Exposure to Air Pollution and Risk of Alzheimer's Disease

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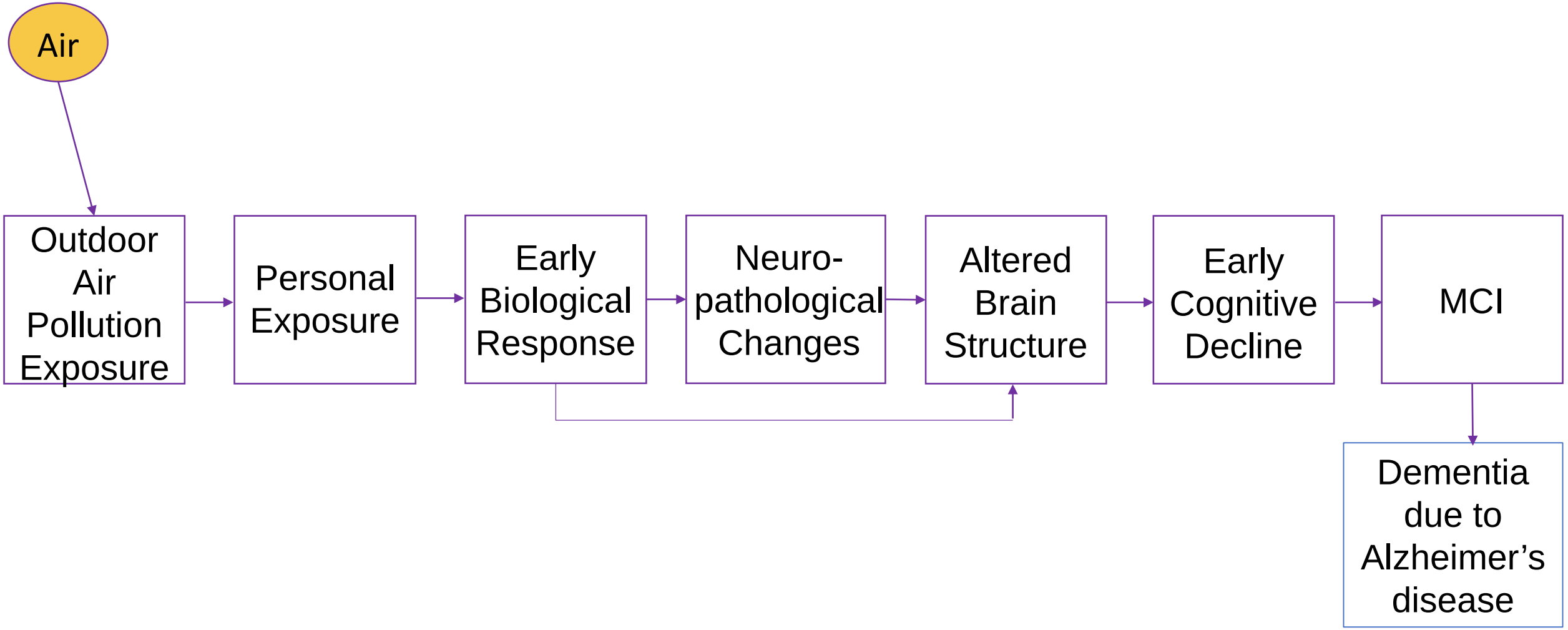
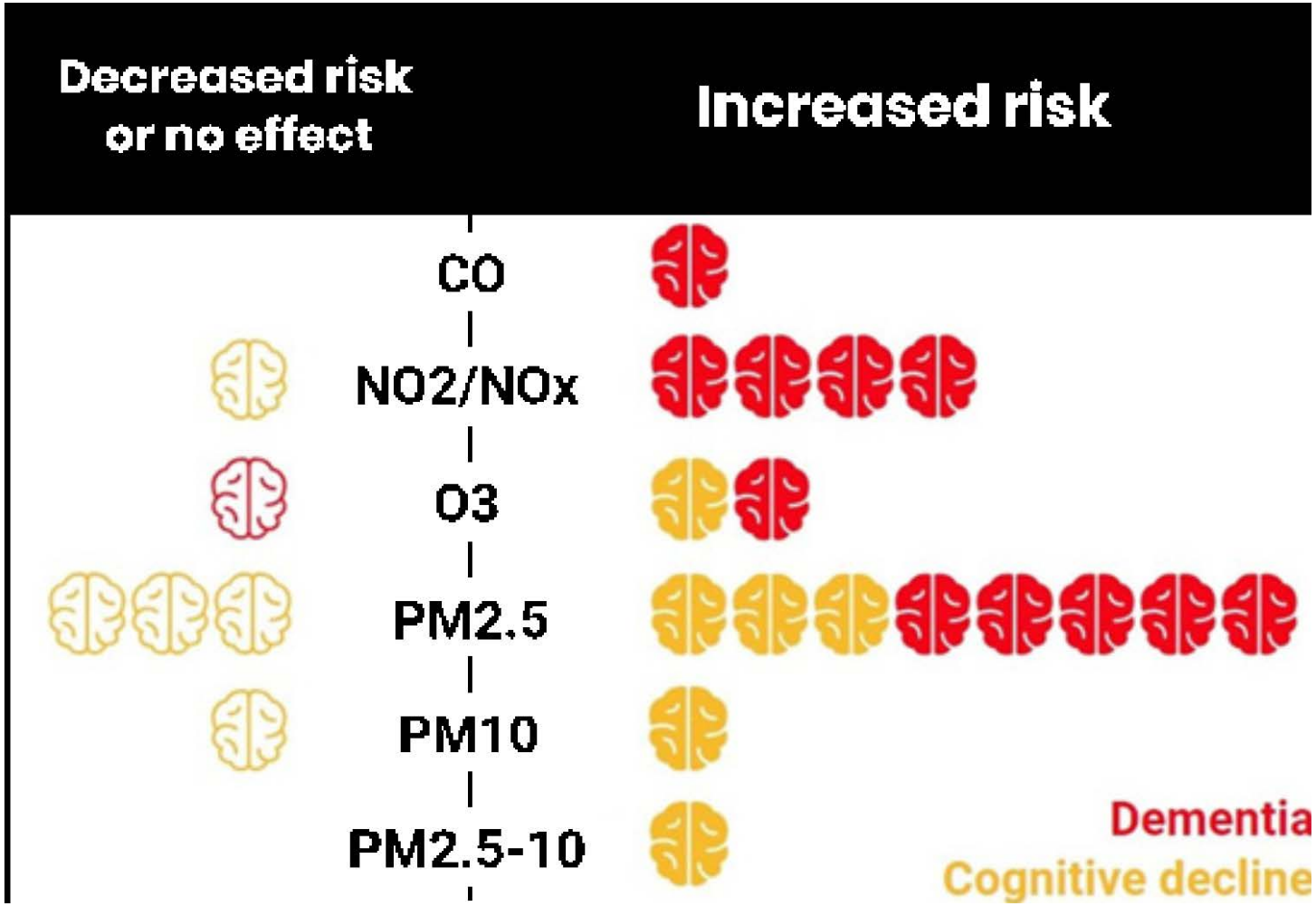
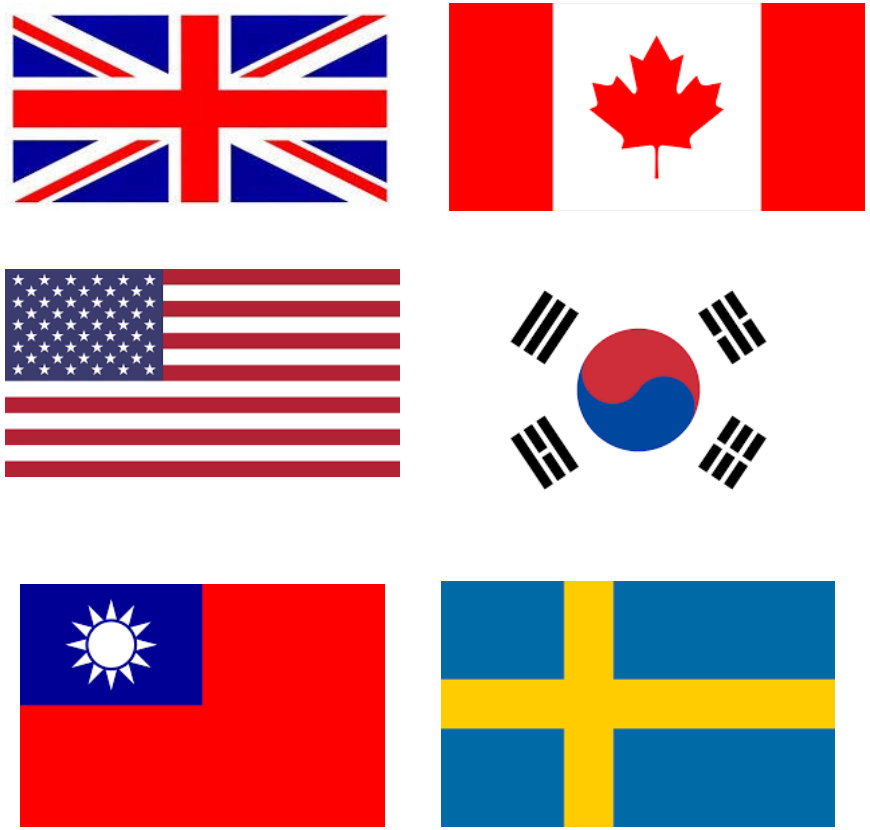
Conceptual diagram of air pollution → Alzheimer's disease



Credit: Jiu-Chiuan Chen

Accumulating evidence that exposure to air pollution is associated with increased risk of dementia





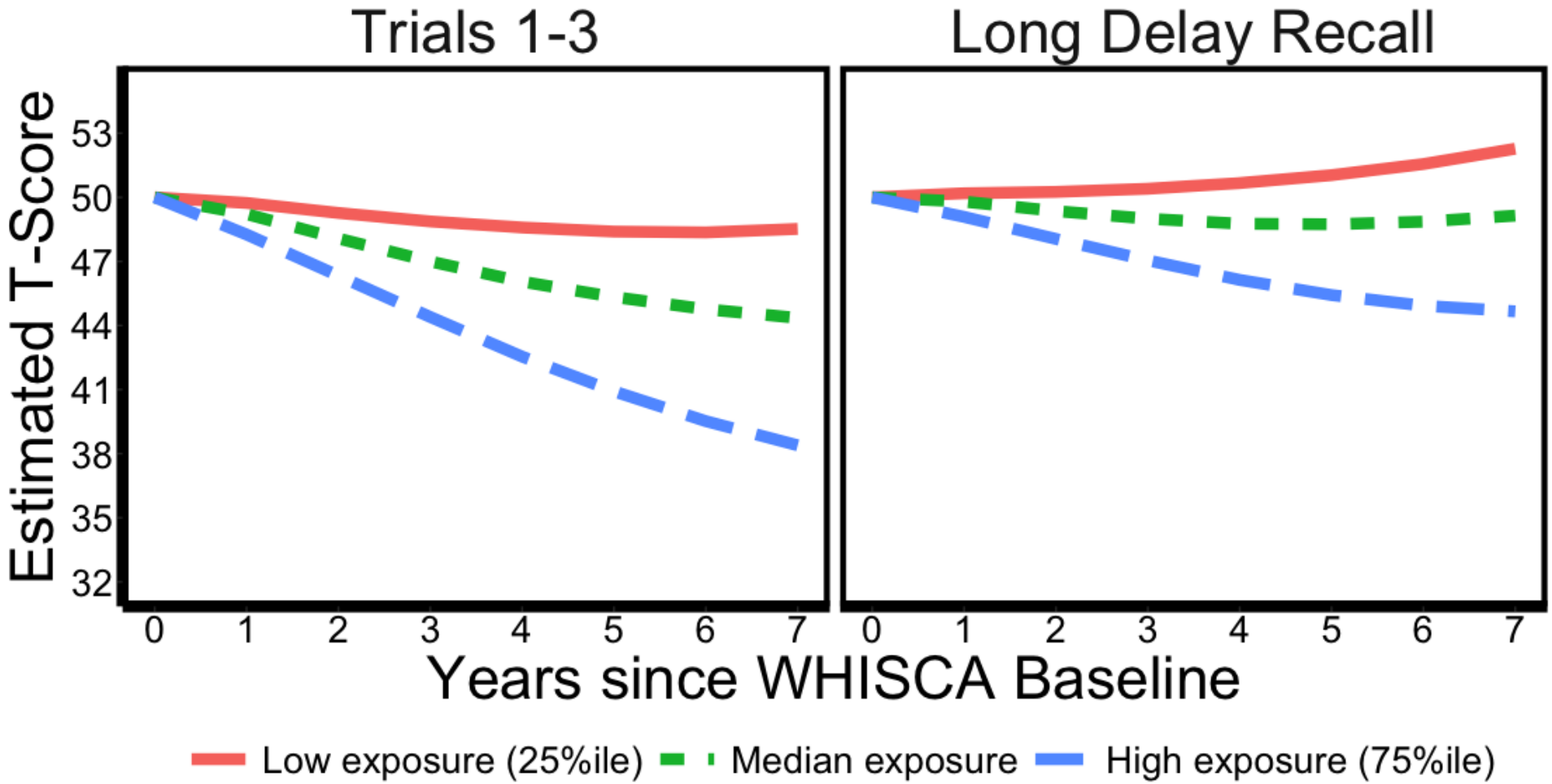
Peters et al. (2019) *Journal of Alzheimer's Disease*

Air pollution is associated with declines in episodic memory in individuals without dementia

Population Characteristics	Exposure	Association
Weuve et al., 2012 USA	Spatiotemporal GAM: $PM_{2.5}$; $PM_{2.5-10}$; PM_{10}	-$PM_{2.5-10}$ and PM_{10} since 1988 → 2-year ↓ VM
Tonne et al., 2014 London	Dispersion model: $PM_{2.5}$; PM_{10}	-No significant association with VM level at W2 -$PM_{2.5}$ and PM_{10} at 4 years prior → 5-year ↓ VM
Kulick et al., 2020 (EnvInt) NYC	Regionalized Universal Kriging: PM_{10}; $PM_{2.5}$; NO_2	-PM_{10}; $PM_{2.5}$; NO_2 → ↓ EM over time -$Age_{(<75, \geq 75)}$ X [PM_{10}; $PM_{2.5}$; NO_2] → decline greater in ≥75 (interaction $p<0.001$)
Kulick et al., 2020 (Neurology) NYC	Regionalized Universal Kriging: PM_{10}; $PM_{2.5}$; NO_2	– PM_{10}; $PM_{2.5}$; NO_2 → lower EM level at baseline – PM_{10}; $PM_{2.5}$; NO_2 → ↓ EM over time – No association of distance to major roadway with EM level or decline
Petkus et al., 2020 USA	Spatiotemporal BME: $PM_{2.5}$	$PM_{2.5}$ → ↓ immediate free recall; delayed free recall
Younan et al., 2020 USA	Spatiotemporal BME: $PM_{2.5}$	$PM_{2.5}$ → ↓ immediate recall (but not level) No association with delayed recall level or decline

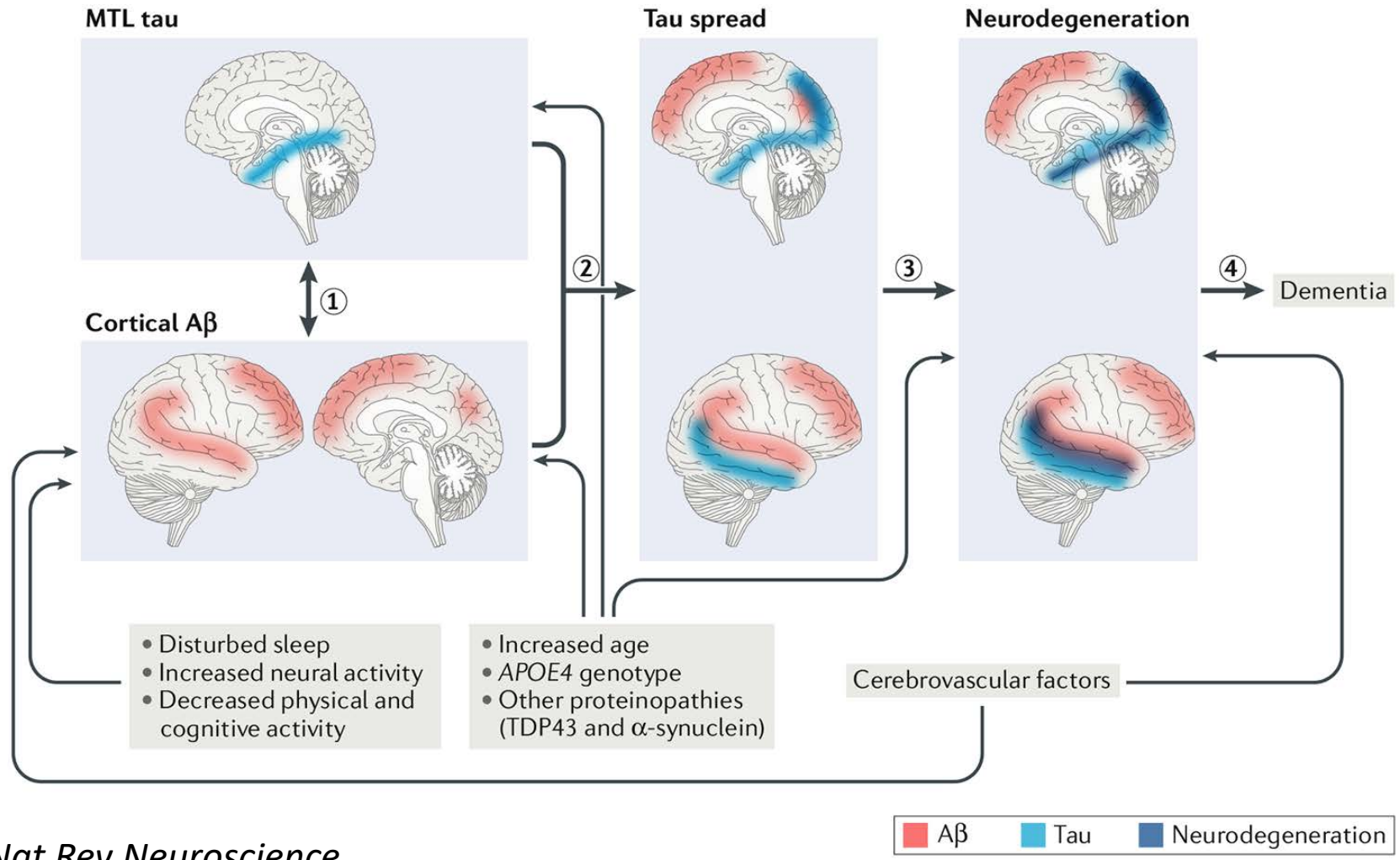
Credit: Diana Younan, Ph.D.

Heterogeneity of exposure effect on aspects of episodic memory



Petkus et al. (2020) *Environment International*

Alzheimer's disease atrophy first occurs in the medial temporal lobe



Jagust (2018) *Nat Rev Neuroscience*

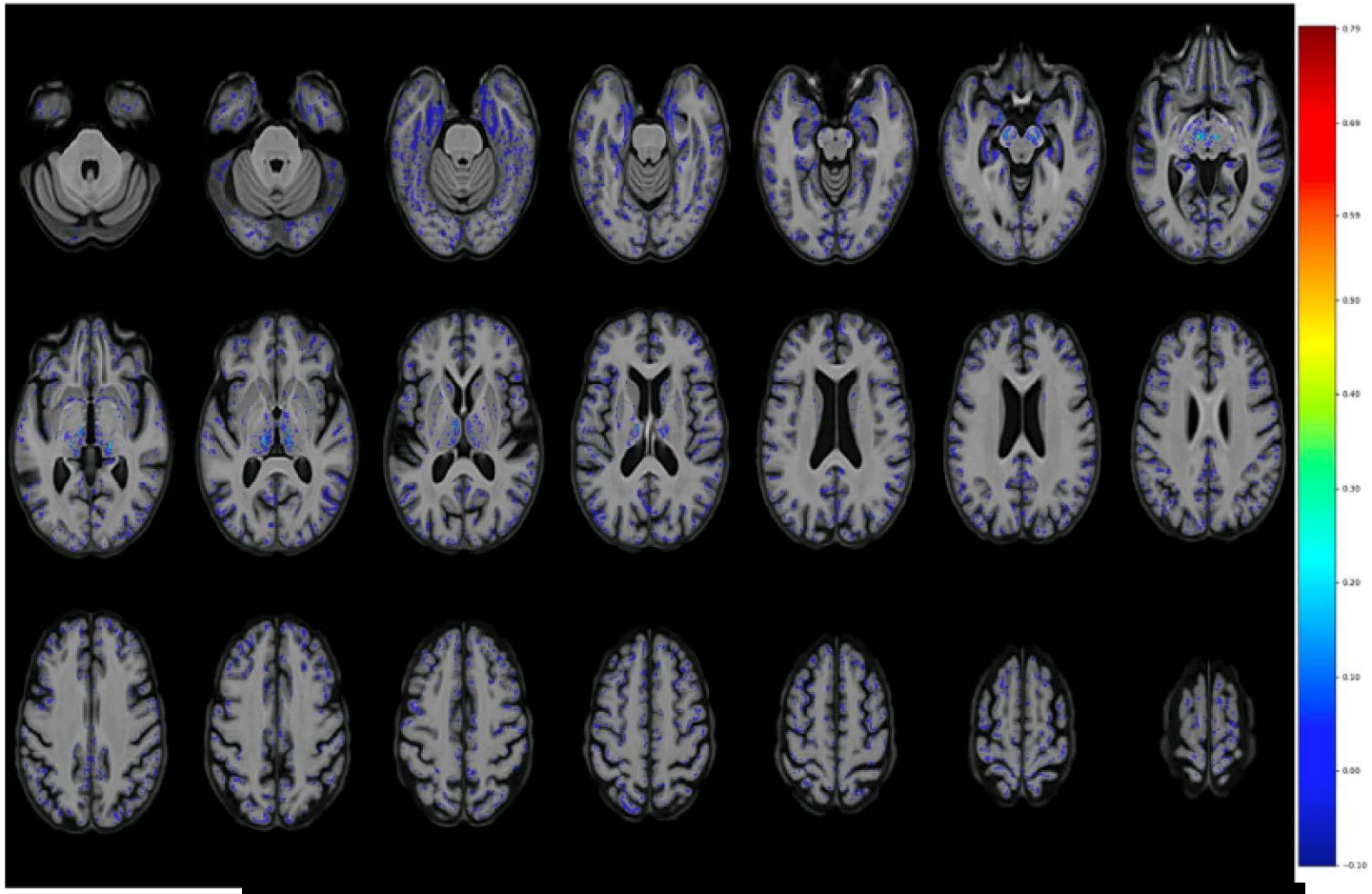
Late-life air pollution exposure and structural MRI

	WMH/ SVID	Infarct/ MB	Hippocampal volume
Semmens, 2012	↑$PM_{10;}$ ↑NO_2	↓PM_{10}	-
Wilker et al., 2015	↑distance (?)	↑$PM_{2.5}$	X
Chen et al., 2015	X	-	X
Wilker et al., 2016	↓$PM_{2.5}$	X	-
Casanova et al., 2016	-	-	X
Kulick et al., 2017	X	X	-
Power et al., 2018	X	X	X
Hedges et al., 2019	-	-	↓$PM_{2.5}$ (left)

Credit: Diana Younan, Ph.D.

Alzheimer’s disease pattern similarity (AD-PS) to quantify Alzheimer’s disease grey matter atrophy

1-SD (SD=0.23) ↑ in AD-PS scores ≈ **122% ↑ risk for dementia over 5-year period**
(HR=2.22; 95% CI: 1.80, 2.75)

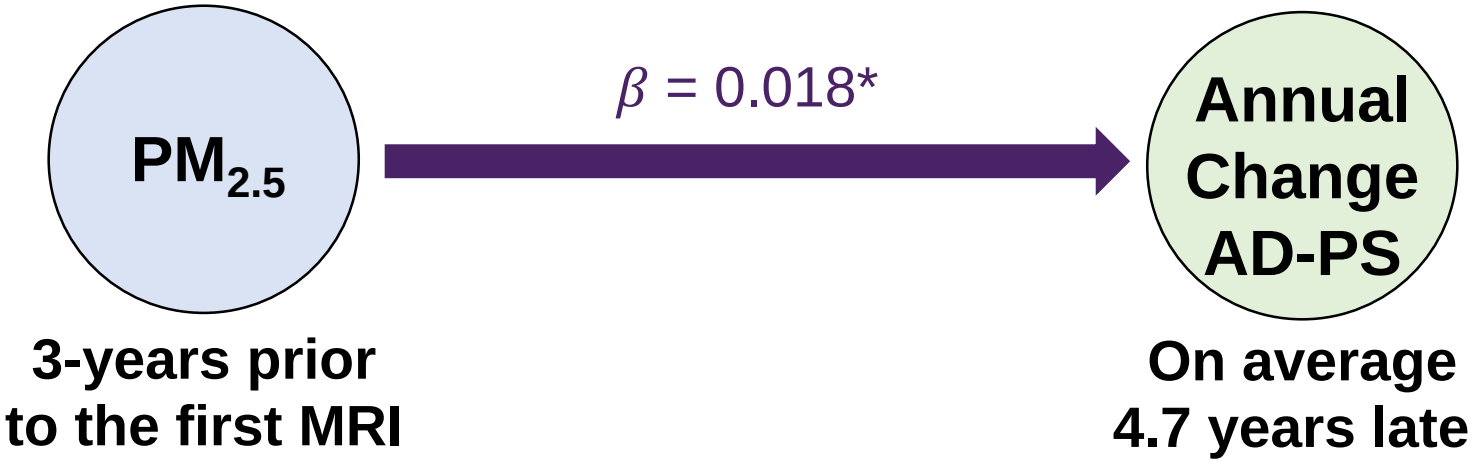


amygdala, hippocampus, parahippocampal gyrus, thalamus, bilateral inferior temporal lobe areas, and midbrain

Casanova et al., 2018

Alzheimer's Disease Pattern Similarity (AD-PS) score and late-life exposure to $PM_{2.5}$

- Women exposed to one interquartile increase in $PM_{2.5}$ for the 3-years before the first MRI had larger grey matter atrophy in areas of the brain impacted in AD
- Effect similar to 24% increase in dementia risk



Younan et al. (2020) *Brain*

*$P < 0.05$

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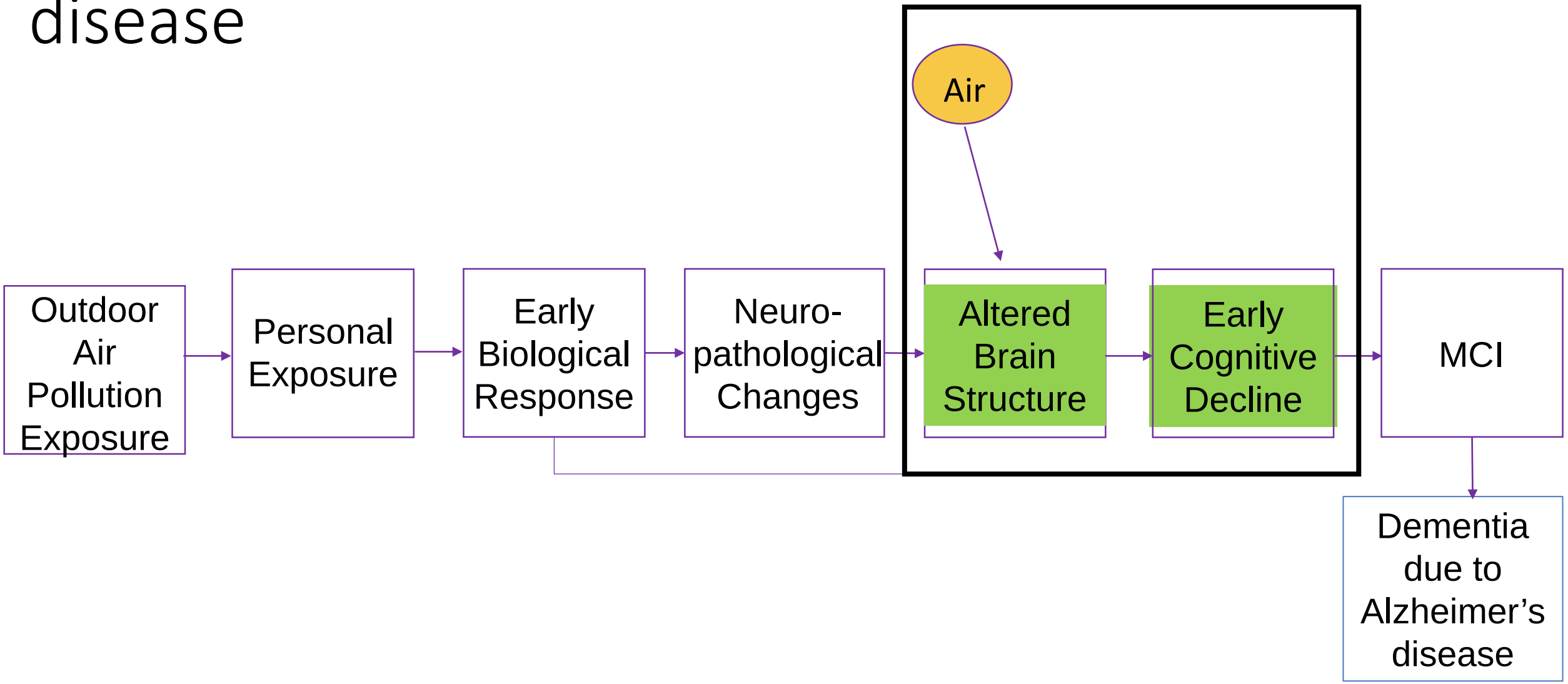
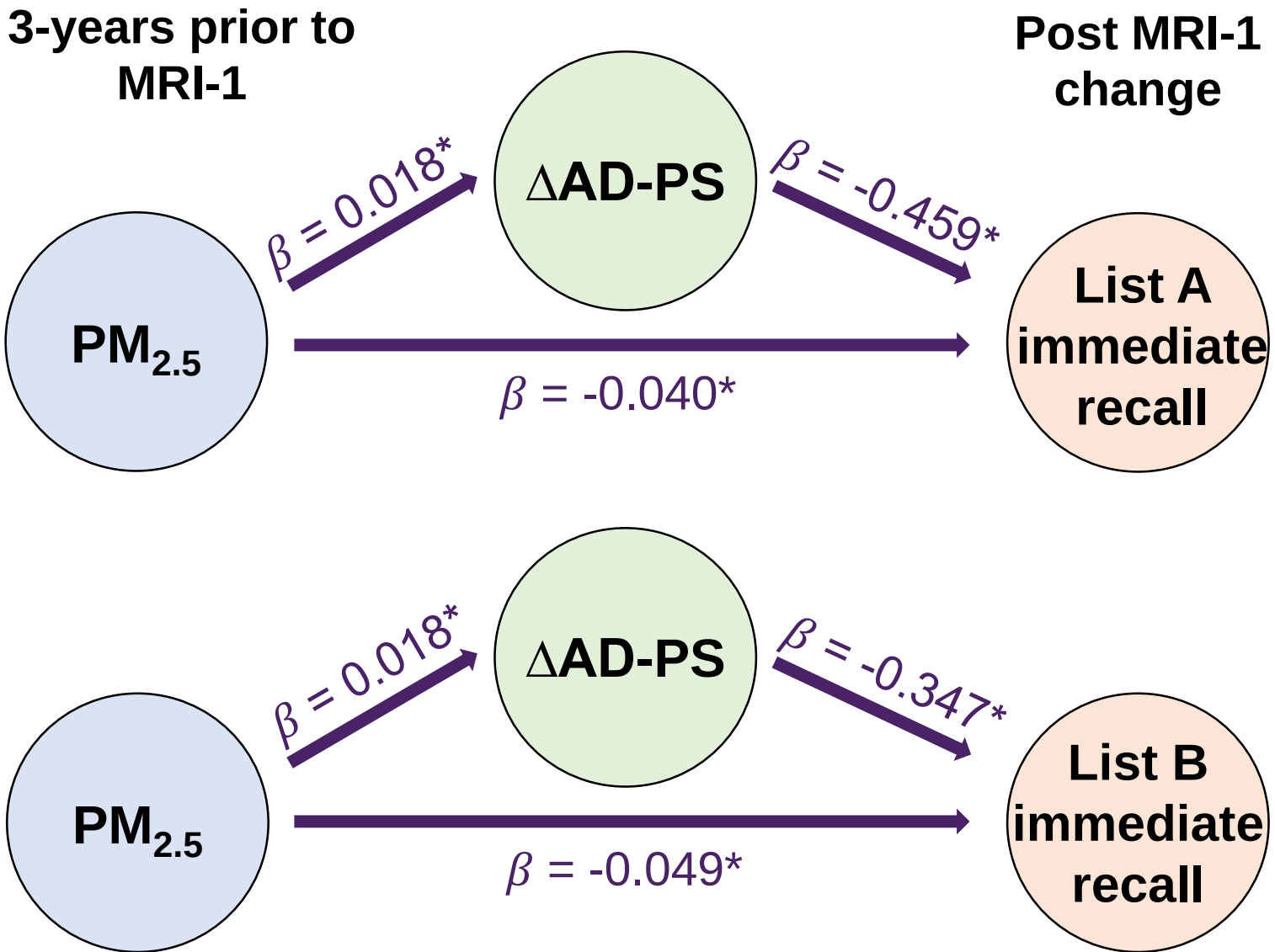


Credit: Jiu-Chiuan Chen

Grey matter atrophy in brain areas implicated in AD partially mediates associations between $PM_{2.5}$ and episodic memory decline



22.6%
(95% CI: 1.0% - 68.9%)

10.7%
(95% CI: 1.0% - 30.3%)

Younan et al. (2020) *Brain*

*$P < 0.05$

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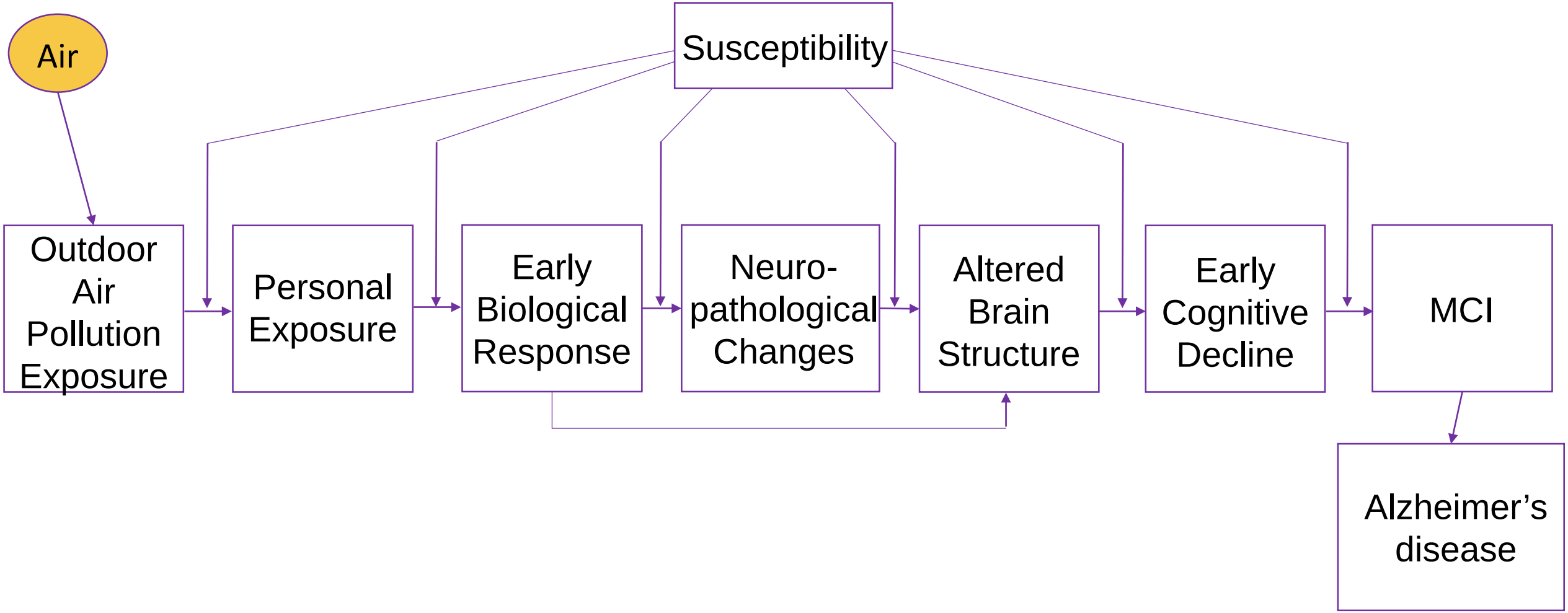


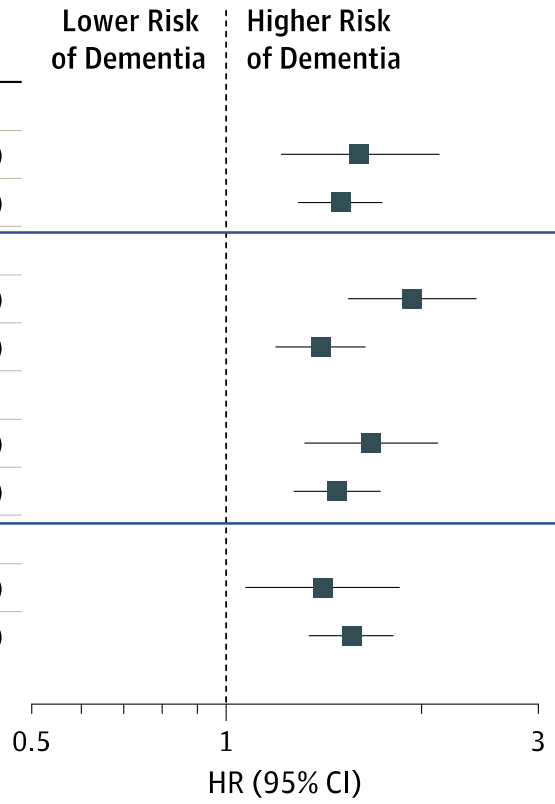
Credit: Jiu-Chiuan Chen

Heart failure and enhanced associated between pollution and dementia

HR per increase of .88 µg/m^3 in $PM_{2.5}$ = 1.54

A Particulate matter no greater than 2.5 µm

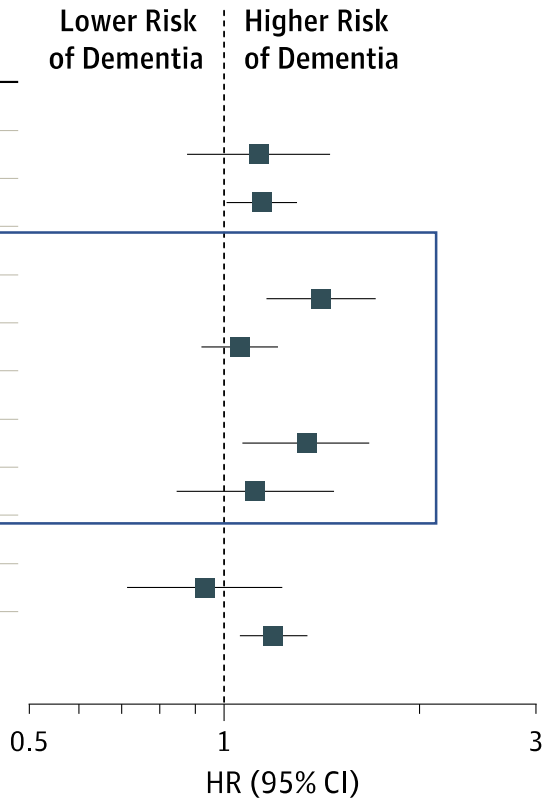
Disease	HR (95% CI)
Atrial fibrillation[a]	
Present	1.60 (1.21-2.13)
Absent	1.50 (1.29-1.74)
Heart failure[b]	
Present	1.93 (1.54-2.43)
Absent	1.40 (1.19-1.64)
Ischemic heart disease[c]	
Present	1.67 (1.32-2.12)
Absent	1.48 (1.27-1.73)
Stroke[d]	
Present	1.41 (1.07-1.85)
Absent	1.56 (1.34-1.81)



HR per increase of 8.35 µg/m^3 in NO_x = 1.14

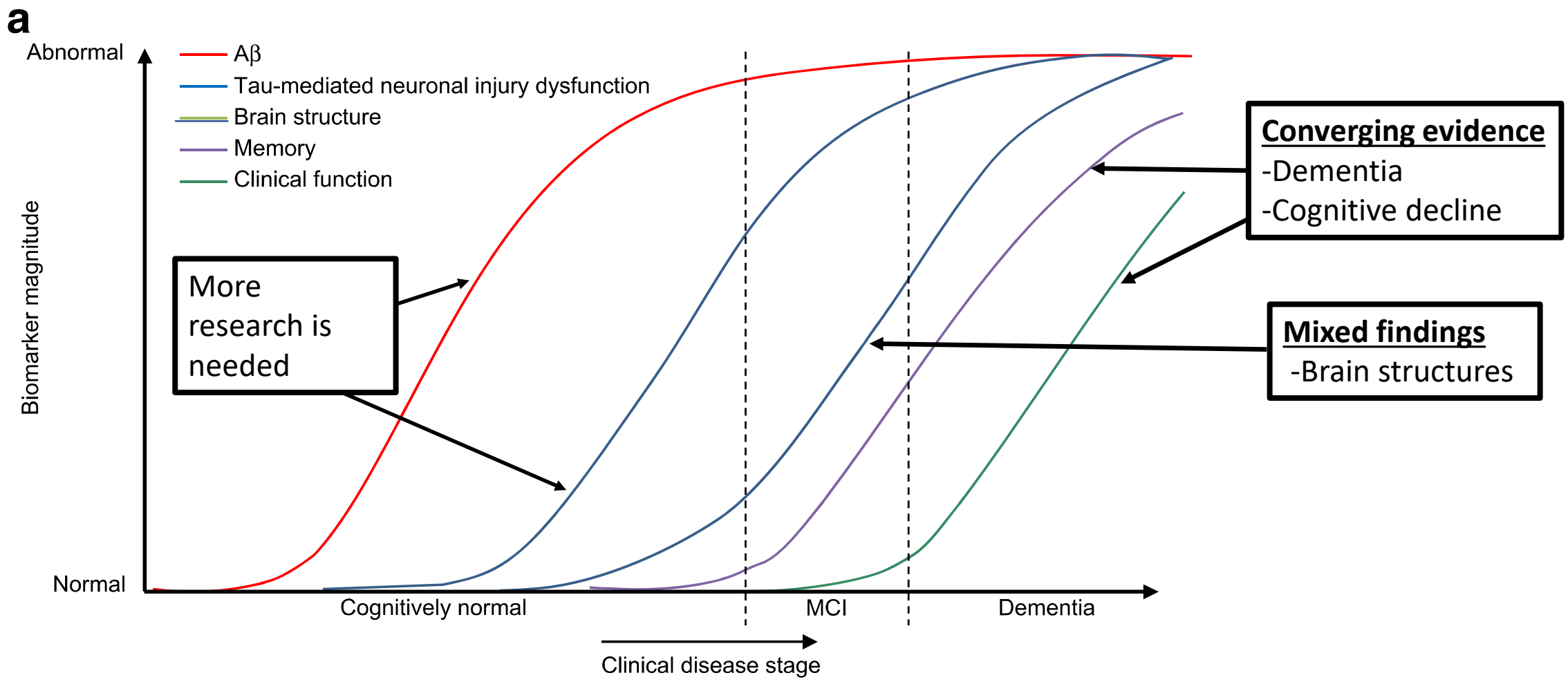
B Nitrogen oxide

Disease	HR (95% CI)
Atrial fibrillation[e]	
Present	1.14 (0.87-1.48)
Absent	1.15 (1.01-1.31)
Heart failure[f]	
Present	1.43 (1.17-1.75)
Absent	1.06 (0.92-1.22)
Ischemic heart disease[g]	
Present	1.36 (1.07-1.71)
Absent	1.12 (0.84-1.50)
Stroke[h]	
Present	0.93 (0.70-1.24)
Absent	1.20 (1.06-1.36)



Grande et al., 2020 *JAMA Neurology*

Continuum of Alzheimer's Disease



Aisen et al. (2017) *Alzheimer's Research and Therapy*

Acknowledgments

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