Supplementary Material

Racial/Ethnic Disparities in the Alzheimer's Disease Link with Cardio and Cerebrovascular Diseases, based on Hawaii Medicare Data

Estimations and testings of multistate models

In our approach, we estimated transition hazard functions using the Nelson Aalen hazard rate estimator and next used the Aalen-Johansen product limit integral estimator to quantify marginal estimates of state occupation probabilities, which are nonparametric techniques that provide a great flexibility of handling multistate system without strict model assumptions [1-3]. Below we provide a general explanation of the estimation procedure.

Consider a general time continuous multistate model with a finite state $k = \{0, .., K\}$, that allows a set of transitions among states. Note that, in the current problem, the initial state is indicated by 0 and K is fixed to be two. Suppose that a set of n individuals move independently in the multistate system starting from state 0. In the current illness and death model, at time 0, there is no subjects present in state 1 or 2. For the ith individual, $i = 1, ..., n$, suppose $S_i(t)$ is the state occupies by the individual at time t and let T_i^* be the time required for the individual to reach the absorbing state (i.e., state K) and C_i be the right censoring time. Note $T_i = \min\{T_i^*, C_i\}$ is the observed time for the ith subject. Say $\delta_i = I(C_i \geq T_i^*)$ is the right-censoring indicator with respect to reaching the absorbing state for the individual. Define $X_i = (X_{i1}, .., X_{ip})^T$ a p dimensional covariate vector contains baseline information of the individual. Thus, the observed data consist of independently and identically distributed copies of $\{S_i(t), 0 \leq t \leq T_i, \delta_i, X_i\}$, $1 \leq i \leq n$, for n subjects.

The state to state transition counting process $N_{kk'}(t)$ correspond to k to k' at time point t is given by

$$N_{kk'}(t) = \sum_{i=1}^{n} I(C_i \geq t, S_i(t-) = k, S_i(t) = k'),$$

where $S_i(t-) = \lim_{v \to t-} S_i(v)$ is the state that ith subject presented just prior to time t. The at-risk process correspond to kth state $Y_k(t)$ at t is given by,

$$Y_k(t) = \sum_{i=1}^{n} I(C_i \geq t, S_i(t-) = k).$$

Next, using the two temporal $N_{kk'}(t)$ and $Y_k(t)$, the Nelson-Aalen estimate of cumulative (integrated) state to state transition hazard $\hat{A}_{jj'}(t)$ is estimated as follows:

$$\hat{A}_{kk'}(t) = \begin{cases} \int_0^t W(v)\hat{Y}_k(v)^{-1} d\hat{N}_{kk'}(v), & \text{if } k \neq k' \\ -\sum_{k \neq k'} \hat{A}_{kk'}(t), & \text{otherwise,} \end{cases}$$

where $W(v) = I(\hat{Y}_j(v) > 0)$ and $I(.)$ is an indicator function. The counting process given by $d\hat{N}_{kk'}(t)$ is obtained by the corresponding increments of state-to-state transitions at $[t-, t)$ window. The above transition hazard estimation allows one to obtain an estimate of cumulative transition matrix of the multistate system, followed by the product limit integral

$$\hat{P}(s,t) = \prod_{(s,t]} (I_K + d\hat{A}),$$

with I_K, $K \times K$ dimensional identity matrix. The marginal estimator of kth state occupation probability $p_k(t) = Prob.[S(t) = k]$ for $k = 1, .., K$ is given by,

$$\hat{p}_k(t) = \sum_{j=0}^{K} \frac{\hat{Y}_j(0+)}{n} \hat{p}_{jk}(0,t),$$

where $\hat{p}_{jk}(0,t)$ is the (j,k)th element of the matrix $\hat{P}(0,t)$. Note: the validity of such estimation formulas for non-Markov models have been established in the literature.

In order to test effects of covariates on state temporal functions of multistate models, method given by the pseudo-values regression, by Anderson and Klein [4] was applied. This method utilizes a pseudo-values based regression concept that initiated with a marginal estimator of the targeted quantity, which could be both parametric or nonparametric, followed by a jackknife estimation process together with flexible generalized estimating equations (GEE) inferencing. A key advantage of this approach is the straightforward interpretation of covariate effects on the measure of interest. The jackknife estimator of the measure of interest at time t, $Q(i)$ is obtained by,

$$\hat{Q}_i^{ps}(t) = n\hat{Q}(t) - (n-1)\hat{Q}^{-i}(t),$$

where $\hat{Q}^{-i}(t)$ is the marginal estimator that obtained from a sample of size $n-1$ by excluding the ith individual data and $\hat{Q}(t)$ is the corresponding estimate calculated from the whole dataset. For example $\hat{Q}(t)$ will be the marginal state occupation probability estimator at a given time t by the Aalen and Johansen, when the measure of interest is state occupation probability [4]. The estimated observed pseudo values at a time grid value are next fitted in a regression model by incorporating the covariates of interest together with a suitable link function and estimated the model via the GEE approach. In this work, we used the GEE model with a complementary log–log link function to estimate the covariate effect.

Supplementary Table 1: The set of ICD 9 and ICD 10 codes used to specify disease conditions.

Atrial fibrillation (AF)	ICD9: 427.3; ICD10: I48.0 I48.1, I48.2, I48.3. I48.4
Acute myocardial infarction (AMI)	ICD9: 410.X; ICD10: I21.X
Heat Failure (HF)	ICD9: 428.X; ICD10: I50.X
Ischemic Heart Disease (IHD)	ICD9: 414.X; ICD10: I25.X
Stroke	ICD9: 433.X, 434.X; ICD10: I63.5, I63.9
Alzheimer's Disease (AD)	ICD9: 331.0; ICD10: G30.0, G30.1, G30.9, G30.8

Supplementary Table 2: A summary of subject characteristics among individuals with the initial event: Atrial Fibrillation (AF), corresponds to the multistate model given in Fig. 1.

		Diseased set	Control
Total number of individuals		12,991	12,991
Age (average, SD)		76.76 (7.85)	76.76 (7.85)
Gender: Male		7,452 (57.36%)	7,301 (56.20%)
Race/Ethnicity	Whites	4,512 (34.73%)	4,788 (36.86%)
	Asian	3,188 (24.54%)	2,950 (22.71%)
	NHPI	2,847 (21.92%)	2,871 (22.10%)
	Other	2,444 (18.81%)	2,382 (18.33 %)
Dual Eligibility		2,145 (16.51%)	2,057 (15.83%)
Chronic Kidney Disease		2,459 (18.93%)	2,032 (15.64%)
Cataract		5,734 (44.14%)	5,246 (40.38%)
Chronic Obstructive Pulmonary Disease		2,003 (15.42%)	2,172 (16.72%)
Diabetes		4,130 (31.79%)	3,985 (30.68%)
Glaucoma		2,332 (17.95%)	2,094 (16.12%)
Hip/Pelvic Fracture		171 (1.32%)	309 (2.38%)
Depression		1,240 (9.55%)	989 (7.61%)
Osteoporosis		1,842 (14.18%)	1,565 (12.05%)
Rheumatoid Arthritis / Osteoarthritis		3,480 (26.79%)	3,793 (29.20%)
Anemia		4,716 (36.30%)	4,690 (36.10%)
Asthma		1,399 (10.77%)	1,636 (12.61%)
Hyperlipidemia		7,865 (60.54%)	7,557 (58.17%)
Hypertension		8,354 (64.31%)	7,810 (60.12%)
Acquired Hypothyroidism		1,190 (9.16%)	912 (7.02%)
Cancer Breast (among females)		451 (8.14%)	594 (10.44%)
Cancer Colorectal		282 (2.17%)	460 (3.54%)
Cancer Lung		141 (1.09%)	299 (2.30%)
Cancer Endometrial		63 (0.48%)	118 (0.91%)

Data are summarized using frequencies and percentages, unless specified otherwise.

Supplementary Table 3: A summary of subject characteristics among individuals with the initial event: Acute Myocardial Infarction (AMI), corresponds to the multistate model given in Fig. 1.

		Diseased set	Control
Total number of individuals		7,856	7,856
Age (average, SD)		77.15 (7.92)	77.15 (7.92)
Gender: Male		4,603 (58.59%)	4,659 (59.30%)
Race/Ethnicity	Whites	2,171 (27.63%)	2,241 (28.53%)
	Asian	2,193 (27.91%)	2,113 (26.90%)
	NHPI	1,864 (23.73%)	1,842 (23.45%)
	Other	1,628 (20.72%)	1,660 (21.13%)
Dual Eligibility		1,474 (18.76%)	1,404 (17.87%)
Chronic Kidney Disease		2,170 (27.62%)	2,036 (25.92%)
Cataract		3,645 (46.40%)	3,775 (48.05%)
Chronic Obstructive Pulmonary Disease		1,339 (17.04%)	1,213 (15.44%)
Diabetes		3,247 (41.33%)	3,152 (40.12%)
Glaucoma		1,518 (19.32%)	1,634 (20.80%)
Hip/Pelvic Fracture		116 (1.48%)	71 (0.90%)
Depression		753 (9.59%)	678 (8.63%)
Osteoporosis		1,126 (14.33%)	1,186 (15.10%)
Rheumatoid Arthritis / Osteoarthritis		2,172 (27.65%)	2,193 (27.91%)
Anemia		3,406 (43.36%)	3,191 (40.62%)
Asthma		947 (12.05%)	845 (10.75%)
Hyperlipidemia		5,315 (67.66%)	5,199 (66.18%)
Hypertension		5,571 (70.91%)	5,436 (69.20%)
Acquired Hypothyroidism		711 (9.05%)	672 (8.55%)
Cancer Breast (among females)		264 (8.12%)	229 (7.15%)
Cancer Colorectal		180 (2.29%)	212 (2.70%)
Cancer Lung		78 (0.99%)	125 (1.59%)
Cancer Endometrial		34 (0.43%)	26 (0.33%)

Data are summarized using frequencies and percentages, unless specified otherwise.

Supplementary Table 4: A summary of subject characteristics among individuals with the initial event: Heart Failure (HF), corresponds to the multistate model given in Fig. 1.

		Diseased set	Control
Total number of individuals		10,748	10,748
Age (average, SD)		76.84 (8.03)	76.84 (8.03)
Gender: Male		6,037 (56.17%)	6,049 (56.28%)
Race/Ethnicity	Whites	3,301 (30.71%)	3,388 (31.52%)
	Asian	2,806 (26.11%)	2,894 (26.93%)
	NHPI	2,434 (22.65%)	2,316 (21.55%)
	Other	2,207 (20.53%)	2,150 (20.0%)
Dual Eligibility		2,090 (19.45%)	2,215 (20.61%)
Chronic Kidney Disease		2,077 (19.32%)	1,937 (18.02%)
Cataract		4,390 (40.84%)	4,516 (42.02%)
Chronic Obstructive Pulmonary Disease		1,492 (13.88%)	1,521 (14.15%)
Diabetes		3,681 (34.25%)	3,566 (33.18%)
Glaucoma		1,889 (17.58%)	2,040 (18.98%)
Hip/Pelvic Fracture		113 (1.05%)	167 (1.55%)
Depression		953 (8.87%)	867 (8.07%)
Osteoporosis		1,397 (13.00%)	1,515 (14.10%)
Rheumatoid Arthritis / Osteoarthritis		2,719 (25.30%)	2,520 (23.45%)
Anemia		3,818 (35.52%)	3,882 (36.12%)
Asthma		1,028 (9.56%)	1,005 (9.35%)
Hyperlipidemia		6,351 (59.09%)	6,368 (59.25%)
Hypertension		6,867 (63.89%)	6,768 (62.97%)
Acquired Hypothyroidism		871 (8.10%)	765 (7.12%)
Cancer Breast (among females)		383 (8.13%)	373 (7.93%)
Cancer Colorectal		217 (2.02%)	247 (2.30%)
Cancer Lung		106 (0.99%)	85 (0.79%)
Cancer Endometrial		39 (0.36%)	71 (0.66%)

Data are summarized using frequencies and percentages, unless specified otherwise.

Supplementary Table 5: A summary of subject characteristics among individuals with the initial event: ischemic heart disease (IHD), corresponds to the multistate model given in Fig. 1.

		Diseased set	Control
Total number of individuals		12,781	12,781
Age (average, SD)		73.47 (7.15)	73.47 (7.15)
Gender: Male		7,810 (61.11%)	7,741 (60.57%)
Race/Ethnicity	Whites	4,246 (33.22%)	4,067 (31.82%)
	Asian	2,749 (21.51%)	2,946 (23.05%)
	NHPI	3,094 (24.21%)	3,144 (24.60%)
	Other	2,692 (21.06%)	2,624 (20.53%)
Dual Eligibility		2,090 (16.35%)	2,294 (17.95%)
Chronic Kidney Disease		1,591 (12.45%)	1,439 (11.26%)
Cataract		3,638 (28.46%)	3,732 (29.20%)
Chronic Obstructive Pulmonary Disease		1,106 (8.65%)	1,281 (10.02%)
Diabetes		3,224 (25.22%)	3,182 (24.90%)
Glaucoma		1,611 (12.60%)	1,591 (12.45%)
Hip/Pelvic Fracture		67 (0.52%)	100 (0.78%)
Depression		825 (6.45%)	906 (7.09%)
Osteoporosis		1,094 (8.56%)	941 (7.36%)
Rheumatoid Arthritis / Osteoarthritis		2,171 (16.99%)	1,936 (15.15%)
Anemia		2,864 (22.41%)	2,941 (23.01%)
Asthma		942 (7.37%)	1,042 (8.15%)
Hyperlipidemia		6,009 (47.02%)	6,148 (48.10%)
Hypertension		6,279 (49.13%)	6,201 (48.52%)
Acquired Hypothyroidism		694 (5.43%)	510 (3.99%)
Cancer Breast (among females)		326 (6.56%)	361 (7.16%)
Cancer Colorectal		166 (1.30%)	120 (0.94%)
Cancer Lung		87 (0.68%)	125 (0.98%)
Cancer Endometrial		37 (0.29%)	19 (0.15%)

Data are summarized using frequencies and percentages, unless specified otherwise.

Supplementary Table 6: A summary of subject characteristics among individuals with the initial event: Stroke, corresponds to the multistate model given in Fig. 1.

		Diseased set	Control
Total number of individuals		7,430	7,430
Age (average, SD)		76.4 (7.48)	76.4 (7.48)
Gender: Male		3,826 (51.49%)	3,763 (50.65%)
Race/Ethnicity	Whites	2,342 (31.52%)	2,230 (30.02%)
	Asian	1,890 (25.44%)	2,002 (26.94%)
	NHPI	1,814 (24.41%)	1,698 (22.85%)
	Other	1,384 (18.63%)	1,500 (20.19%)
Dual Eligibility		1,262 (16.99%)	1,267 (17.05%)
Chronic Kidney Disease		1,377 (18.53%)	1,294 (17.41%)
Cataract		3,526 (47.46%)	3,631 (48.87%)
Chronic Obstructive Pulmonary Disease		1,057 (14.23%)	1,116 (15.02%)
Diabetes		2,596 (34.94%)	2,459 (33.10%)
Glaucoma		1,522 (20.48%)	1,635 (22.00%)
Hip/Pelvic Fracture		82 (1.10%)	100 (1.35%)
Depression		801 (10.78%)	735 (9.89%)
Osteoporosis		1,244 (16.74%)	1,235 (16.62%)
Rheumatoid Arthritis / Osteoarthritis		2,074 (27.91%)	1,933 (26.01%)
Anemia		2,791 (37.56%)	2,671 (35.95%)
Asthma		722 (9.72%)	818 (11.01%)
Hyperlipidemia		5,024 (67.62%)	4940 (66.49%)
Hypertension		4,770 (64.2%)	4,703 (63.3%)
Acquired Hypothyroidism		718 (9.66%)	828 (11.15%)
Cancer Breast (among females)		293 (8.13%)	249 (6.78%)
Cancer Colorectal		160 (2.15%)	189 (2.55%)
Cancer Lung		74 (1.00%)	61 (0.82%)
Cancer Endometrial		25 (0.34%)	37 (0.50%)

Data are summarized using frequencies and percentages, unless specified otherwise.

Supplementary Table 7: Estimated Occupational Probabilities for Developing AD and Death after Heart Disease and Stroke Conditions, Corresponds to Fig. 1.

		Model	Controls	Diseased Set
State - 0	48 Months	AF	81.60(81.01,82.28)	62.30(61.22,63.21)
		AMI	79.05(78.09,79.84)	55.57(54.12,57.01)
		HF	85.18(84.32,85.92)	57.60(56.51,58.70)
		IHD	86.27(85.51,86.90)	74.48(73.47,75.25)
		Stroke	81.14(80.07,82.05)	71.37(70.28,72.53)
	96 Months	AF	59.37(58.10,60.76)	40.57(39.05,42.21)
		AMI	54.76(52.99,56.70)	35.44(33.79,37.16)
		HF	64.76(63.27,66.11)	35.03(33.29,36.61)
		IHD	68.45(66.81,69.76)	56.73(55.10,58.11)
		Stroke	57.91(56.06,59.75)	50.18(48.53,51.86)
State - 1	48 Months	AF	1.32(1.11,1.55)	1.08(0.89,1.31)
		AMI	1.43(1.13,1.69)	1.09(0.82,1.31)
		HF	1.30(1.05,1.57)	1.07(0.80,1.28)
		IHD	0.88(0.70,1.04)	0.98(0.79,1.23)
		Stroke	1.32(1.03,1.64)	1.49(1.16,1.77)
	96 Months	AF	2.29(1.87,2.78)	1.48(1.14,1.98)
		AMI	2.17(1.61,2.85)	1.29(0.71,1.97)
		HF	2.20(1.74,2.70)	0.95(0.54,1.49)
		IHD	1.81(1.30,2.35)	1.22(0.56,1.80)
		Stroke	1.97(1.43,2.53)	2.34(1.56,3.06)
State - 2	48 Months	AF	17.14(16.46,17.79)	36.63(35.73,37.61)
		AMI	19.59(18.81,20.58)	43.40(41.99,44.91)
		HF	13.59(12.85,14.36)	41.35(40.13,42.46)
		IHD	12.86(12.20,13.56)	24.56(23.76,25.53)
		Stroke	17.57(16.66,18.54)	27.16(25.99,28.17)
	96 Months	AF	38.38(37.11,39.52)	58.05(56.42,59.53)
		AMI	43.07(41.10,44.83)	63.27(61.69,65.03)
		HF	33.09(31.53,34.74)	64.01(62.25,65.82)
		IHD	29.74(28.40,31.23)	42.04(40.69,43.86)
		Stroke	40.12(38.22,41.99)	47.49(45.73,49.33)

Table shows estimated state occupational probabilities and 95% confidence inter-vals for developing AD and death after heart disease and stroke, corresponding to Fig. 1.

Supplementary Table 8: Effects of the dual eligibility indicator on transitions in the multistate model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	1.628(1.277, 2.075)	<0.0001	1.072(0.865, 1.328)	0.5244	1.419(1.195, 1.685)	<0.0001
AMI	3.948(2.025, 7.696)	<0.0001	1.349(1.038, 1.753)	0.0252	1.272(1.129, 1.433)	<0.0001
HF	1.463(1.093, 1.958)	0.0105	0.977(0.588, 1.623)	0.9284	1.113(1.033, 1.199)	0.0047
IHD	1.962(1.404, 2.742)	<0.0001	1.766(1.329, 2.347)	<0.0001	1.447(1.203, 1.740)	<0.0001
Stroke	1.391(1.054, 1.836)	0.0197	1.397(1.027, 1.901)	0.0334	1.311(1.144, 1.502)	<0.0001

The table presents the effects of the dual eligibility indicator on transitions in the multistate model shown in Fig. 2, by the risk ratio (RR). The estimated RR values correspond to the effect of the dual-eligible cohort compared to the Medicare-only cohort.

Supplementary Table 9: Effects of the gender on transitions in the multistate model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	0.808(0.653, 1.000)	0.0496	0.868(0.758, 0.993)	0.0397	1.076(1.021, 1.134)	0.0064
AMI	0.484(0.322, 0.728)	0.0005	1.208(0.983, 1.484)	0.0718	0.981(0.911, 1.056)	0.6093
HF	0.748(0.584, 0.958)	0.0216	0.988(0.680, 1.434)	0.9494	1.202(1.098, 1.316)	<0.0001
IHD	0.645(0.518, 0.803)	<0.0001	1.584(1.152, 2.177)	0.0046	1.080(1.023, 1.140)	0.005
Stroke	0.802(0.624, 1.031)	0.0852	1.268(0.965, 1.667)	0.0888	1.309(1.143, 1.499)	<0.0001

The table presents the effects of the gender on transitions in the multistate model shown in Fig. 2, by the risk ratio (RR). The estimated RR values correspond to the effect of males compared to females.

Supplementary Table 10: Effects of the age variable on transitions in the multistate model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	1.089(1.044, 1.136)	<0.0001	1.032(1.016, 1.048)	<0.0001	1.055(1.028, 1.083)	<0.0001
AMI	1.110(1.054, 1.169)	<0.0001	1.068(1.034, 1.103)	<0.0001	1.056(1.028, 1.085)	<0.0001
HF	1.088(1.044, 1.134)	<0.0001	1.038(1.011, 1.066)	0.0063	1.040(1.020, 1.060)	<0.0001
IHD	1.109(1.054, 1.167)	<0.0001	1.039(1.019, 1.059)	0.0001	1.059(1.029, 1.090)	<0.0001
Stroke	1.102(1.050, 1.157)	<0.0001	1.035(1.015, 1.056)	0.0006	1.060(1.030, 1.091)	<0.0001

The table presents the effects of the age variable on transitions in the multistate model shown in Fig. 2, by the risk ratio (RR). The estimated RR values correspond to the effect age by a unit (i.e., years) increment.

Supplementary Table 11: Effects of Chronic Kidney Disease history on transitions in the multistate model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	1.006(0.997, 1.015)	0.1672	3.271(1.469, 7.282)	0.0037	1.867(1.381, 2.524)	<0.0001
AMI	1.000(0.986, 1.015)	0.9701	3.859(1.924, 7.741)	0.0001	1.691(1.312, 2.180)	<0.0001
HF	0.993(1.005, 0.981)	0.2706	1.604(0.961, 2.677)	0.0706	1.432(1.010, 2.031)	0.0441
IHD	0.990(0.981, 0.998)	0.0203	1.580(0.985 2.535)	0.0580	1.722(1.324, 2.239)	<0.0001
Stroke	0.998(0.987, 1.009)	0.7279	1.503(0.816, 2.769)	0.1909	1.628(1.286, 2.061)	<0.0001

The table presents the effects of the Chronic Kidney Disease history on transitions in the multistate model shown in Fig. 2, by the risk ratio (RR).

Supplementary Table 12: Effects Diabetes history on transitions in the multistate model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	1.005(0.996, 1.014)	0.2559	1.767(1.067, 2.926)	0.0270	1.418(1.198, 1.679)	<0.0001
AMI	1.007(0.993, 1.022)	0.3244	1.292(0.961, 1.737)	0.0898	1.354(1.166, 1.572)	<0.0001
HF	1.122(1.001, 1.257)	0.0474	1.652(0.958, 2.849)	0.0711	1.298(0.938, 1.797)	0.1160
IHD	1.098(1.001, 1.205)	0.0482	1.295(0.900, 1.864)	0.1643	1.477(1.217, 1.793)	<0.0001
Stroke	0.991(0.979, 1.004)	0.1577	1.565(1.080, 2.268)	0.0180	1.561(1.247 1.954)	<0.0001

The table presents the effects of the Diabetes history on transitions in the multi-state model shown in Fig. 2, by the risk ratio (RR).

Supplementary Table 13: Effects of Hypertension history on transitions in the multistate model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	1.089(0.993, 1.194)	0.0704	0.940(0.871, 1.014)	<0.1101	1.075(0.993, 1.164)	0.0753
AMI	1.109(0.973, 1.265)	0.1225	0.967(0.908, 1.030)	0.2990	1.095(0.877, 1.368)	0.4238
HF	1.195(1.028, 1.389)	0.0204	0.923(0.472, 1.804)	0.8150	1.211(1.064, 1.378)	0.0037
IHD	1.181(1.027, 1.357)	0.0192	0.993(0.982, 1.004)	0.2196	1.088(0.890, 1.330)	0.4108
Stroke	0.995(0.986, 1.003)	0.2231	0.819(0.645, 1.039)	0.1002	0.994(0.970, 1.018)	0.6221

The table presents the effects of the Hypertension history on transitions in the multistate model shown in Fig. 2, by the risk ratio (RR).

Supplementary Table 14: Effects of Hyperlipidemia history on transitions in the multi-state model, given in Fig. 2.

	State-0 to State-1		State-1 to State-2		State-0 to State-2	
	RR (95% CI)	p	RR (95% CI)	p	RR (95% CI)	p
AF	1.000(0.992, 1.008)	0.9510	1.161(0.748, 1.801)	0.5066	0.842(0.643, 1.102)	<0.2101
AMI	0.985(0.969, 1.001)	0.0725	0.621(0.280, 1.378)	0.2411	0.828(0.625, 1.097)	<0.1891
HF	0.994(0.985, 1.003)	0.2017	1.511(0.943, 2.421)	0.0860	1.025(0.984, 1.067)	0.2358
IHD	0.897(0.880, 1.005)	0.3621	1.003(0.997, 1.009)	0.3407	0.861(0.684, 1.084)	<0.2022
Stroke	1.006(0.997, 1.014)	0.2119	0.745(0.546, 1.018)	0.0648	0.876(0.674, 1.138)	<0.3214

The table presents the effects of the Hyperlipidemia history on transitions in the multistate model shown in Fig. 2, by the risk ratio (RR).

Supplementary Table 15: Results of a sensitivity analysis conducted on transitioning from heart disease and stroke to AD (State 0 to 1, Fig. 1) using the Fine and Gray competing risk approach.

	HR	p
AF	1.152	<0.0001
AMI	1.125	0.0352
HF	1.161	<0.0001
IHD	1.204	<0.0001
Stroke	1.168	<0.0001

The estimated hazard ratio (HR) values correspond to the effect of the disease groups (i.e., AF, AMI, HF, IHD, and stroke) compared to the control group.

Supplementary Table 16: Results of a sensitivity analysis conducted on transitioning from heart disease and stroke to AD (State 0 to 1, Fig. 2) using the Fine and Gray competing risk approach: Racial/ethnic effects.

		NHPI vs. Whites		NHPI vs. Asians		Asians vs. Whites	
		HR	p	HR	p	HR	p
Medicare only	AF	0.856	0.0701	0.895	0.1112	0.956	0.7863
	AMI	0.971	0.9045	1.154	0.5521	0.841	0.1245
	HF	0.686	0.0208	0.581	<0.0001	1.181	0.1265
	IHD	0.721	0.0544	0.587	<0.0001	1.228	0.0504
	Stroke	0.979	0.2502	0.905	0.6211	1.082	0.8626
Dual Eligible	AF	1.023	0.8022	1.615	0.0004	0.633	<0.0001
	AMI	0.939	0.4025	1.578	0.0121	0.595	<0.0001
	HF	1.445	0.0121	1.805	<0.0001	0.801	0.0301
	IHD	1.155	0.0675	1.855	<0.0001	0.623	<0.0001
	Stroke	1.388	0.0192	1.951	<0.0001	0.711	0.0458

The table summarizes the race/ethnicity-based hazard ratio (HR) values observed in the transition from state 0 to state 1 in the multistate model presented in Fig. 2.

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