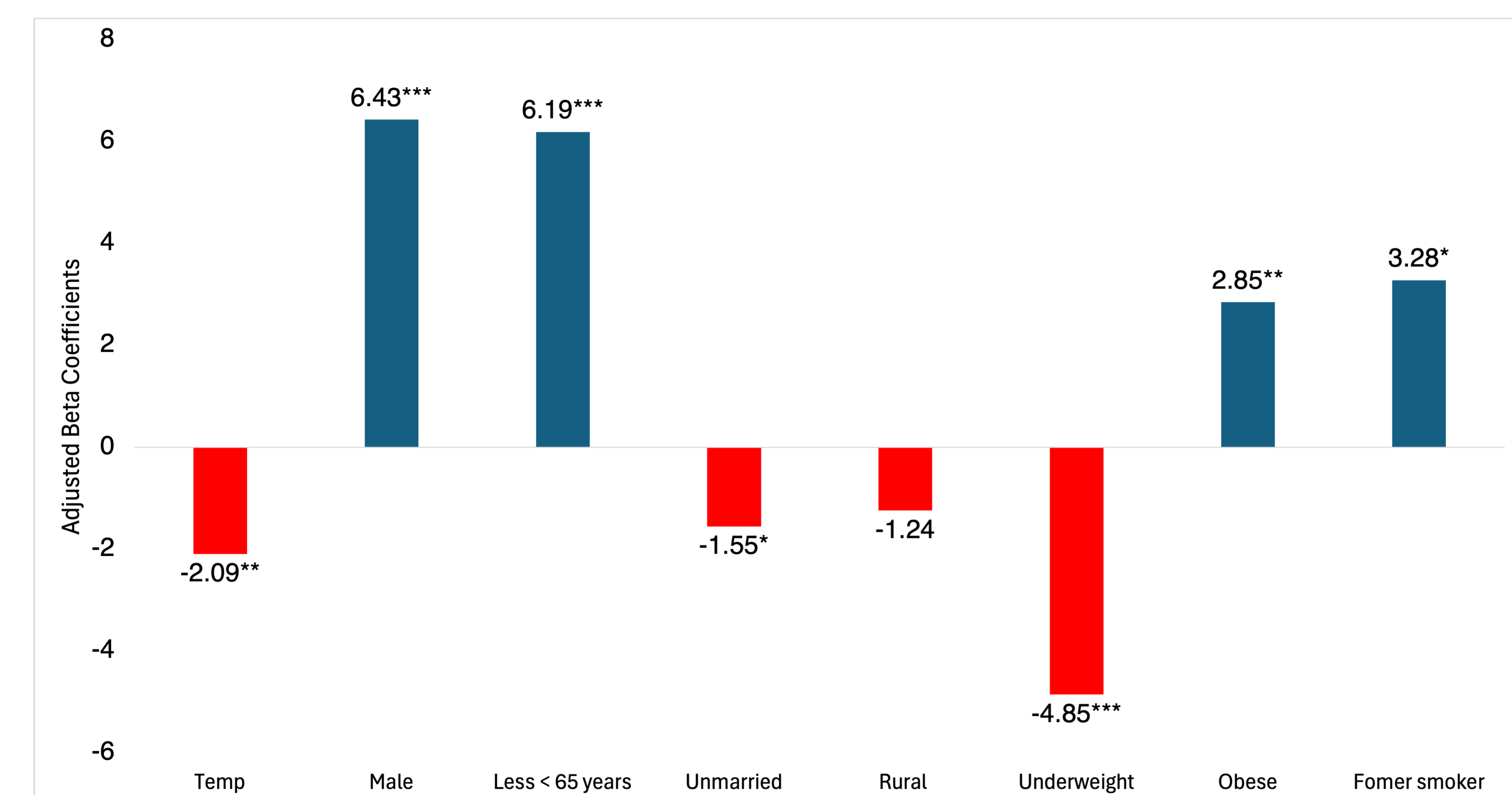


Fig. 5. Adjusted beta coefficients showing the effect of the past year's mean ambient temperature on cognitive scores (**H₂**)

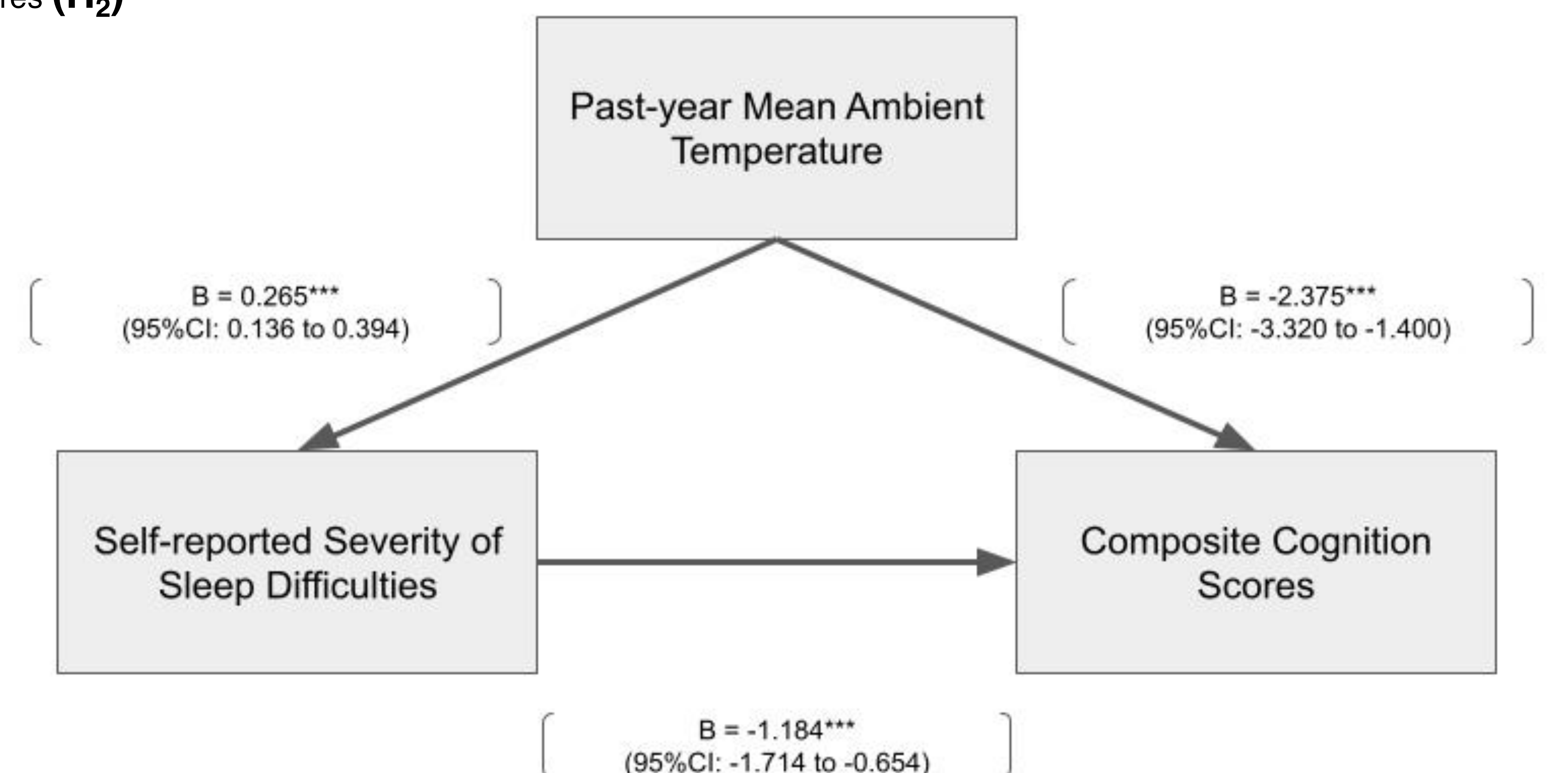


Fig. 6. The mediation effect of sleep difficulties on the relationship between the past year's mean ambient temperature and cognitive scores. (**H₃**)

Summary

- Cognitive scores were found to differ significantly by temperature variability; with lower mean ambient temperature associated with higher cognitive function and higher mean ambient temperatures associated with lower cognitive function.
- Higher ambient temperatures were associated with higher perceived severity of sleep difficulties and lower ambient temperatures with lower severity of sleep difficulties.
- Higher ambient temperatures were significantly associated with increased severity of sleep difficulties and decreased cognitive function among older adults > 65 years.
- An indirect relationship was established between ambient temperature and cognitive function. Higher ambient temperatures increased the severity of sleep difficulties, which in turn decreased cognitive function.

Conclusions

- Increasing ambient temperature disrupts sleep and impairs cognitive function more significantly among older adults aged 65 years and above than those less than 65 years.
- With an increasing trend of ambient temperatures, national strategies to make artificial cooling through residential air conditioning more widely available in Ghana need to be made accessible to the most vulnerable – older adults and those living in rural/poorer settings.

References

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