

Does Allostatic Load Modify the Neuroprotective Effects of Lifestyle Activity Behaviours In Midlife? Evidence From the UK Biobank

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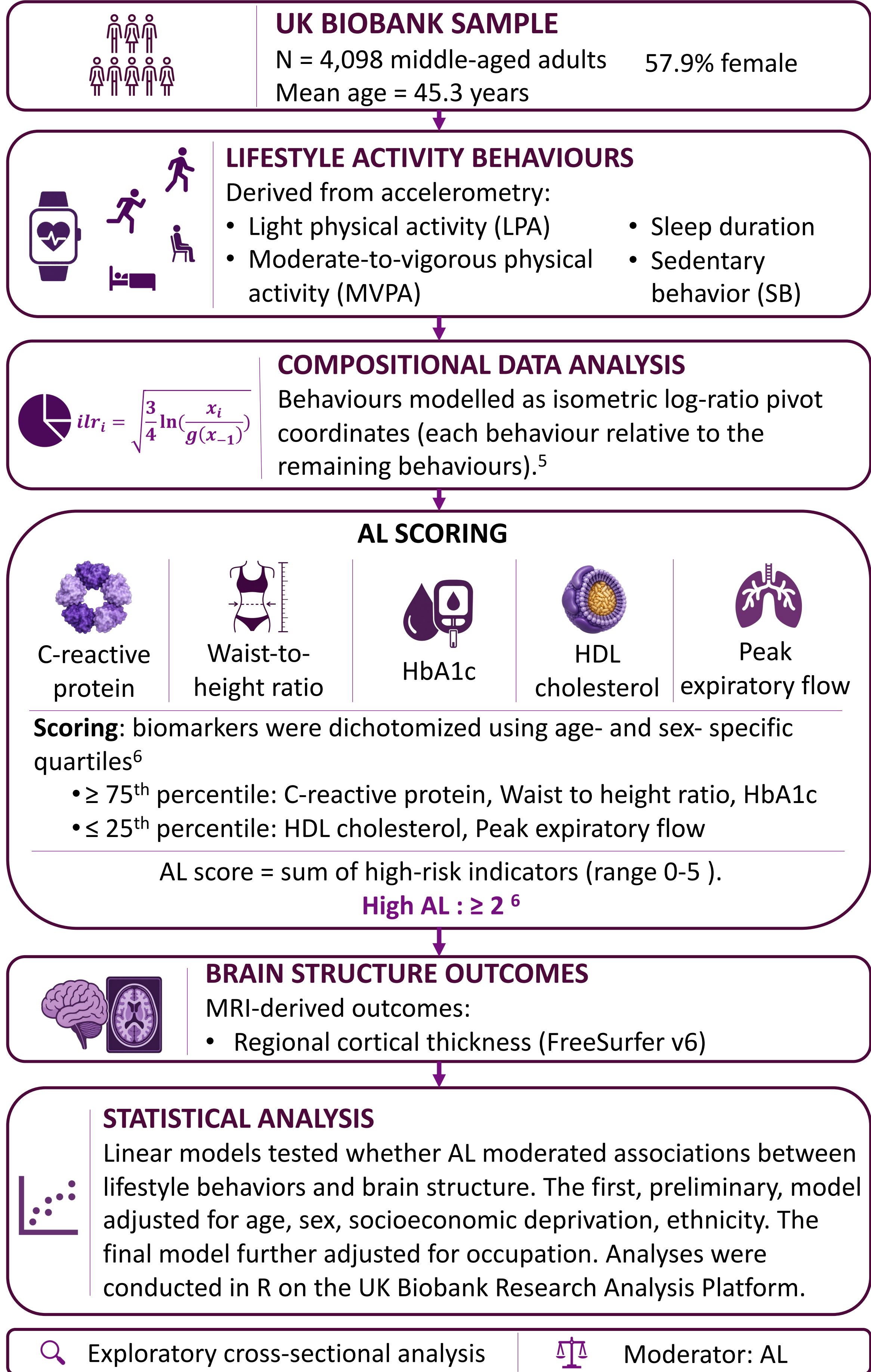
BACKGROUND AND OBJECTIVES

- Lifestyle activity behaviours, including physical activity, sedentary behaviour, and sleep, are linked to brain health.¹
- Allostatic load (AL) reflects cumulative physiological stress,² is associated with poorer health outcomes,³ and may influence brain structure.⁴
- However, it is unclear whether AL changes the relationship between daily lifestyle behaviours and brain outcomes in midlife.

Our objective was to examine whether AL modifies associations between lifestyle activity behaviours and brain structure, cortical thickness, in midlife.

METHODS

Figure 1. Study flowchart.



RESULTS

Preliminary analysis sample (n = 5,534; mean [SD] age = 45.22 [3.36] years; 58.5% female), AL significantly moderated lifestyle-cortical thickness associations before adjustment for occupation:

- MVPA: inverse associations with pars opercularis, pericalcarine, and rostral middle frontal thickness in the high AL group.
- LPA, SB, and sleep: positive region-specific associations in the high AL group.

Tables and figures present the final analysis (n = 4,098), adjusting for potential effects of physical/manual labour occupations.

Table 1. Baseline demographic

Characteristic	Overall (n = 4,098)
Age, years, mean (SD)	45.32 (3.41)
Sex, n (%)	
Female	2,372 (57.9)
Male	1,726 (42.1)
Ethnicity, n (%)	
White	3,820 (93.2)
Other ethnicity	278 (6.8)
Allostatic load group, n (%)	
Low	2,694 (65.7)
High	1,404 (34.3)
Occupation, n (%)	
Managers and Senior Officials	774 (18.9)
Professional Occupations	1,093 (26.7)
Associate Professional and Technical Occupations	890 (21.7)
Administrative and Secretarial Occupations	606 (14.8)
Other occupations	735 (17.9)

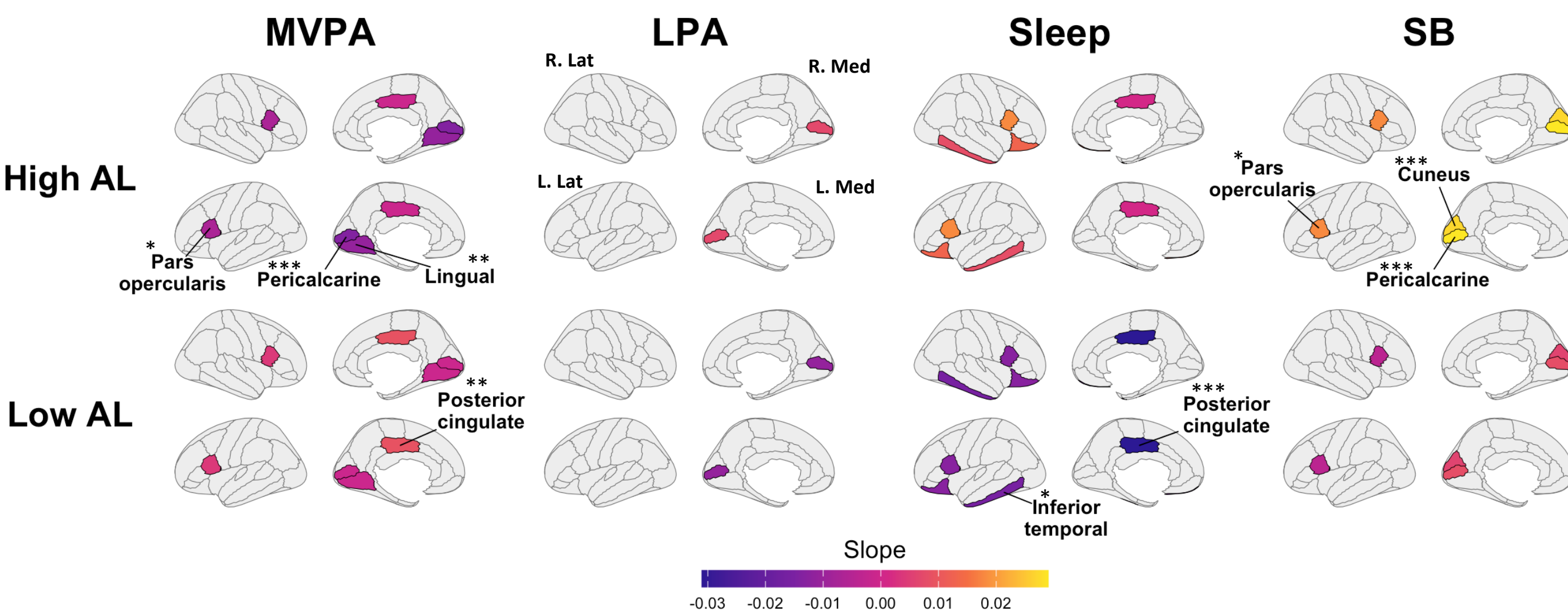
Note. Values are presented as mean (SD) for age and n (%) for categorical variables. Other occupations include skilled trades, personal service, sales and customer service, process/plant/machine operatives, and elementary occupations. High AL was defined as a score ≥ 2.

Table 2. Significant allostatic load moderation effects on cortical thickness

Lifestyle behaviour × AL group	Cortical region	B [95% CI]	p-value
MVPA × High AL	Pericalcarine	-0.013 [-0.022, -0.004]	0.007
MVPA × High AL	Pars opercularis	-0.012 [-0.021, -0.002]	0.015
MVPA × High AL	Lingual	-0.010 [-0.019, 0.000]	0.043
MVPA × High AL	Posterior cingulate	-0.010 [-0.021, 0.000]	0.045
LPA × High AL	Pericalcarine	0.018 [0.000, 0.036]	0.047
SB × High AL	Pericalcarine	0.021 [0.001, 0.040]	0.037
SB × High AL	Pars opercularis	0.021 [0.002, 0.041]	0.033
SB × High AL	Cuneus	0.021 [0.002, 0.040]	0.032
Sleep × High AL	Pars opercularis	0.031 [0.006, 0.055]	0.013
Sleep × High AL	Posterior cingulate	0.033 [0.006, 0.059]	0.016
Sleep × High AL	Lateral orbitofrontal	0.026 [0.003, 0.049]	0.028
Sleep × High AL	Inferior temporal	0.024 [0.002, 0.047]	0.036

Note. AL = allostatic load; MVPA = moderate-to-vigorous physical activity; LPA = light physical activity; SB = sedentary behaviour; CI = confidence interval. B values are adjusted interaction estimates testing whether lifestyle-cortical thickness associations differed by AL level. Models controlled for age, sex, socioeconomic deprivation, ethnicity, and occupation. Only significant results are shown (p < .05).

Figure 2. Associations between lifestyle behaviours and cortical thickness by AL level



Note. Brain maps show fully adjusted simple-slope associations between lifestyle behaviours and regional cortical thickness by AL level. Models controlled for age, sex, socioeconomic deprivation, ethnicity, and occupation. Warm/cool colors indicate positive/negative slope estimates. Only significant regions from moderation models are labelled. Significance: *p < .05, **p < .01, ***p < .001.

AL modified associations between lifestyle behaviours and cortical thickness. MVPA and SB showed clearer patterns in the high AL group, while sleep showed clearer patterns in the low allostatic load group

DISCUSSION AND CONCLUSIONS

- AL may modify how lifestyle behaviours relate to regional cortical thickness in midlife adults.
- In individuals with high AL, MVPA was negatively associated with cortical thickness, while LPA, SB, and sleep duration showed positive associations in specific cortical regions.
- In the low AL group, greater sleep relative to other daily behaviours was associated with lower cortical thickness in the posterior cingulate and inferior temporal regions.
- Findings were exploratory, cross-sectional, and based on a sample that was predominantly female and White, limiting causal interpretation and generalizability.
- Future longitudinal studies are needed to clarify whether reducing physiological stress may support healthier brain aging.
- Adjustment for occupation did not change the main findings.

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