

Hypertension And Incident Dementia Among U.S. Veterans: Heterogeneity By Age And Race/Ethnicity

Michelle Caunca, MD, PhD¹, Adina Zeki Al Hazzouri, PhD², Feng Xia, MPH³, Sebastian Calonico, PhD⁴, John Boscardin, PhD⁵, Kristine Yaffe, MD^{1,5,6}

1. Department of Neurology, University of California, San Francisco, San Francisco, CA; 2. Department of Epidemiology, Columbia University, New York, NY; 3. Northern California Institute for Research and Education, San Francisco, CA; 4. Graduate School of Management, UC Davis, Davis, CA; 5. Department of Epidemiology and Biostatistics, University of California, San Francisco, CA; 6. Department of Psychiatry and Behavioral Sciences, University of California, San Francisco, San Francisco, CA

Background

- Hypertension is a modifiable risk factor for dementia¹, but the association among U.S. military veterans has not been fully characterized.
- Military veterans in the U.S. represent a population that warrant specific study, given their complex burden of cardiometabolic and psychosocial risk factors later in life compared to the general population.
- Hypertension prevalence is estimated around 40% in the U.S. Veteran population,
- Some studies estimate about 25% of Veterans have uncontrolled blood pressures measuring over 140/90².
- Differences in the association between hypertension and dementia across age, race/ethnicity, and sex/gender in the Veteran population has not yet been well characterized.

Methods

Study Sample

- The study data are derived from Veterans Health Administration (VHA) electronic health records, derived from a random sample of older Veterans from VHA electronic health record (EHR) between 10/1/1999-9/30/2023 (5% sample selected each fiscal year from 2000 to 2023).
- We first selected all Veterans in our random sample aged 60 years or older at 10/1/2010 and had 1 or more follow-up visits from fiscal year (FY) 2011 to 2023 (n=2,071,071). We defined the baseline period as FY2009-FY2010.
- Inclusion criteria into the study sample included: 1) mild cognitive impairment and dementia-free during baseline period, 2) had 2 or more visits during the baseline period, 3) had at least 2 outpatient blood pressure (BP) measures during baseline period.

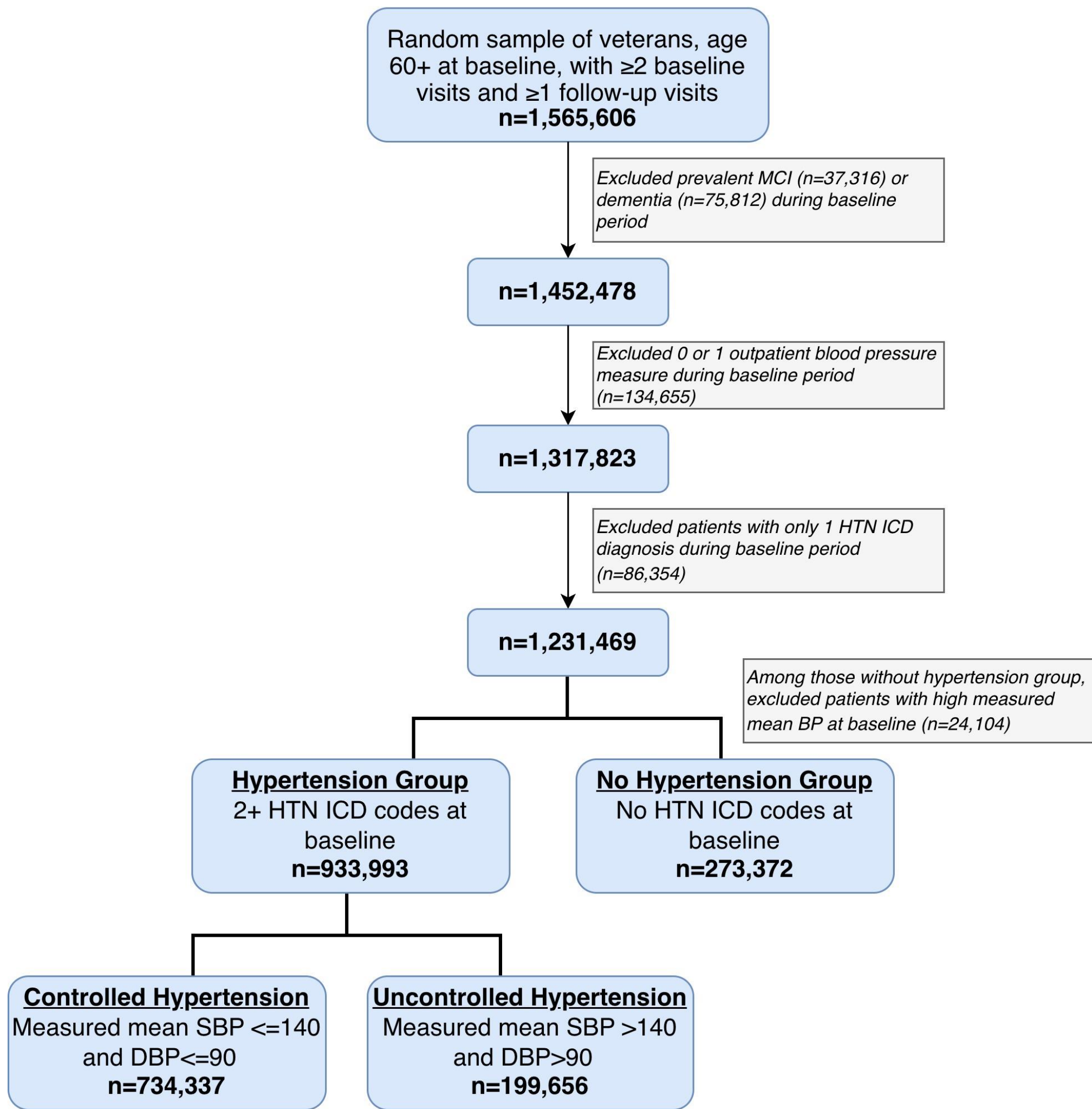
Variables

- Hypertension** was defined during the baseline period using a combination of inpatient and outpatient data, using ICD-9 codes for hypertension. **Controlled** hypertension was defined as a mean SBP $\leq$ 140 and $\leq$ DBP 90 (n=734,337), and uncontrolled hypertension was defined as a mean SBP>140 or DBP>90 (n=199,656), based on 2024 European Society of Cardiology guidelines.
- Incident all-cause dementia** was operationalized ICD-9 and ICD-10 codes validated against external reference standards. Patients were followed until incident dementia, death, or last observed visit.

Analysis

- We estimated the association between hypertension group (no hypertension as the reference group) and time-to-incident dementia diagnosis using multivariable Cox proportional hazards models with follow-up time in years as the time scale.
- Model 1 was adjusted for age, sex/gender, race/ethnicity, area-level educational attainment. Model 2 was further adjusted for diabetes, obesity, hypercholesterolemia, TBI, current tobacco use, PTSD, depression, and substance use disorder.
- To explore heterogeneity in associations, we added multiplicative interaction terms with hypertension group and age and race/ethnicity, tested in separate models. We also conducted stratified analyses by age group and race/ethnicity.
- In sensitivity analyses, we used Fine-Gray models with Wolber's approximation to account for competing risk of death⁴.

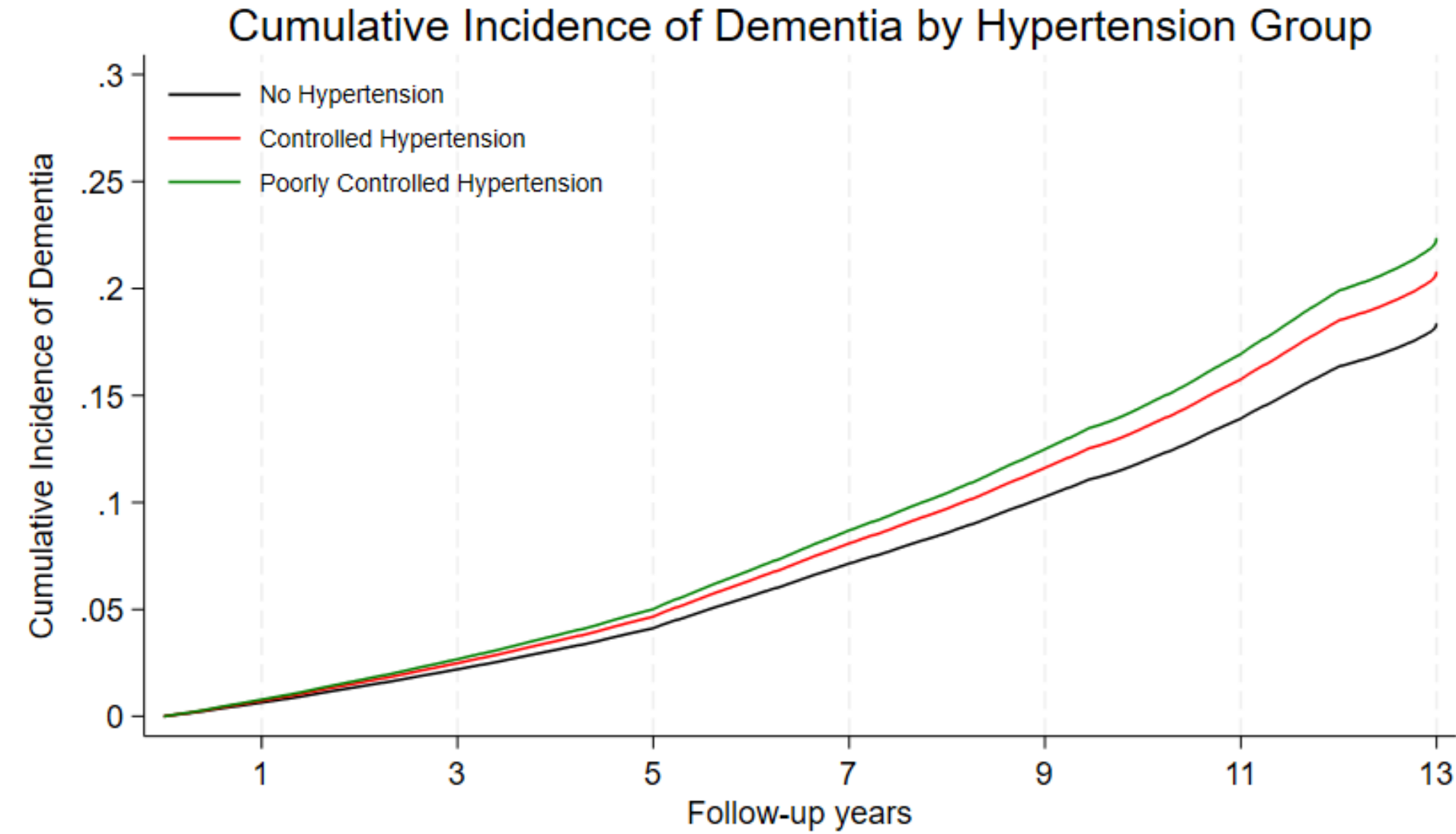
Sample Selection



Hypertension and Risk of Dementia

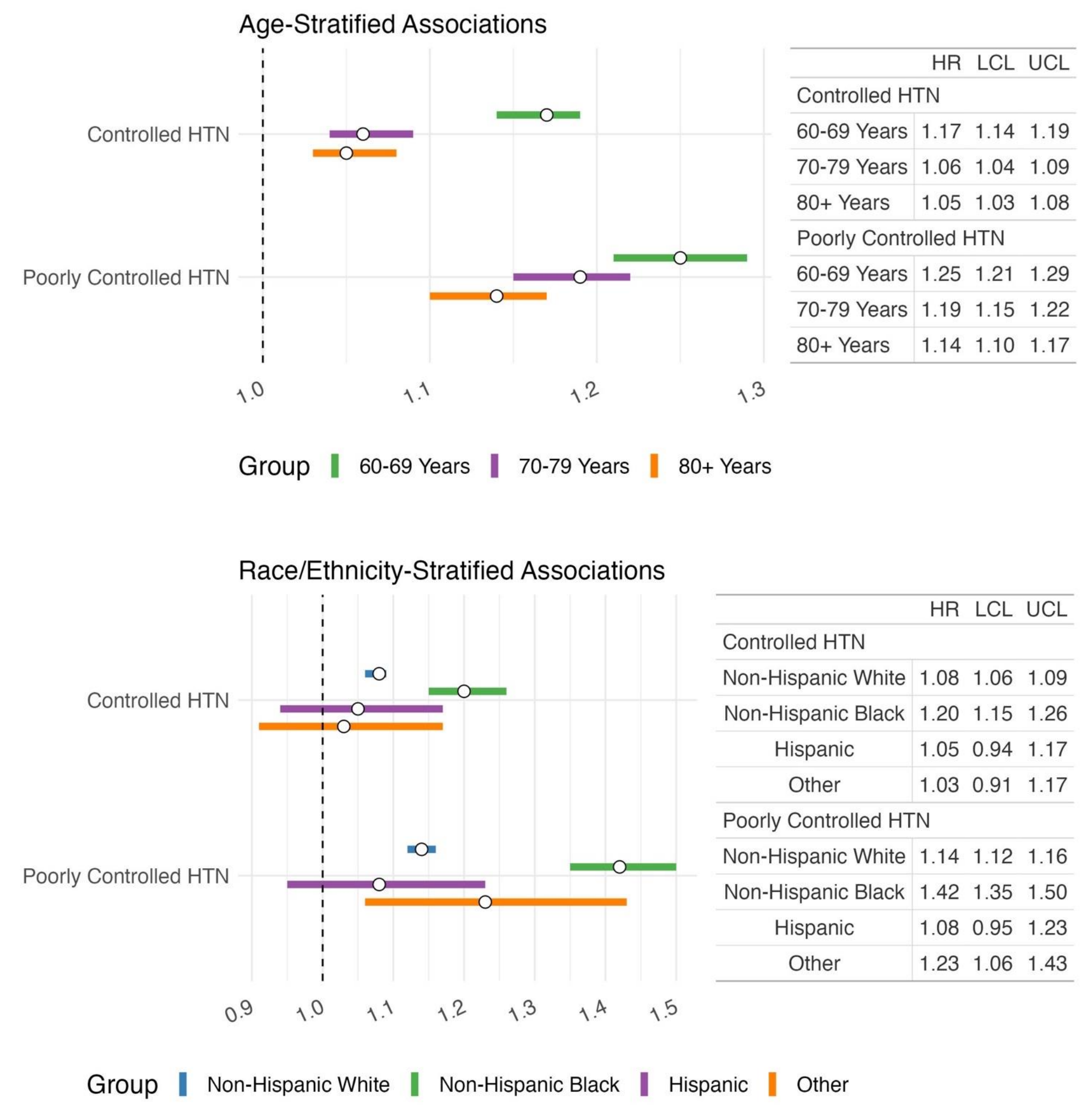
	No Hypertension n=273,372	Controlled n=734,337	Poorly Controlled n=199,656
Age, y, mean (SD)	70.3 (8.3)	72.2 (8.5)	72.3 (8.8)
Men	265,903 (97.3)	720,541 (98.1)	194,759 (97.5)
Race			
Non-Hispanic White	249,031 (91.1)	633,800 (86.3)	164,436 (82.4)
Non-Hispanic Black	18,364 (6.7)	84,259 (11.5)	30,313 (15.2)
Hispanic	2,442 (0.9)	7,497 (1.0)	2,419 (1.2)
Other ^a	3,535 (1.3)	8,781 (1.2)	2,488 (1.2)
>25% college-educated in zip code	106,996 (40.0)	261,076 (36.3)	65,994 (33.8)
Diabetes	46,781 (17.1)	296,537 (40.4)	77,182 (38.7)
Obesity	34,416 (12.6)	170,922 (23.3)	44,022 (22.0)
Hypercholesterolemia	174,304 (63.8)	598,567 (81.5)	150,101 (75.2)
TBI	908 (0.33)	2,481 (0.34)	632 (0.32)
Current tobacco use	51,256 (18.7)	112,626 (15.3)	33,181 (16.6)
PTSD	34,316 (12.6)	81,690 (11.1)	20,557 (10.3)
Depression	45,394 (16.6)	119,456 (16.3)	29,061 (14.6)
Alcohol use disorder	17,117 (6.3)	43,633 (5.9)	15,383 (7.7)
Substance use disorder	7,367 (2.7)	14,924 (2.0)	5,148 (2.6)

Cumulative Incidence



Poorly Controlled Hypertension	
Incidence (95% CI), %	22.95 (22.72, 23.18)
Risk difference (95% CI), %	3.45 (3.16, 3.74)
Controlled Hypertension	
Incidence (95% CI), %	21.62 (21.49, 21.75)
Risk difference (95% CI), %	2.12 (1.91, 2.34)
No Hypertension	
Incidence (95% CI), %	19.50 (19.31, 19.69)
Risk difference (95% CI), %	ref
Model adjusted for age, sex/gender, race/ethnicity, area-level education, calculated at end of follow up (year 13).	

	Controlled Hypertension HR (95% CI)	Poorly Controlled Hypertension HR (95% CI)
Model 1	1.13 (1.12, 1.15)	1.21 (1.19, 1.23)
Model 2	1.08 (1.07, 1.10)	1.17 (1.15, 1.19)
Hazard ratio and 95% confidence interval. Follow-up time as timescale. No hypertension group as reference group. Model 1: age, sex/gender, race/ethnicity, area-level education. Model 2: Model 1 plus diabetes, obesity, hypercholesterolemia, TBI, current tobacco use, PTSD, depression, substance use disorder.		



Stratified analyses run with Model 2.

Adjusting for Competing Risk of Death

	Controlled Hypertension HR (95% CI)	Poorly Controlled Hypertension HR (95% CI)
Model 1	1.07 (1.05, 1.08)	1.10 (1.08, 1.12)
Model 2	1.03 (1.02, 1.04)	1.07 (1.05, 1.09)

Follow-up time as timescale. No hypertension group as reference group. CI: confidence interval. Model 1: age, sex/gender, race/ethnicity, area-level education. Model 2: Model 1 plus diabetes, obesity, hypercholesterolemia, TBI, current tobacco use, PTSD, depression, substance use disorder.

Discussion

- In this analysis of VHA data, a substantial proportion of U.S. Veterans had hypertension, both controlled and uncontrolled, which was associated with a greater risk of all-cause dementia compared to those without hypertension.
- Associations were stronger among younger Veterans and Veterans who identify as Black.
- Associations persisted though were slightly attenuated after adjustment for cardiometabolic and military-related risk factors as well as after accounting for competing risk of death.

Conclusion

Overall, we found that both poorly controlled and controlled hypertension are associated with increased risk of dementia among U.S. Veterans. These associations varied across age and racial/ethnic groups such that younger patients and patients who identified as Black had the greatest risk of dementia. Future work should examine sex differences in Veteran women as well as explore associations across intersectional groups.

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Michelle.Caunca@ucsf.edu