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Compositional modeling to estimate the associations of reallocating behaviors (sleep, physical activity, sedentary time) on blood pressure among Black adults

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Hypertension is a key risk factor for cardiovascular disease

- Disproportionately burdened by Black adults
  - Despite availability and affordability of anti-hypertensive medications
- Reduction of the hypertension burden may involve targeting lifestyle factors - physical activity and sleep
- Lifestyle behaviors and modifications are correlative
  - Adoption of individual lifestyle behaviors may correspond with the adoption of other recommended behaviors

Research aim

- To estimate how reallocating time spent in one movement behavior for another influences hypertension and hypertension control while accounting for the remaining movement behavior among Black adults in the Jackson Heart Study

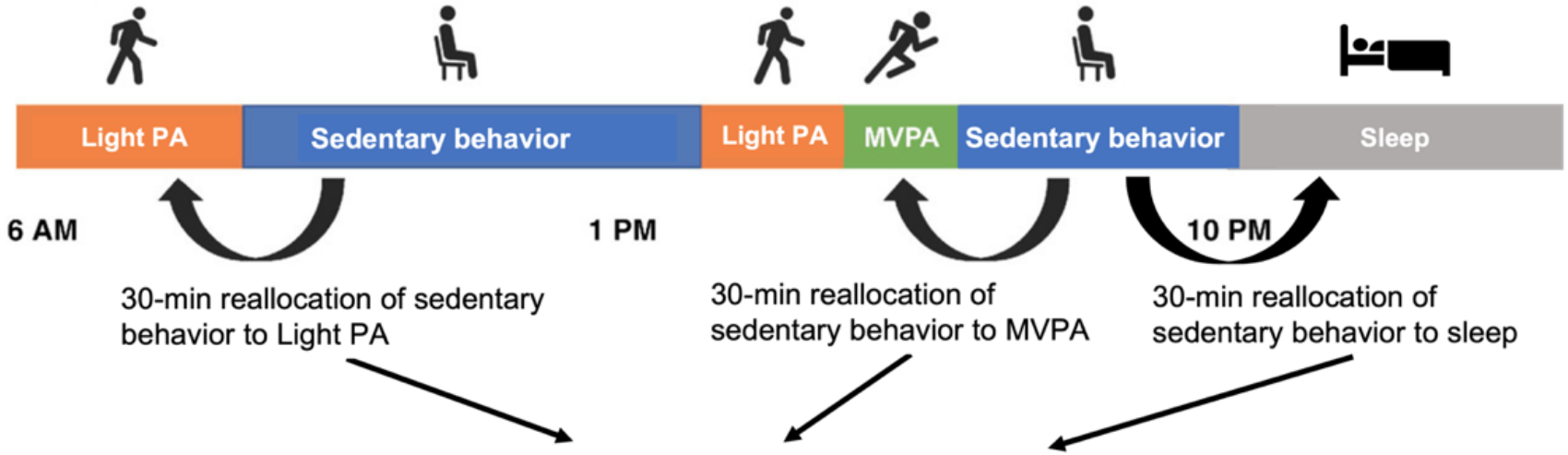
Measurements

Behavior	Measurement	Exam
Physical activity	30-Item modified Baecke questionnaire	Exam 3
Objective sleep duration	7-day actigraphy, average	Sleep exam
Self-reported sleep duration	# of Hrs of actual sleep at night over the past month	Sleep exam, Exam 3
Uncontrolled blood pressure_1	Average Systolic > 140 or diastolic > 90 among those with hypertension	Sleep exam, Exam 3
Uncontrolled blood pressure_2	Average Systolic > 130 or diastolic > 80 among those with hypertension	Sleep exam, Exam 3
High blood pressure_1	Average Systolic > 140 or diastolic > 90, self-report, or use of antihypertensive medications	Sleep exam, Exam 3
High blood pressure_2	Average Systolic > 130 or diastolic > 80, self-report, or use of antihypertensive medications	Sleep exam, Exam 3

Isotemporal models

- Estimate associations between theoretically substituting one type of physical activity or sleep for others

Figure 1. A Conceptual Example of 24-Hour Activity Reallocation



MVPA= moderate-to-vigorous levels of physical activity, Light PA = Light levels of physical activity, Illustrated by Full et al. (2020) [38] and edited by the authors

Statistical Analysis

- CoDA and isotemporal substitution
- To estimate the hypothetical effects on BP of substituting lifestyle behaviors (sleep, physical activity, sedentary time):
  - Step 1: Use single variable regression models to estimate the independent association of each behavior (sleep, physical activity, sedentary time) with BP
  - Step 2: Use partition models to examine the association between each behavior and BP after adjusting for all other behavior variables
  - Step 3: Use isotemporal substitution models to estimate the effects of reallocating one component for another (e.g., 30 minutes of sedentary behavior to sleep) on BP, while adjusting for other variables
- Adjusted for age, sex, and education

Sample demographics

- Black adults
  - N=821 (sleep exam)
  - N=3763 (Exam 3)
- 63 years of age
- Mostly female (65.4%)
- College educated (68.3%)

Odds ratios for uncontrolled hypertension based on changes in composition of activity and sleep

	Decrease by up to 30m			
Increase by up to 30m	LPA	MVPA	Sleep duration	Sedentary
Uncontrolled BP, Systolic BP ≥130 or Diastolic BP ≥80				
LPA	---	0.94 (0.64, 1.37)	1.02 (0.79, 1.32)	1.03 (0.80, 1.33)
MVPA	0.98 (0.67, 1.42)	---	1.03 (0.91, 1.17)	1.03 (0.92, 1.16)
Sleep duration	0.97 (0.67, 1.38)	0.92 (0.68, 1.25)	---	1.00 (0.95, 1.06)
Sedentary	0.97 (0.67, 1.38)	0.92 (0.68, 1.24)	1.00 (0.94, 1.06)	---
Uncontrolled BP, Systolic BP ≥140 or Diastolic BP ≥90				
LPA	---	0.99 (0.62, 1.58)	0.98 (0.71, 1.35)	0.91 (0.66, 1.25)
MVPA	1.10 (0.70, 1.75)	---	1.04 (0.89, 1.22)	0.96 (0.84, 1.11)
Sleep duration	1.10 (0.70, 1.71)	1.01 (0.70, 1.46)	---	**0.93 (0.87, 1.00)**
Sedentary	1.12 (0.72, 1.74)	1.05 (0.73, 1.51)	1.08 (1.00, 1.16)	---

LPA=light physical activity; MVPA=moderate to vigorous physical activity

Odds ratios for hypertension based on changes in composition of activity and self-reported sleep

	Decrease by up to 30m			
Increase by up to 30m	LPA	MVPA	Sleep duration	Sedentary
Hypertension, 2017 ACC/AHA defn.				
LPA	---	1.21 (0.93, 1.59)	0.86 (0.70, 1.06)	0.86 (0.70, 1.06)
MVPA	1.14 (0.88, 1.48)	---	**0.87 (0.77, 0.97)**	**0.87 (0.78, 0.97)**
Sleep duration	1.19 (0.93, 1.53)	1.32 (1.06, 1.64)	---	1.00 (0.97, 1.03)
Sedentary	1.19 (0.93, 1.53)	1.32 (1.07, 1.64)	1.00 (0.96, 1.04)	---
Hypertension, JNC7 defn.				
LPA	---	1.20 (0.95, 1.53)	**0.80 (0.66, 0.96)**	**0.79 (0.66, 0.95)**
MVPA	1.25 (0.99, 1.58)	---	**0.86 (0.77, 0.95)**	**0.85 (0.77, 0.93)**
Sleep duration	1.32 (1.05, 1.65)	1.37 (1.13, 1.66)	---	0.99 (0.96, 1.02)
Sedentary	1.32 (1.05, 1.65)	1.37 (1.13, 1.66)	1.01 (0.97, 1.04)	---

LPA=light physical activity; MVPA=moderate to vigorous physical activity

Conclusion

- Increased sedentary time at the expense of objective sleep increases the risk of hypertension
- Decreased sedentary time and self-reported sleep and increased physical activity lowers the risk of hypertension
- Results varied based on hypertension definition and sleep measurement
- Promoting sleep or physical activity in place of sedentary time may reduce the burden of hypertension

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