

Modelling Health Impacts Related to Transportation

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Healthy Community Design Initiative

Pro-Walk Pro-Bike Pro-Place
2014

CDC and Transportation Partnerships

- CDC provides assistance to state and local partners in matters of public health



CDC and Transportation Partnerships

- **The Healthy Community Design Initiative**

- Focus on built environment and health
- The design of communities impacts the health of residents, including chronic diseases, injuries, and environmentally-mediated illness

- **Community design elements include:**

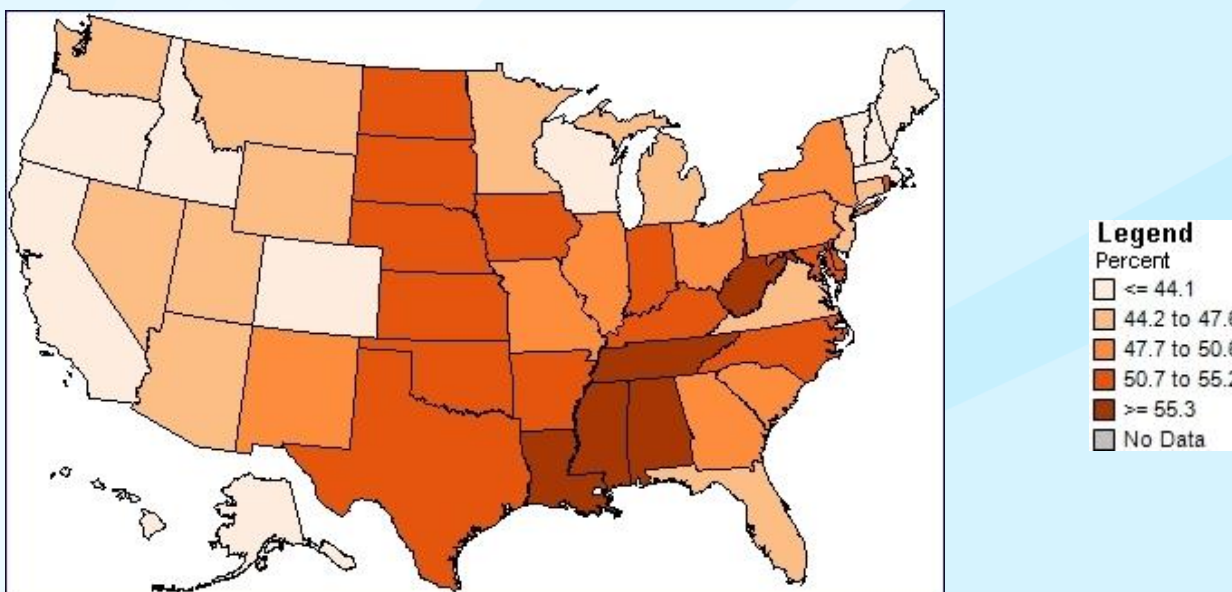
- Transportation systems
- Public spaces
- Zoning

Ineffective Community Design



Inactivity in Tennessee

- **2011: 61% do not meet aerobic physical activity guidelines**
 - National rank: 50th



- **Nashville area slightly better: 57%**
- **Tennessee tied for 10th highest prevalence of obesity (31.1%)**

Physical inactivity: 2011 BRFSS; obesity: 2012 BRFSS

Nashville MPO: Transportation and Health

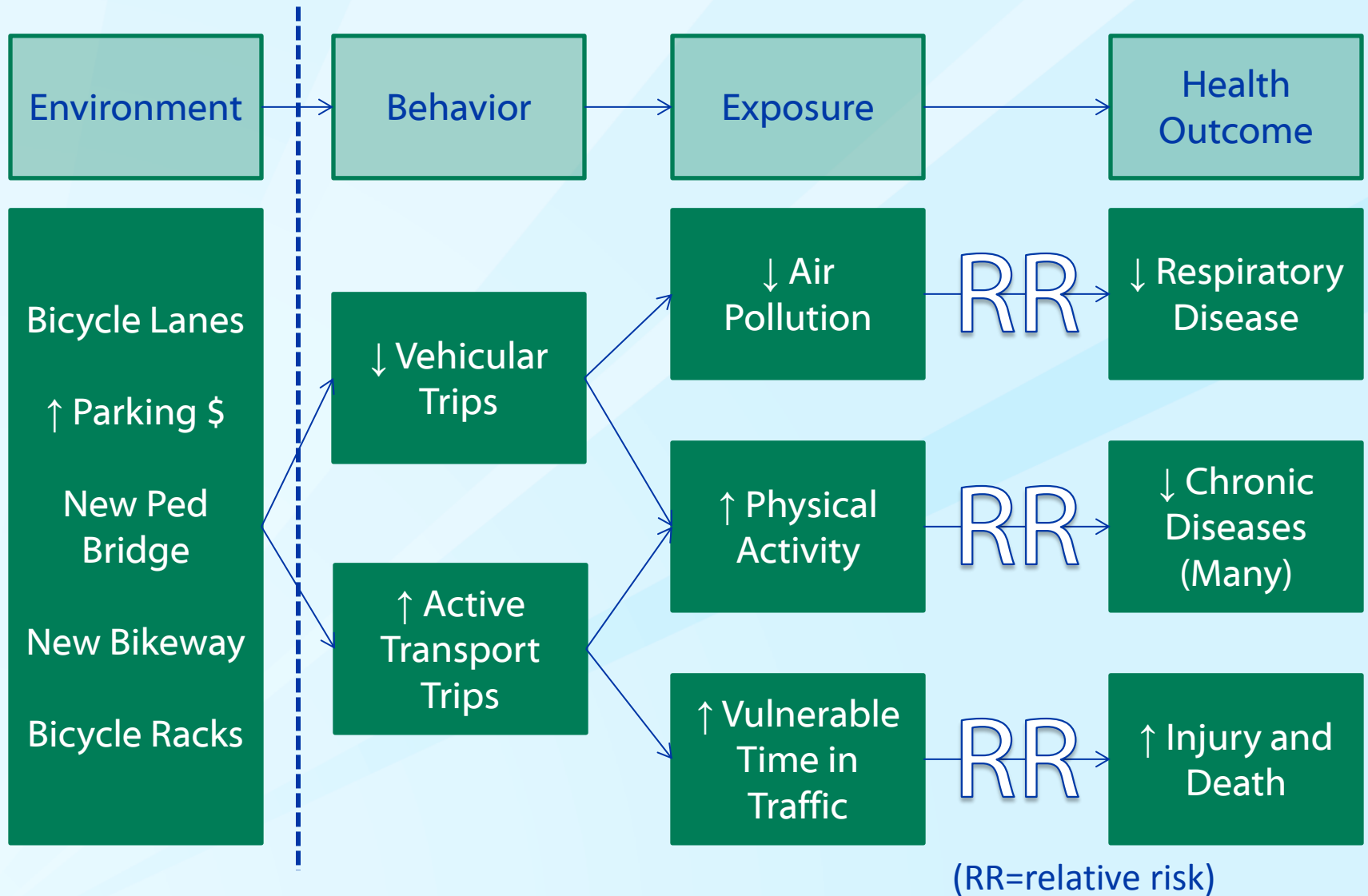
- **The Nashville Metropolitan Planning Organization (MPO) recognized these problems**
- **All can be influenced by transportation planning, which is the MPO's mission**
- **Nashville MPO among the first to incorporate multiple health issues in planning**
 - Health score for proposed projects
 - Health questions in transportation planning study (2012)
 - Health impact modelling, focus of this talk

Health Impact Modeling

- **Previous transportation health impact models**
 - Focus on health benefit of walking and bicycling
 - Ignored concomitant health risks
 - Assumed equal effects for all age/sex groups
 - E.g. WHO's Health Economic Assessment Tool (HEAT)

- **Next generation**
 - Health benefits of physical activity
 - Health benefits of reduced air pollution
 - Health risks of bike/ped vs auto accidents
 - Age/Sex effects
 - E.g. Integrated Transportation and Health Impact Modelling Tool (ITHIM)

ITHIM Model Schematic



Diseases and Exposures

Physical Activity	Air Pollution	Collisions
Ischemic Heart Disease	Respiratory Infections	Auto
Depression	Cardiovascular Disease	Bicycle
Dementia	Hypertensive Heart Disease	Pedestrian
Diabetes	Inflammatory Heart Disease	Bus
Colon Cancer	Lung Cancer	Truck
Breast Cancer	Respiratory Disease	Highway
All-Cause Mortality	Stroke	Arterial
		Local
		Fatal
		Non-Fatal

- **Key Point: Thoroughness = Data-hunger!**

Table 1. Key Parameters and Their Definition, Units, Strata and Data Sources

No.	Item Definition	Units	Strata
1	Per capita mean daily travel distance	Miles/person/d	Age and sex [#] by mode [†]
2	Per capita mean daily travel time	Min/person/d	Travel mode
3	Ratio of per capita mean daily active travel time (relative to females aged 15-29 years old)	Dimensionless	Walk, bicycle
4	Standard deviation of mean daily active travel time	Min/person/d	Walk + bicycle
5	Distribution of population by age and gender	Percent	None
6	Age-sex specific ratio of disease-specific mortality rate between geographic area and United States	dimensionless	Global burden of disease group ^s
7	Proportion of colon cancers from all colo-rectal cancers	dimensionless	NA
8	Walk-speed	mi/h	Walk
9	Per capita weekly non-travel related physical activity expressed as metabolic equivalent tasks (kcal/kg body weight/hr of activity)	MET-hours/week	Median of quintile of walk+bicycle METS
10	Personal travel distance by facility type	mi/d	Travel mode and facility type
11	Vehicle distance traveled (VMT) by facility type	mi/d	Travel mode and facility
12	CO ₂ emitted per distance traveled	lbs/mi	Car
13	Serious and fatal injuries between a striking vehicle and victim vehicle in road traffic collisions	injuries	Severity, Striking mode × victim mode
14	Emissions of primary and secondary sources of PM _{2.5}	tons/d	PM _{2.5} , tire wear, brake wear, NO _x , SO ₂ , ROG
15	Ratio of daily per capita bicycling time to walking time	dimensionless	Bicycle:walk

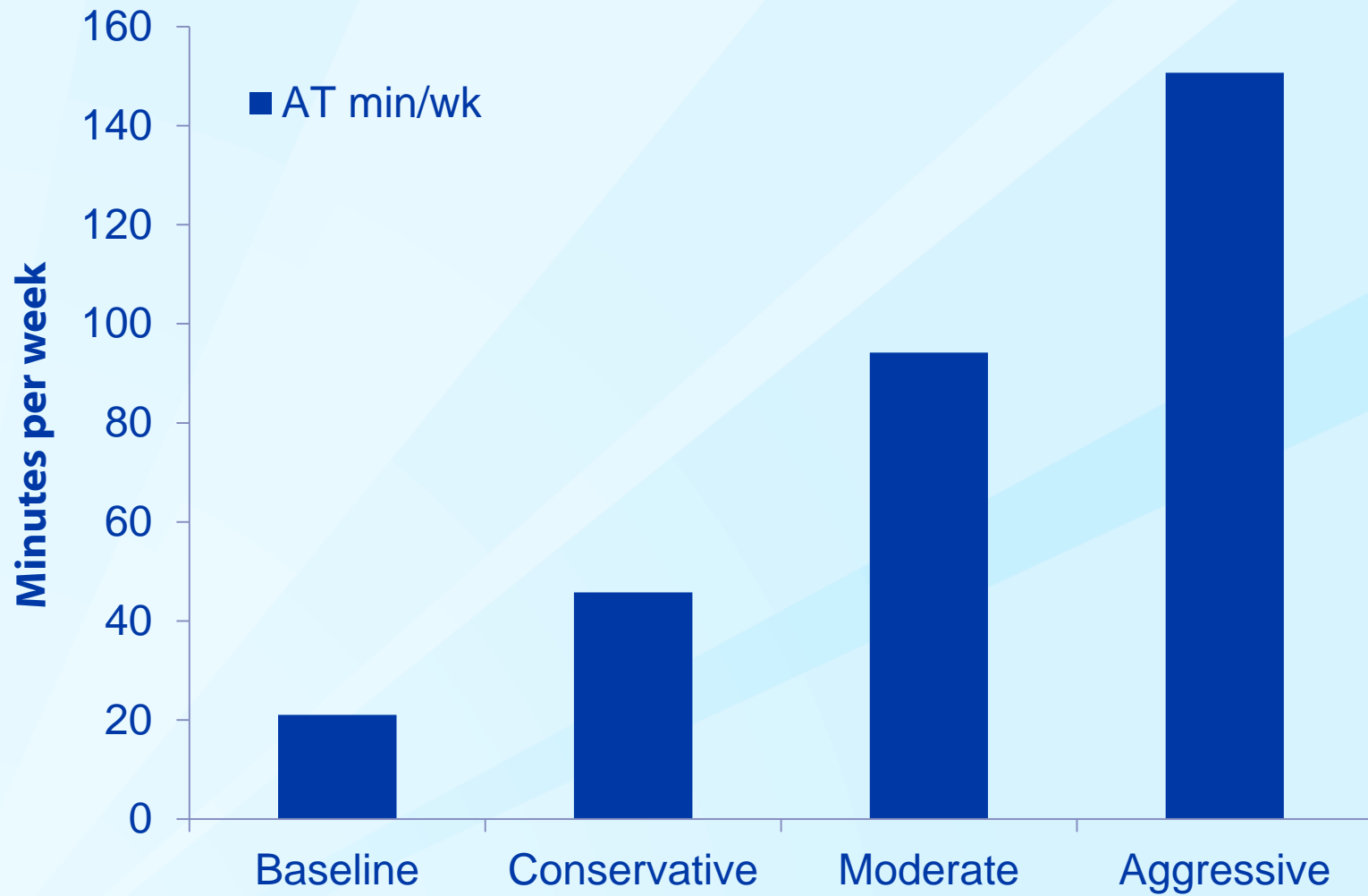
Example – Physical Activity and Ischemic Heart Disease

PA – min/day	Relative Risk	% of Pop at PA Level	
		BAU	Scenario
0	1.00 (ref)	50%	5%
1-9	0.67	30%	7.5%
10-19	0.56	10%	12.5%
20-39	0.33	7%	55%
40+	0.22	3%	20%
Weighted Average “risk”:		0.79	0.40
Population Attributable Fraction:			$0.40 / 0.79 = 0.49$
Change in Disease Burden:		$0.49 * \text{Current DALYs}$	

Running the Model

- **After calibration, enter scenarios for comparison**
- **Following slides present shifts from car to bike/ped:**
 - Conservative
 - Moderate
 - Aggressive

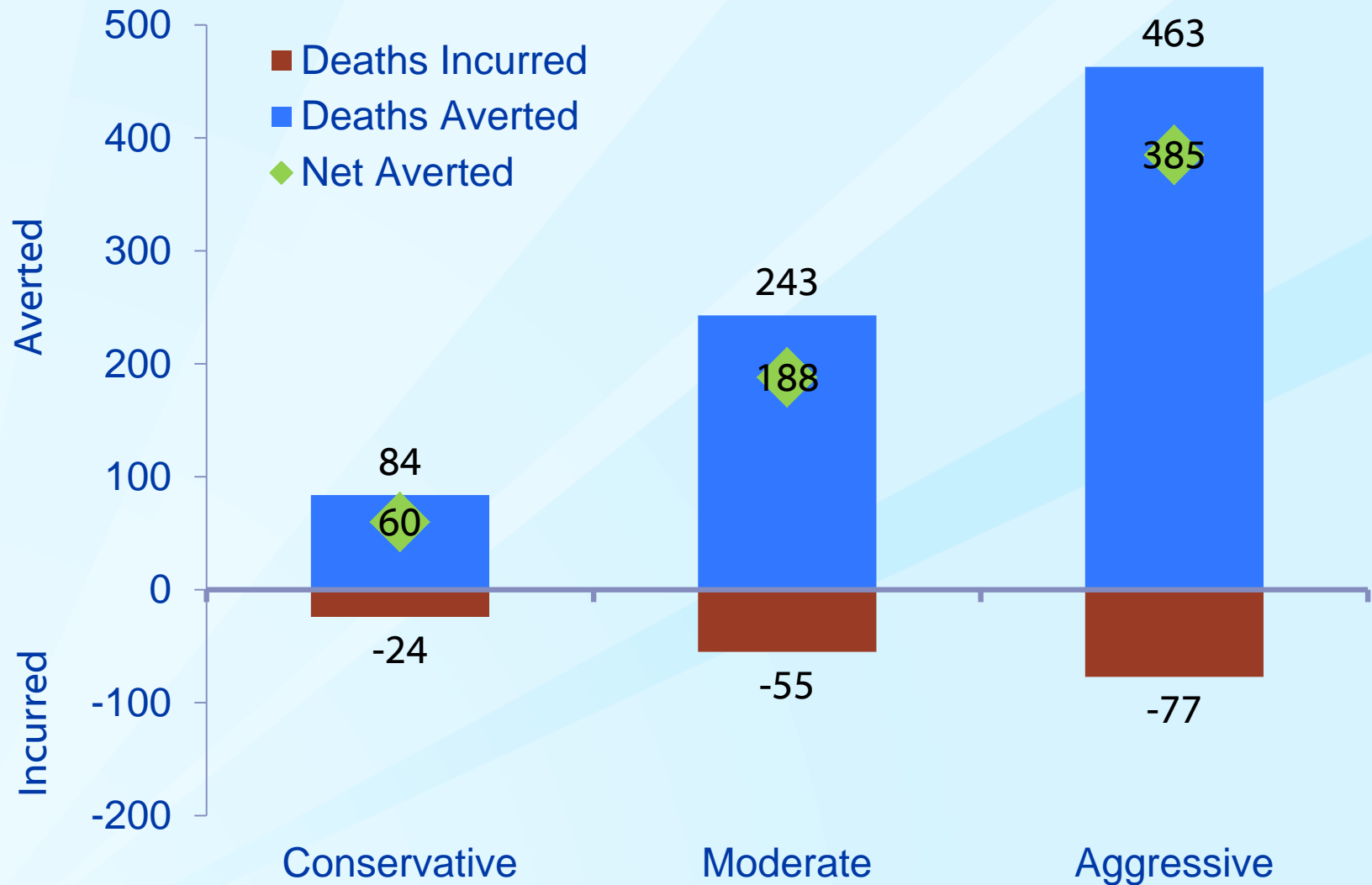
Active Transportation Across Scenarios



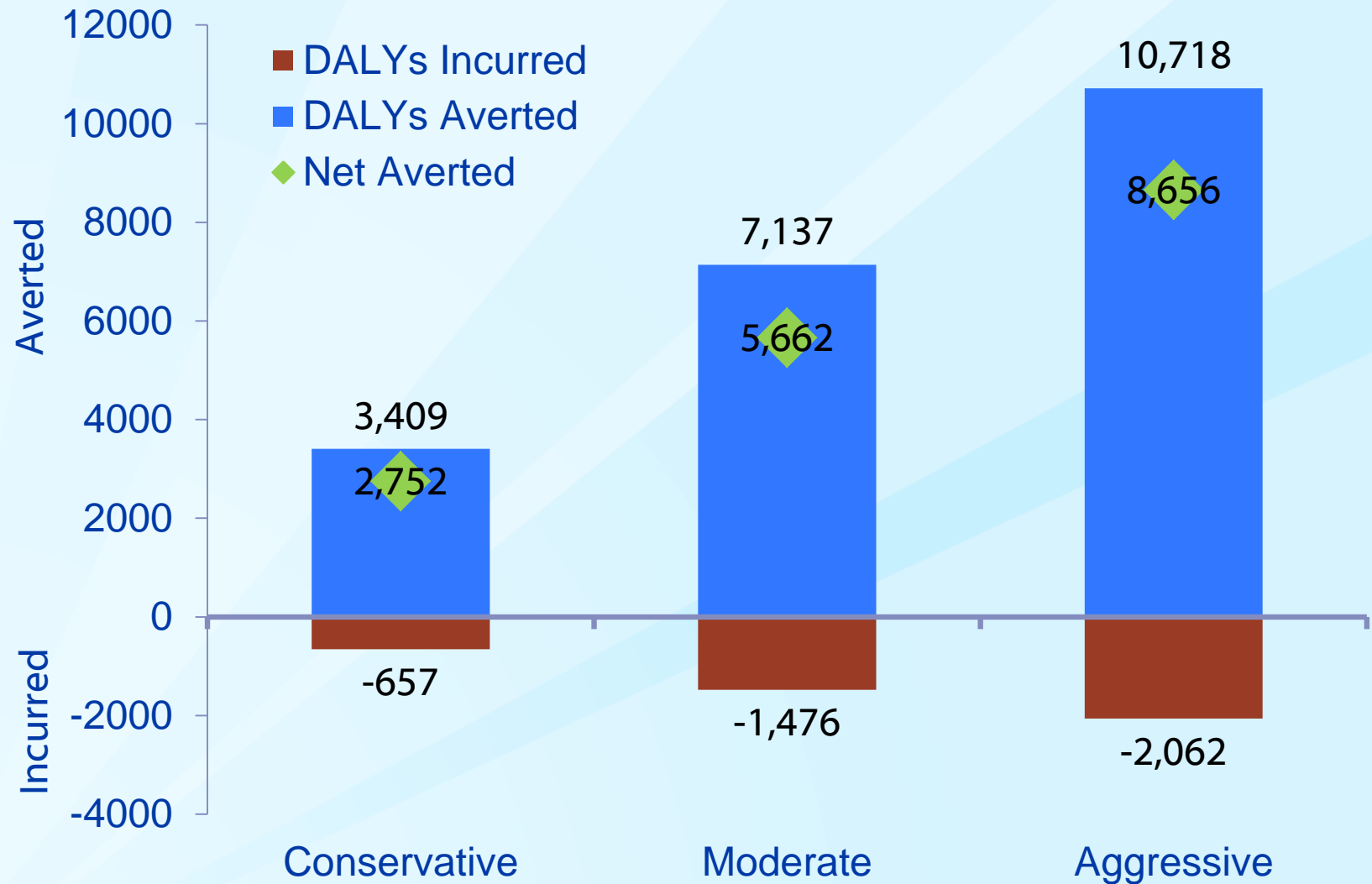
Active Transportation Across Scenarios



Change in Deaths by Scenario



Change in DALYs by Scenario



Health Outcome Detail

		Breast Cancer		Colon Cancer		Stroke		IHD		Depression		Dementia		Diabetes		Hypertensive Heart Disease		Lung Cancer		Acute Resp Infections		Inflammatory Heart Disease		Resp Diseases		Road Traffic Injuries		Total		All-cause mortality		Total	
		f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	injuries	all	
Deaths	0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0	-0					0	0	0	0	0	0		
	5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							1	0	1	0	0	0			
	15-29	-0	-0	-0	-0	-0	-0	0	0	0	0	-0	-0	-0	-0	-0	0	0	0	0	0	0	0	0	8	3	7	3	-1	-2			
	30-44	-0	-0	-0	-1	-1	-5	-2	-0	-0	-0	-0	-1	-1	-2	-1	-0	-0	-0	-0	-0	-0	-0	-0	5	2	-4	-2	-5	-4			
	45-59	-1	-0	-1	-4	-4	-23	-10	-0	-0	-0	-0	-3	-3	-7	-4	-0	-0	-0	-0	-0	-0	-0	-0	2	1	-36	-22	-14	-22			
	60-69	-2	-1	-1	-5	-4	-28	-11	-0	-0	-1	-1	-4	-3	-4	-2	-0	-0	-0	-0	-0	-0	-0	-0	2	2	-41	-21	-22	-58			
	70-79	-1	-1	-1	-6	-5	-18	-10	-0	-0	-3	-5	-3	-2	-2	-2	-0	-0	-0	-0	-0	-0	-0	-0	4	3	-28	-23	-41	-71			
	80+	-0	-0	-0	-0	-7	-0	-16	-0	-0	-3	-10	0	-2	-0	-4	-0	-0	-0	-0	-0	-0	-0	-0	9	13	5	-26	-30	-49			
	total	-5	-2	-2	-16	-21	-74	-50	-0	-0	-7	-16	-12	-11	-15	-8	-0	-0	-0	-0	-0	-0	-0	-0	-0	30	26	-96	-91	-114	-206	55	-188
		3%		2%	6%	7%	50		2%		3%	-16	8%	-11	8%		0%		0%		0%		0%		15%		1,7%		2,9%				
YLL	0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0	-0					19	17	19	17	0	0			
	5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							41	33	41	33	0	0			
	15-29	-1	-0	-0	-8	-8	-12	-5	0	0	0	0	-6	-6	-4	-2	0	0	0	0	0	0	0	0	446	209	415	187	-81	-93			
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		3%		3%	9%	34,9	10%	-821		3%	3%	-137	10%	-244	11%	-221	0%	-1	0%	-0	0%	-0	0%	0%	15%	535	1,7%	1,381	1,646	3,194			
YLD	0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0	0	0	0	1	1	1	1	0	0			
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		3%		3%	12%	27,2	11%	-103		3%	4%	-479	12%	-433	6%	-16	0%	0	0%	0	0%	0	0%	0%	0%	31	31	932	1,677	0	0		
DALYs	0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0	-0	0	0	0	0	20	18	20	18	0	0		
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	15-29	-1	-0	-0	-15	-16	-13	-5	-14	-61	-1	-2	-13	-16	-4	-2	0	0	0	0	0	0	0	0	463	223	403	119	-81	-93			
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	total	-124	-41	-53	-504	-622	-1,662	-923	-110	-349	-263	-616	-555	-697	-378	-238	-1	-1	-0	-0	-0	-0	-0	-0	-0	910	565	-3,604	-3,058	-1,646	-3,194	1,476	-5,662
		2,8%		2,6%	10,4%	10,2%	10,2%		2,7%		3,9%		11,2%		10,6%		0,0%		0,0%		0,0%		0,0%		0,0%	13,8%	565	1,7%	3,058	1,646	3,194	1,476	-5,662

Conclusion

- **Nashville MPO is active in health-oriented transportation planning**
- **Modelling can help foster support for bike/ped initiatives**
- **ITHIM is a comprehensive tool for modelling health impact of biking and walking**
- **Data requirements as tradeoff of thoroughness**

Visit HCDE:

www.cdc.gov/healthyplaces

Acknowledgements

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