Healthy Performance Measures: Health Impact Modeling in Nashville, TN

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National Center for Environmental Health
Healthy Community Design Initiative

CDC and Transportation Partnerships

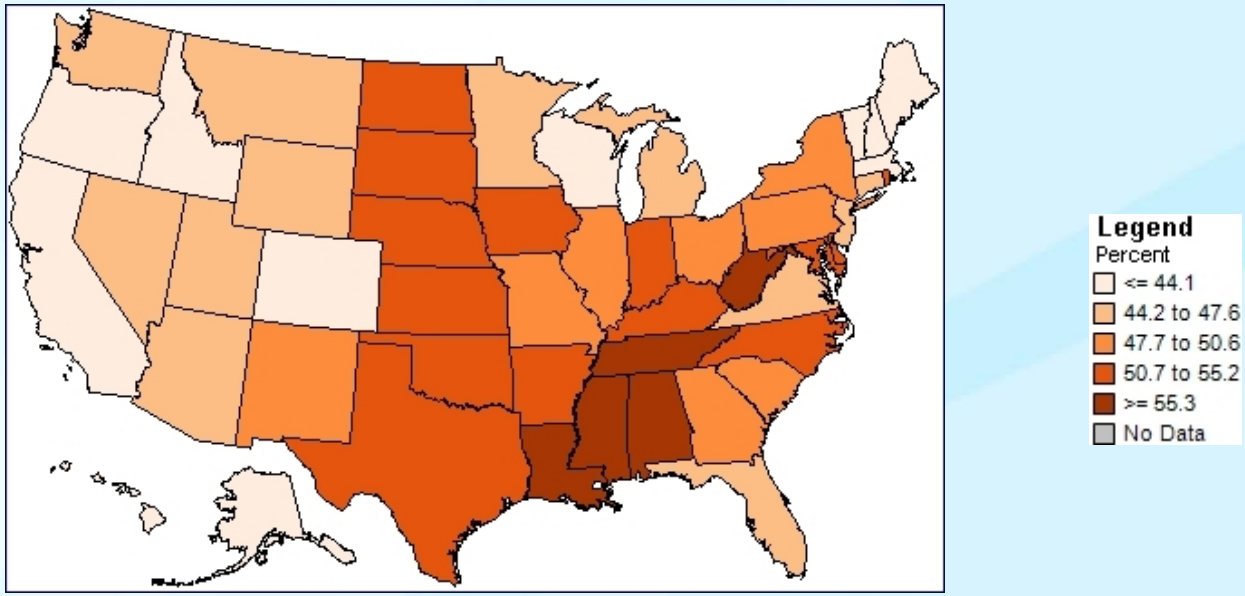
- **The Healthy Community Design Initiative**
  - At the National Center for Environmental Health
  - Focus on built environment and health
  - The design of communities impacts the health of residents, including chronic diseases, injuries, and environmentally-mediated illness

- **Community design elements include:**
  - Transportation systems
  - Public spaces
  - Zoning

Community Design Challenges

Inactivity in Tennessee

- **2013: 62% do not meet aerobic physical activity guidelines**
  - National rank: 49th



- **Nashville area slightly better (2011): 57%**
- **Tennesseans have 4th highest prevalence of obesity (33.7%)**

Physical inactivity: 2013 and 20122 BRFSS; obesity: 2013 BRFSS

Nashville Area Metropolitan Planning Organization

- **Public opinion survey**
  - Walking, bicycling, transit
- **Revised project scoring**
  - 70% included bike/ped
- **Data collection and use**
  - Middle Tennessee Transportation and Health Survey
  - High health impact areas
  - Health impact modeling

"ITHIM" Tool

Integrated Transportation and Health Impact Modeling Tool

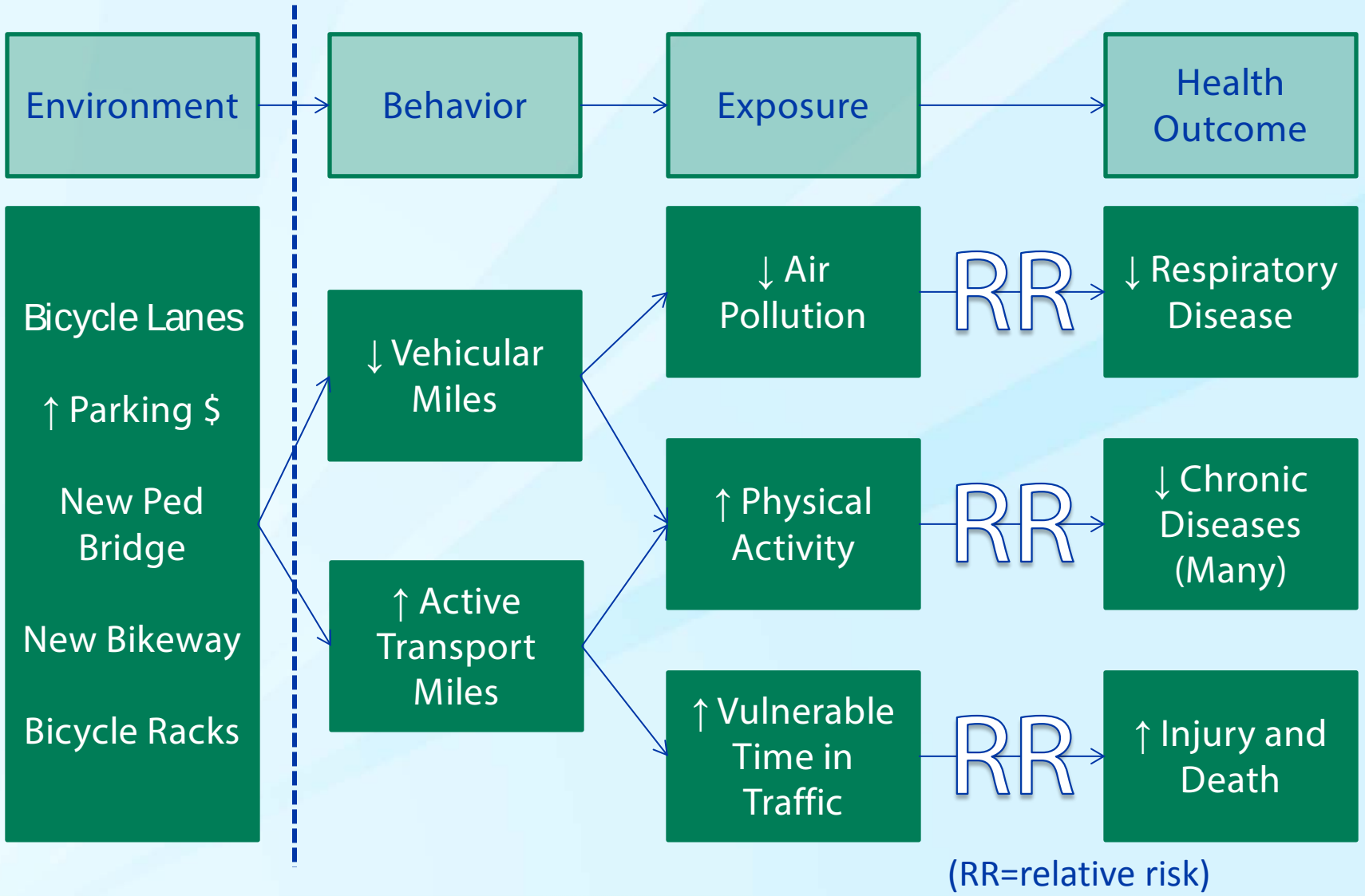
James Woodcock, PhD at Cambridge

Neil Maizlish, PhD at California Department of Health

Computes impacts across three areas:

- **Physical activity**
- **Air pollution**
- **Crashes**

ITHIM Model Schematic



(RR=relative risk)

Diseases and Exposures

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

For each disease (and by age and sex): comparative risk assessment

#	Item Definition	Units	Strata
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

#	Item Definition	Units	Strata
1	Per capita mean daily travel distance	Miles/Person/Day	Mode
2	Per capita mean daily travel time	Min/Person/Day	Mode
3	Per capita mean daily AT time (ratio)	Dimensionless	Walk, Bike
4	SD of mean daily active travel time	Min/Person/Day	Walk, Bike
5	Walk speed	Miles/Hour	None
6	Personal travel distance and time	Miles & Hours/Day	Drive, Passenger
7	Ratio daily per capita bicycling to walking	Dimensionless	None
8			
9			
10			
11			
12			
13			
14			

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8	Vehicle miles traveled	Miles/Day	Mode, Road type
9			
10			
11			
12			
13			
14			

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8	Vehicle miles traveled	Miles/Day	Mode, Road type
9	Emissions of $PM_{2.5}$ per vehicle mile traveled	$\mu g / m^3$	None
10	Disease-specific mortality rate (Ratio)	Dimensionless	Age, Sex, Disease
11	Proportion of colorectal cancers at the colon	%	None
12	Serious and fatal injuries from collisions	Injuries	Mode (2), Road type
13			
14			

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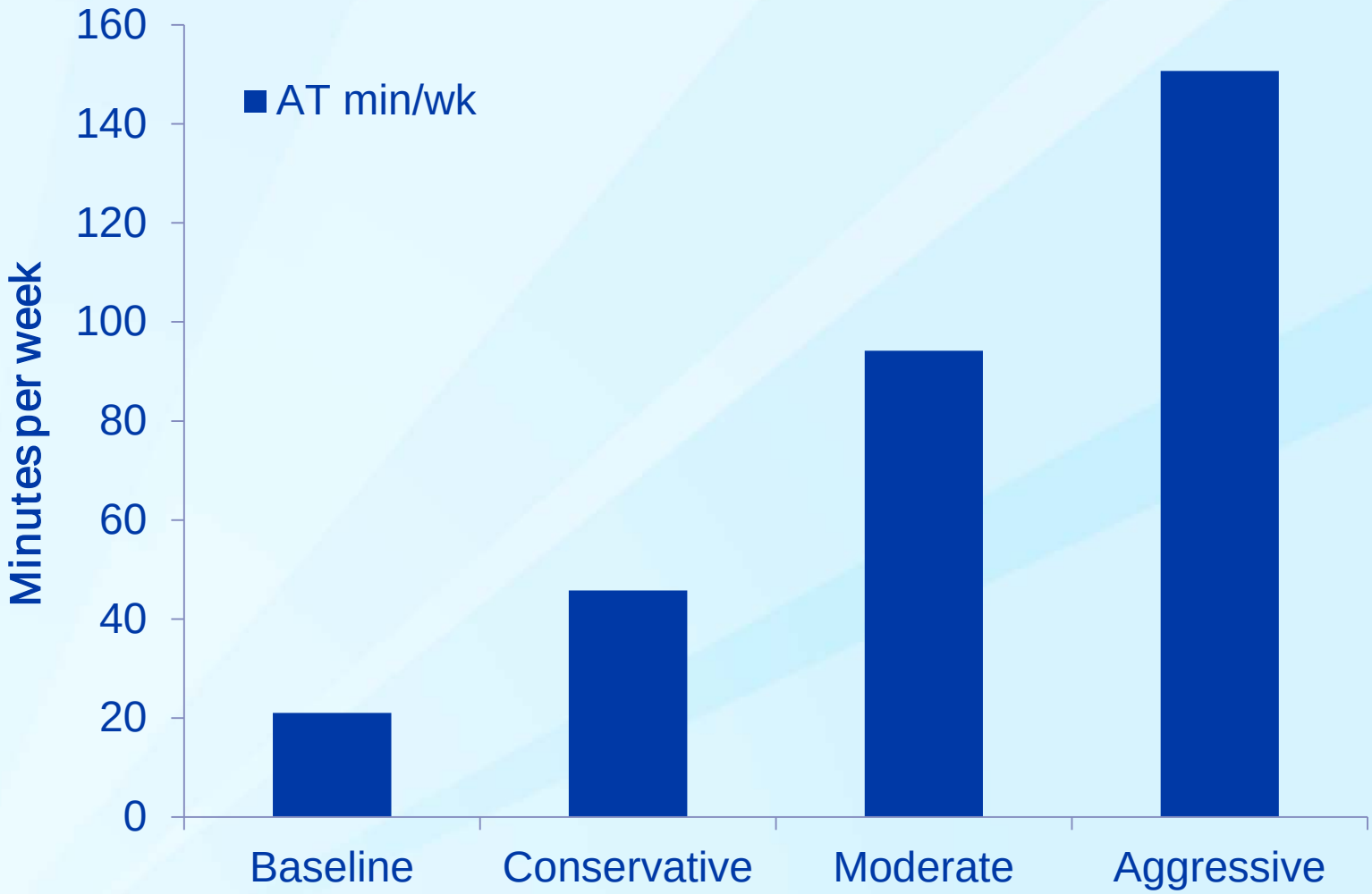
11	Proportion of colorectal cancers at the colon	%	None
12	Serious and fatal injuries from collisions	Injuries	Mode (2), Road type
13	Per capita non-travel physical activity	MET-hours/Week	Travel PA, Age, Sex
14	Population Distribution	Percent	Age, Sex

Scenarios

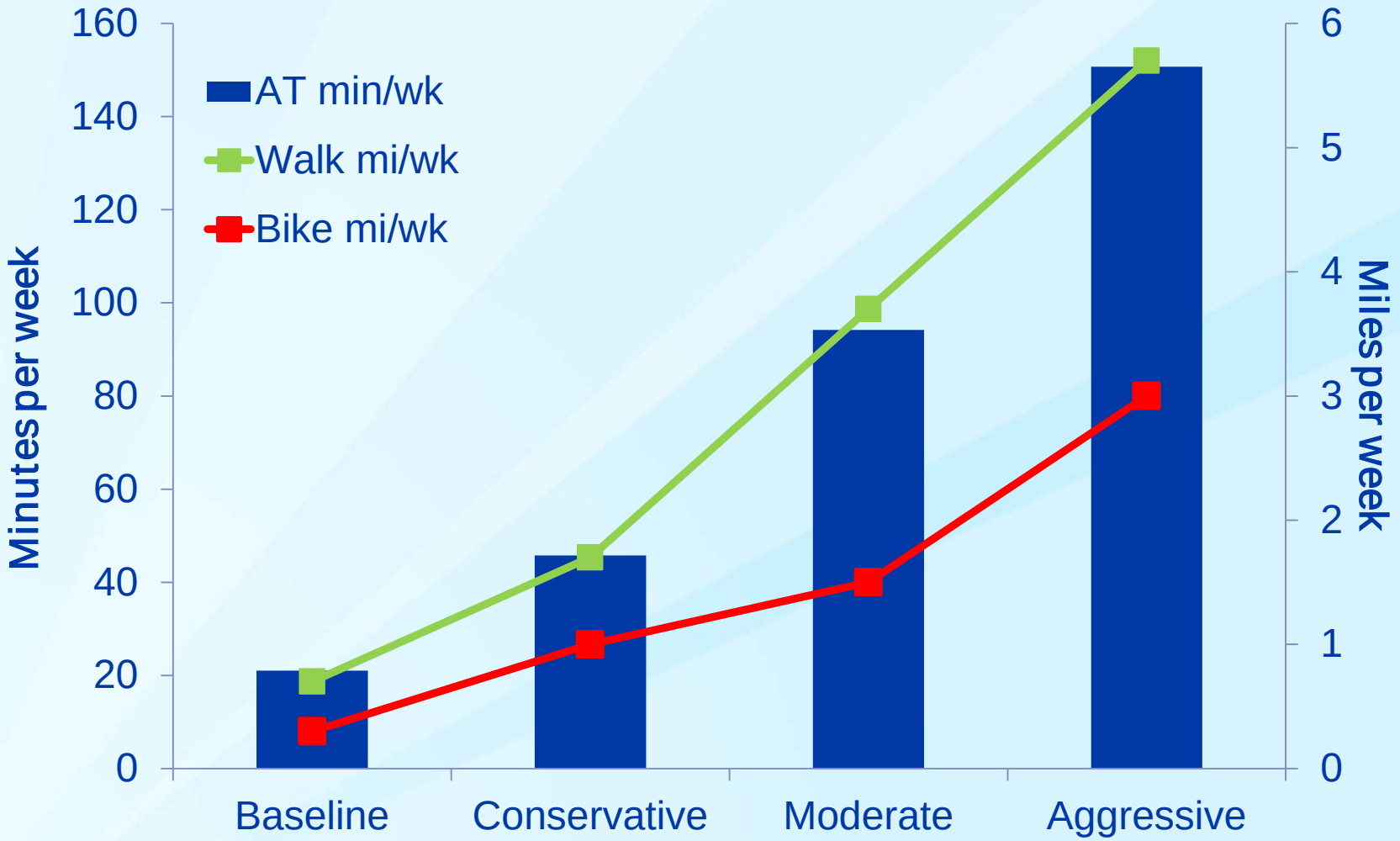
After calibration, three scenarios were developed

1. Conservative: Three additional minutes per day of active transportation
2. Moderate: Ten additional minutes per day of active transportation
3. Aggressive: The average person meets activity guideline through active transportation

Active Transportation Across Scenarios

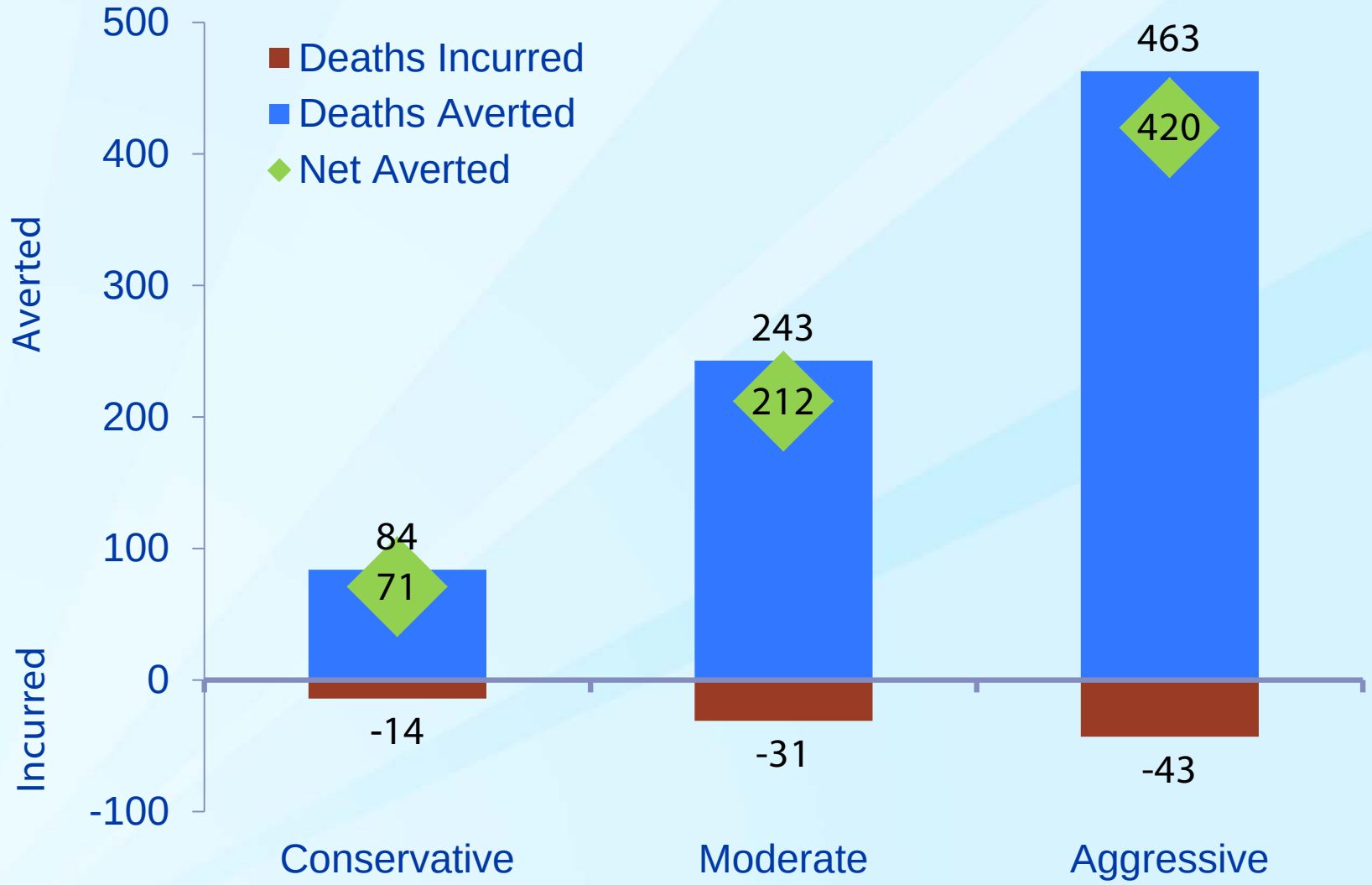


Active Transportation Across Scenarios

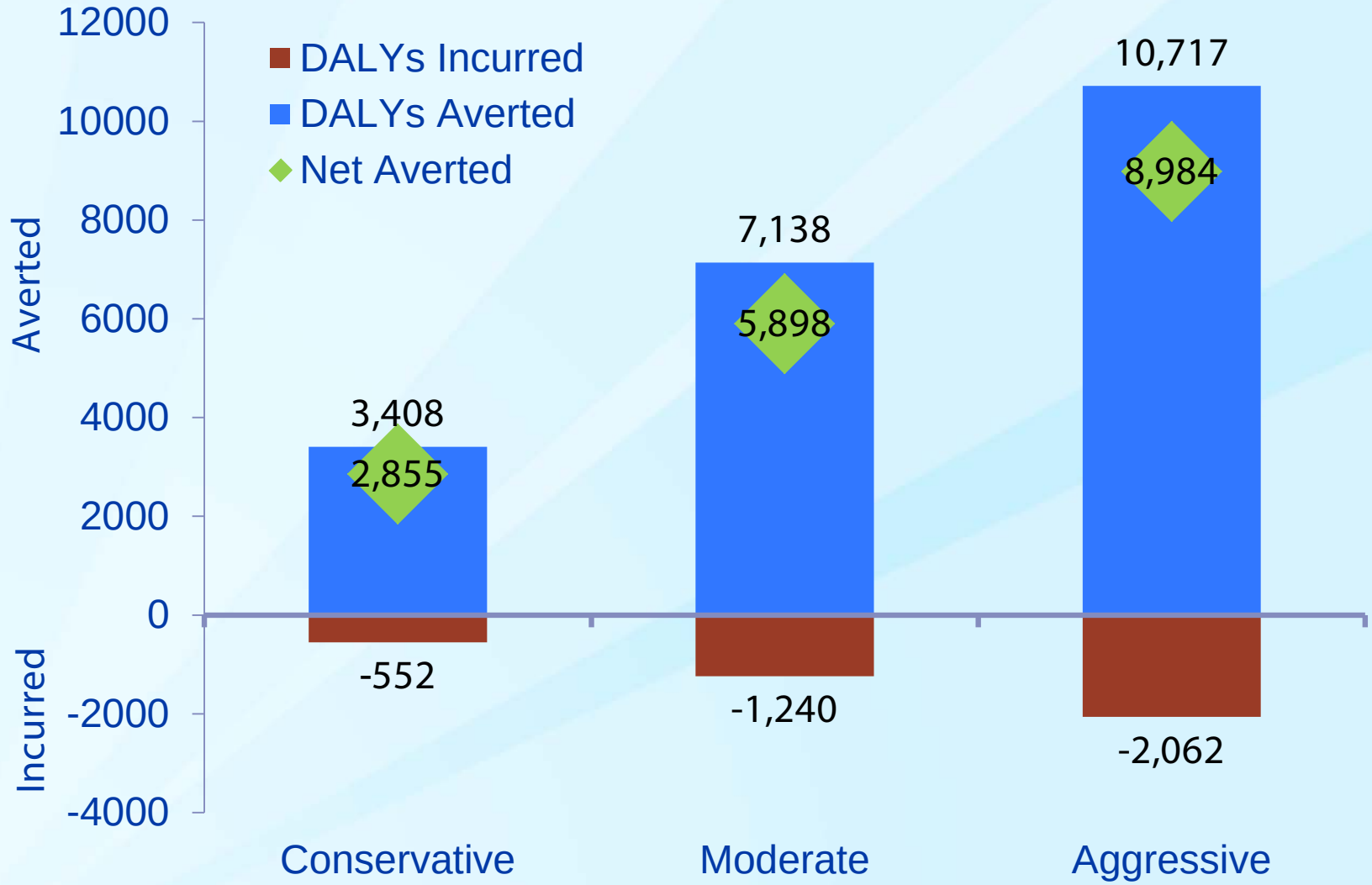


OUTPUTS

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		
	5-14	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	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	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	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	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	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	9	13	5	-26	-30	-49		
	total	-5	-2	-2	-16	-21	-74	-50	-0	-0	-7	-16	-12	-11	-15	-12	-0	-0	-0	-0	-0	-0	-0	-0	30	26	-96	-91	-114	-206	55	-188
		3%	2%		6%		7%		2%		3%		8%		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					19	17	19	17	0	0		
	5-14	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	446	209	415	187	-81	-93		
	30-44	-9	-5	-3	-37	-44	-198	-76	-0	-0	-0	-0	-50	-39	-80	-28	-0	-0			-0	-0	-0	-0	209	98	-160	-102	-224	-176		
	45-59	-41	-10	-17	-117	-130	-653	-323	-0	-0	-1	-3	-94	-101	-189	-116	-0	-0			-0	-0	-0	-0	54	44	-1,011	-686	-403	-672		
	60-69	-34	-10	-14	-87	-77	-484	-218	-0	-0	-13	-28	-78	-60	-69	-36	-0	-0			-0	-0	-0	-0	31	34	-710	-433	-381	-1,169		
	70-79	-13	-7	-8	-56	-58	-187	-126	-0	-0	-28	-62	-30	-29	-20	-23	-0	-0			-0	-0	-0	-0	39	41	-289	-278	-416	-861		
	80+	-1	-1	-1	-0	-32	-0	-73	-0	-0	-16	-44	0	-8	-0	-16	-0	-0			-0	-0	-0	-0	41	58	23	-119	-141	-222		
	total	-99	-33.5	-42.9	-305	-349	-1,533	-821	-0	-1	-59	-137	-258	-244	-362	-221	-1	-1	-0	-0	-0	-0	-0	-0	879	535	-1,671	-1,381	-1,646	-3,194	1,414	-3,052
		3%	3%		9%		10%		3%		3%		10%		11%		0%		0%		0%		0%		15%		1.7%		2.7%			
YLD	0-4	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		
	5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							3	3	3	3	0	0		
	15-29	-0	-0	-0	-7	-8	-1	-1	-14	-61	-1	-2	-7	-9	-0	-0	0	0			0	0	0	0	16	14	-13	-67	0	0		
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	60-69	-6	-2	-3	-44	-34	-35	-26	-14	-67	-77	-179	-46	-54	-5	-2	0	0			0	0	0	0	1	1	-223	-370	0	0		
	70-79	-3	-1	-2	-10	-11	-12	-12	-3	-10	-90	-187	-11	-15	-3	-3	0	0			0	0	0	0	1	1	-131	-241	0	0		
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	total	-25	-7	-10	-200	-272	-129	-103	-110	-349	-204	-479	-298	-453	-16	-16	0	0	0	-0	0	0	0	0	31	31	-932	-1,677	0	0	62	-2,610
		3%	3%		12%		11%		3%		4%		12%		6%		0%		0%		0%		0%		4%		1.6%		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	20	18	20	18	0	0		
	5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	44	36	44	36	0	0		
	15-29	-1	-0	-0	-15	-16	-13	-5	-14	-61	-1	-2	-13	-16	-4	-2	0	0			0	0	0	0	463	223	403	119	-81	-93		
	30-44	-13	-6	-3	-70	-106	-222	-89	-52	-100	-1	-2	-166	-201	-81	-29	-0	-0			-0	-0	-0	-0	216	105	-381	-438	-224	-176		
	45-59	-53	-13	-21	-222	-283	-710	-370	-27	-110	-5	-16	-211	-309	-196	-119	-0	-0			-0	-0	-0	-0	55	46	-1,329	-1,235	-403	-672		
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	70-79	-16	-8	-9	-66	-69	-199	-138	-3	-10	-118	-249	-41	-44	-23	-26	-0	-0			-0	-0	-0	-0	40	43	-419	-519	-416	-861		
	80+	-2	-1	-2	-0	-37	-0	-77	-1	-2	-48	-141	0	-13	-0	-24	-0	-0			-0	-0	-0	-0	41	59	-9	-237	-141	-222		
	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	910	565	-2,604	-3,058	-1,646	-3,194	1,476	-5,662
		2.8%	2.6%		10.4%		10.2%		2.7%		3.9%		11.2%		10.6%		0.0%		0.0%		0.0%		0.0%		13.8%		1.7%		1.4%			

Moderate Scenario	Change in disease burden	Change in DALYs per year
Cardiovascular Diseases	10.4% ↓	1442
Diabetes	11.2% ↓	1252
Depression	2.7% ↓	460
Dementia	3.9% ↓	879
Breast cancer	2.8% ↓	124
Colon Cancer	2.6% ↓	94
Collisions	13.8% ↑	1240

Traffic Injury Burden

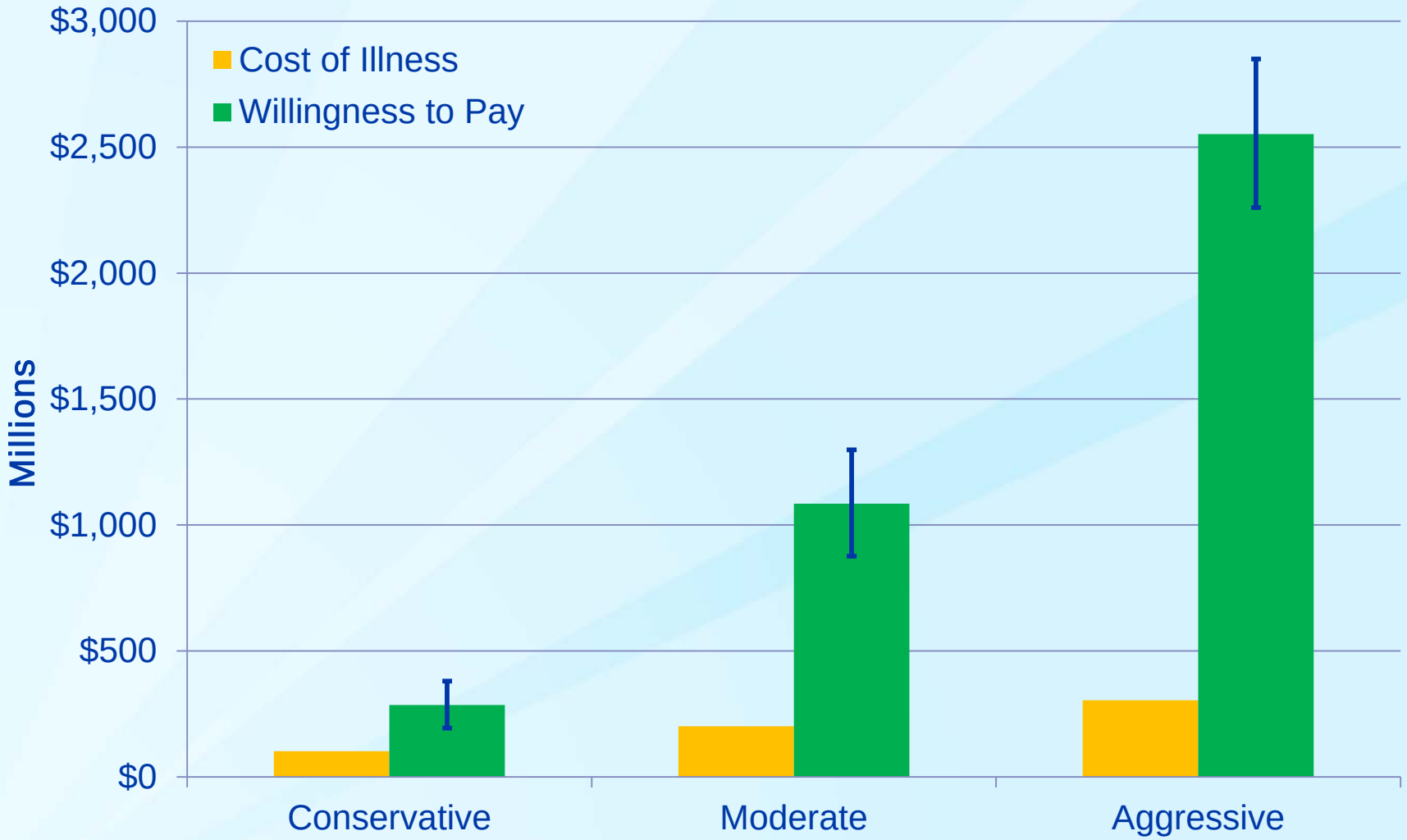
Baseline injury burden is accrued with existing built environment

Prediction of increased burden may argue for new infrastructure

-Amplification of "safety in numbers"

Photo credit: Michael Rankin, source: http://safety.fhwa.dot.gov/ped_bike/tools_solve/walkways_trifold/

Economic Impact Analysis



Conclusions

- Comprehensiveness → data needs
- ITHIM calibration in Nashville was a collaborative effort
- ITHIM provided Nashville with detailed estimates of health and economic impacts

Visit HCDI:

www.cdc.gov/healthyplaces

Acknowledgements

CDC
Arthur Wendel

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Leslie Meehan
Michael Skipper

ITHIM Developers
Neil Maizlish
James Woodcock

xdh5@cdc.gov

For more information please contact Centers for Disease Control and Prevention

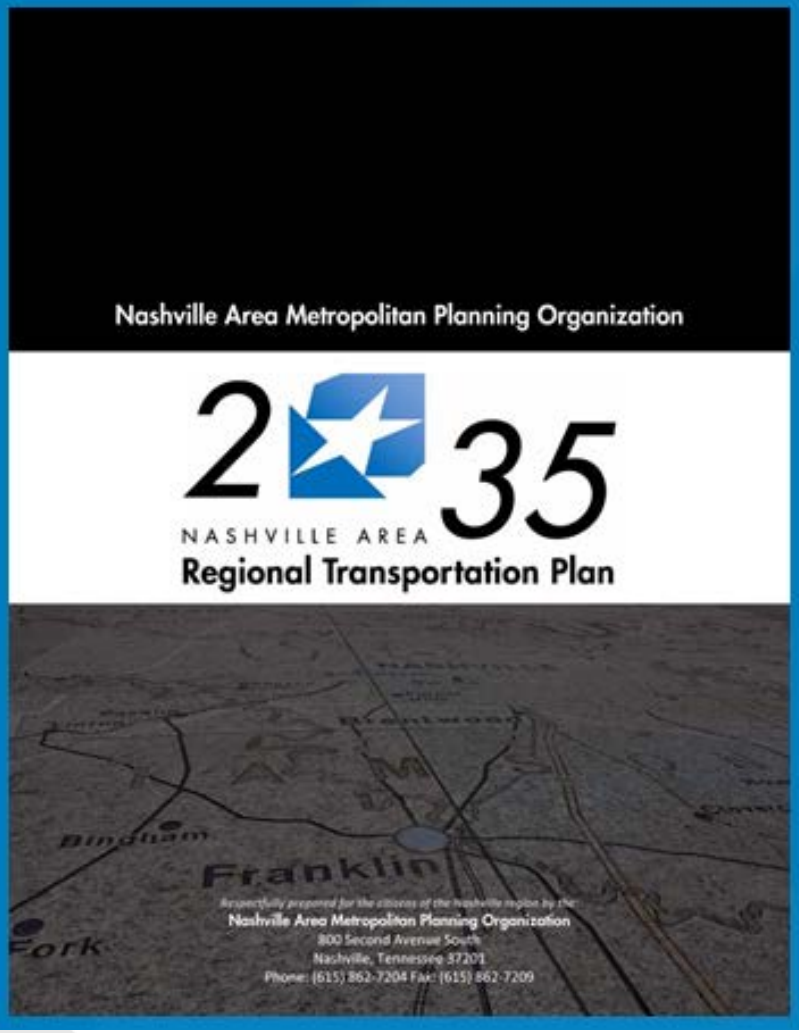
1600 Clifton Road NE, Atlanta, GA 30333

Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348

Visit: www.cdc.gov | Contact CDC at: 1-800-CDC-INFO or www.cdc.gov/info

EXTRA SLIDES

Policy: Public Opinions



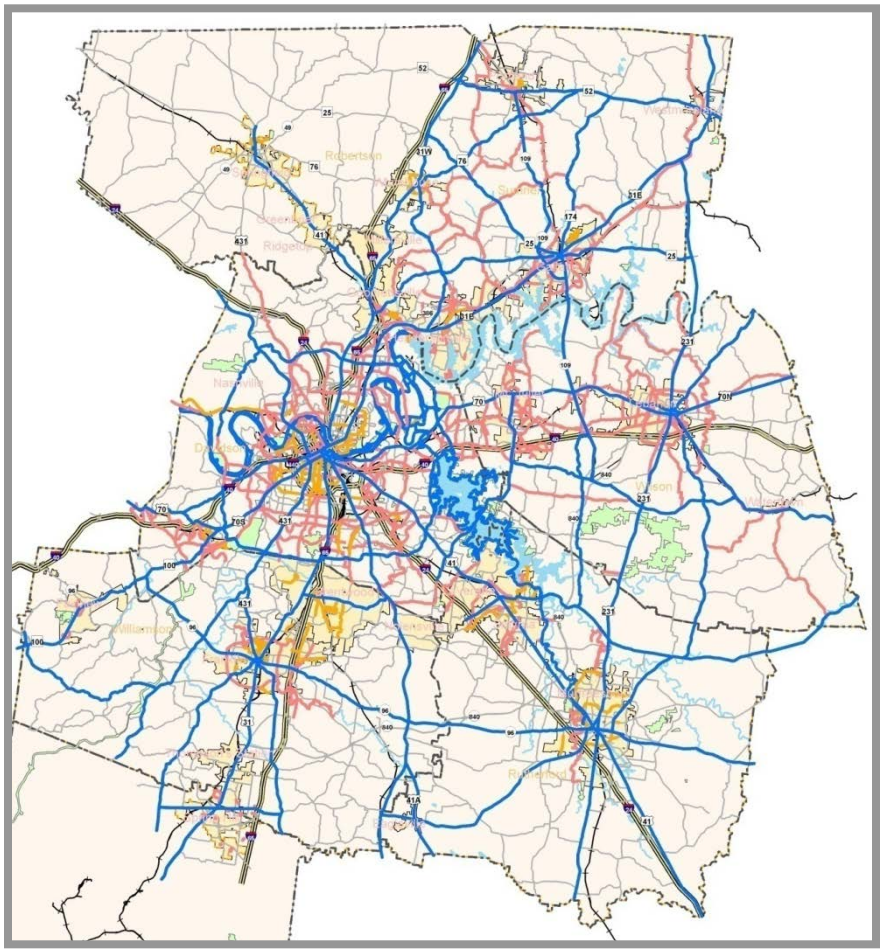
#1
A Bold, New Vision for Mass Transit

#2
Support for Active Transportation & Walkable Communities

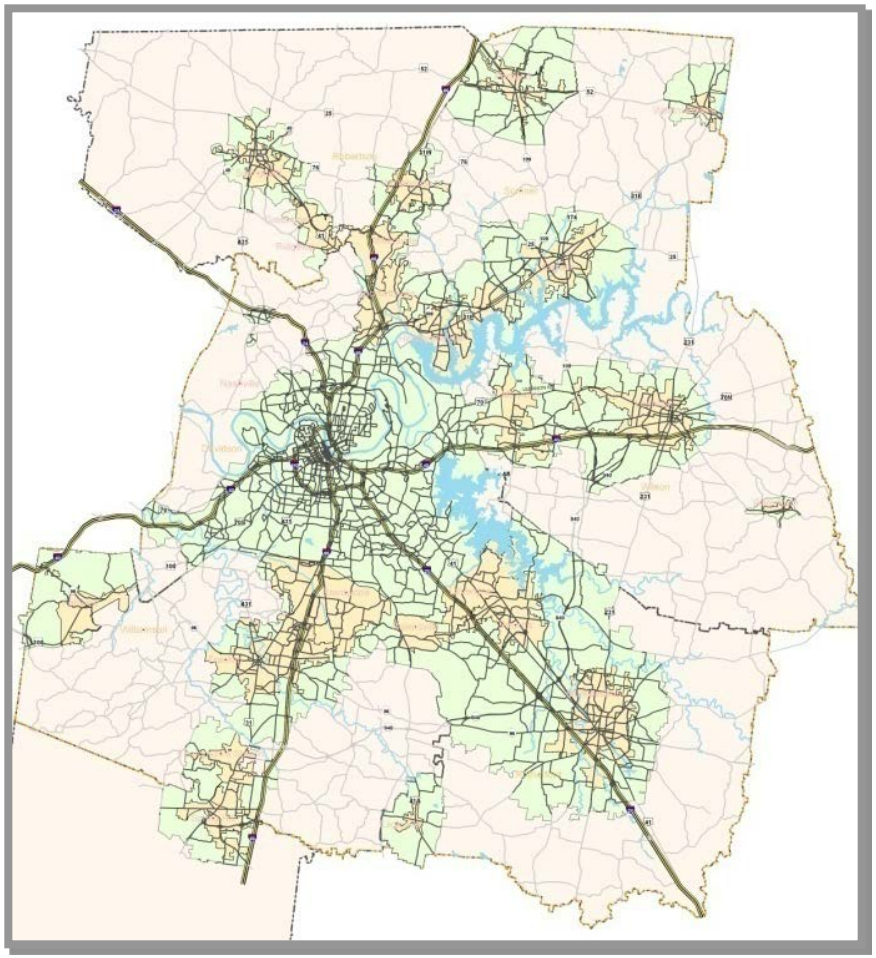
#3
Preservation & Enhancement of Strategic Roadways

Plan: Regional Vision for Non-Motorized Modes

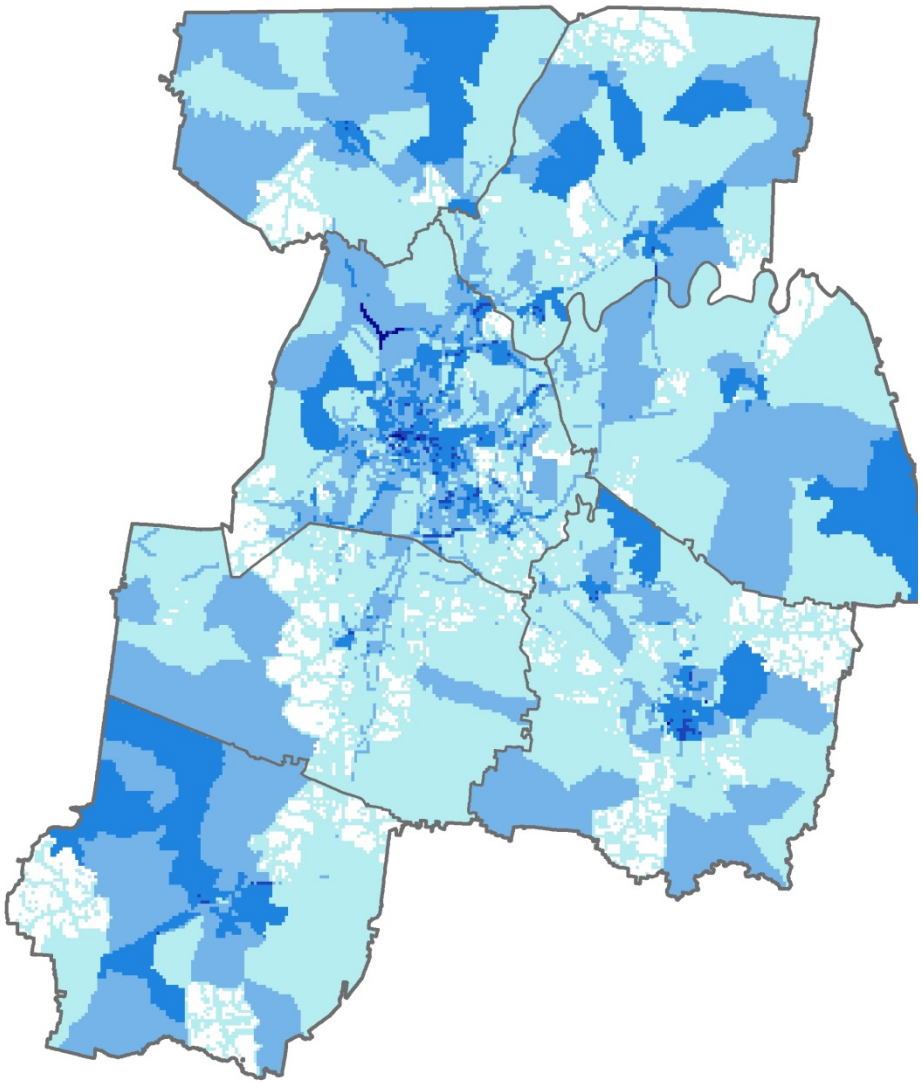
Bikeways

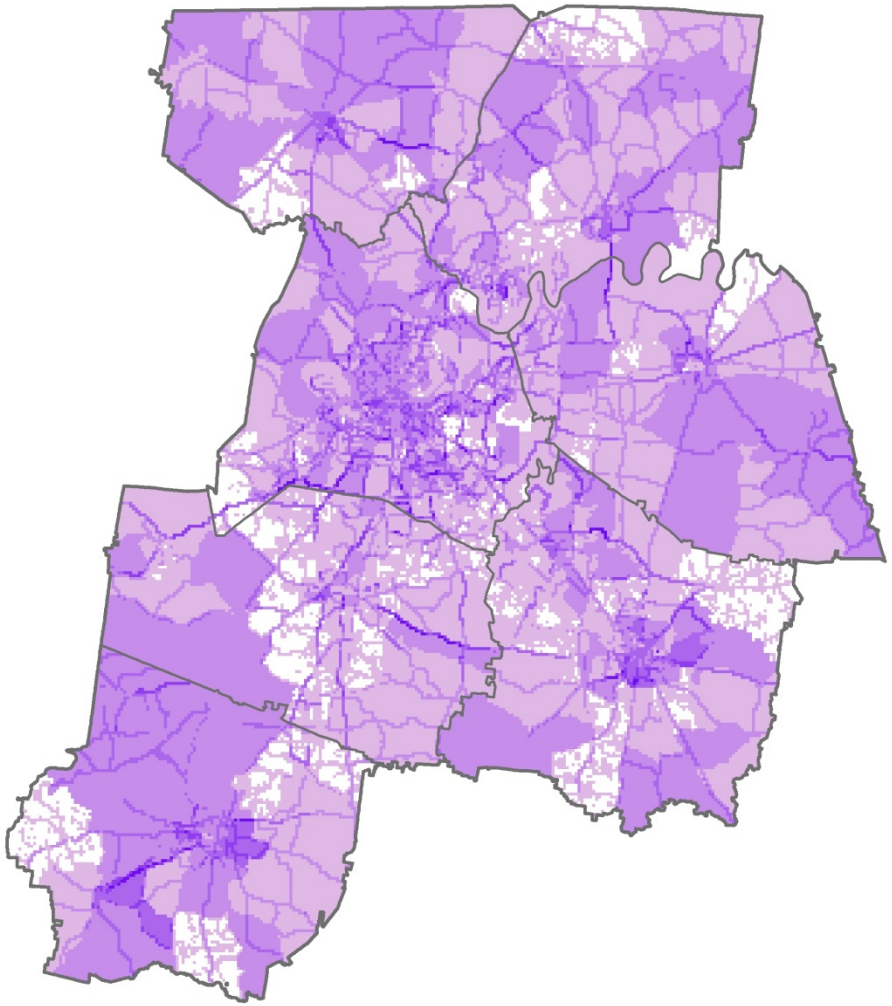


Sidewalks



Composite Bike/Ped Priority Areas





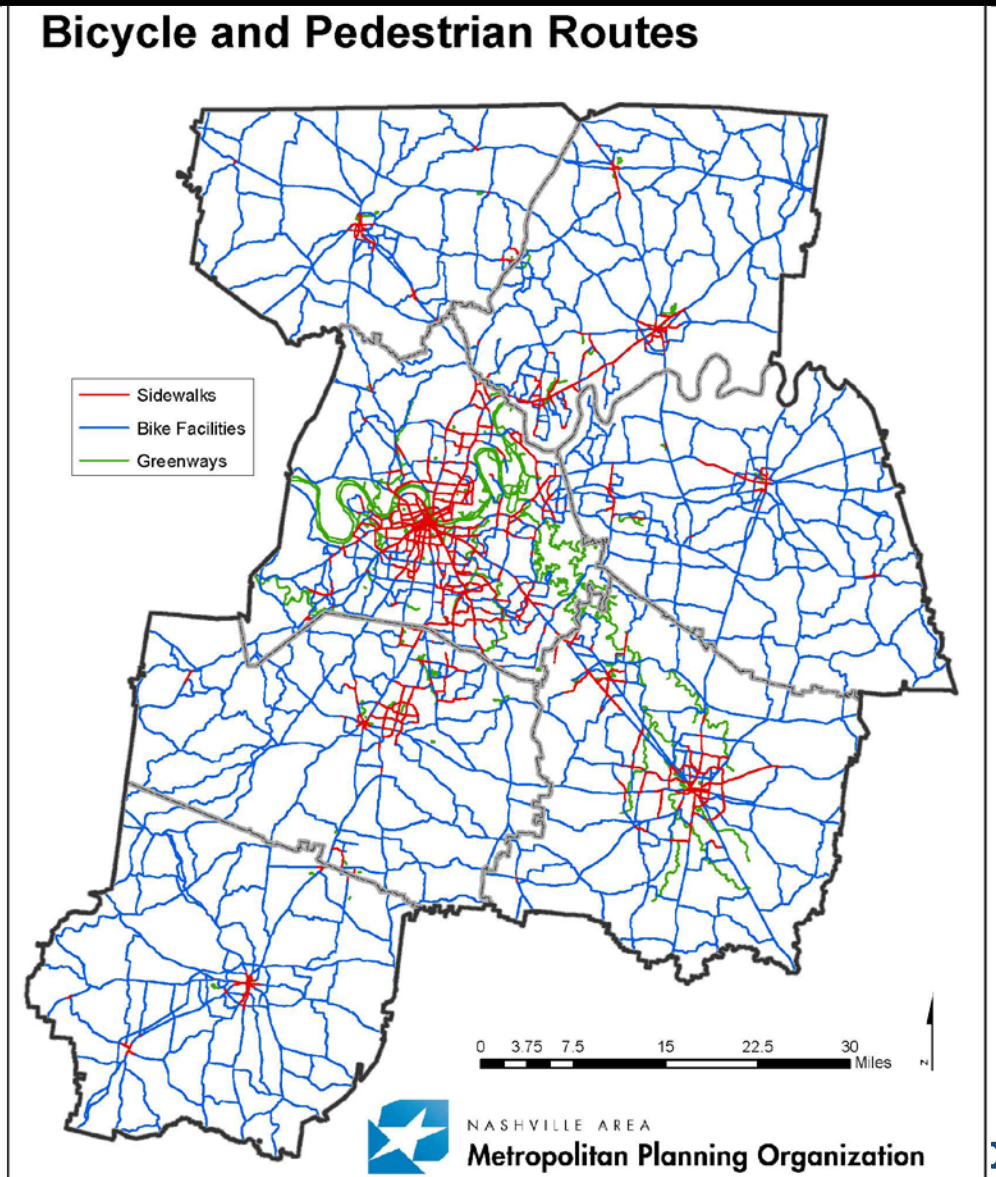
Bikeways, Sidewalks Greenways

2015

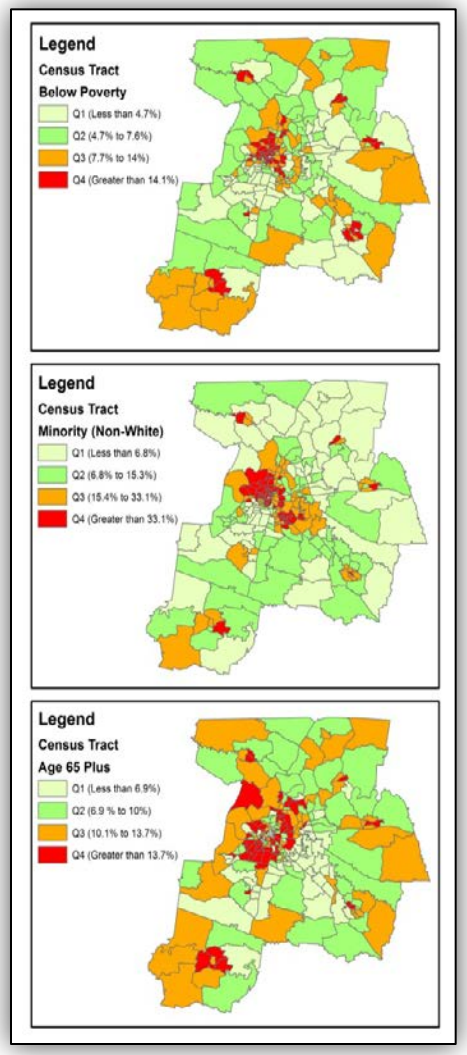
Sidewalks - 505 miles

Bikeways –423 miles
(bike lanes, buffered bike lanes, bike routes and sharrows)

Greenways –185 miles
(greenways, multi-use trails and park trails)



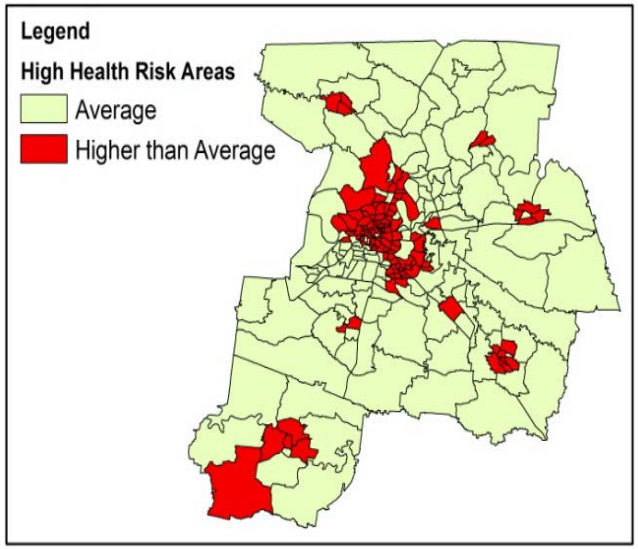
Prioritizing Projects – Health Analysis



There is a strong link between the lack of physical activity and health (e.g. heart disease, obesity, and other chronic conditions).

Research has also shown certain population groups have a higher disparity. These groups include:

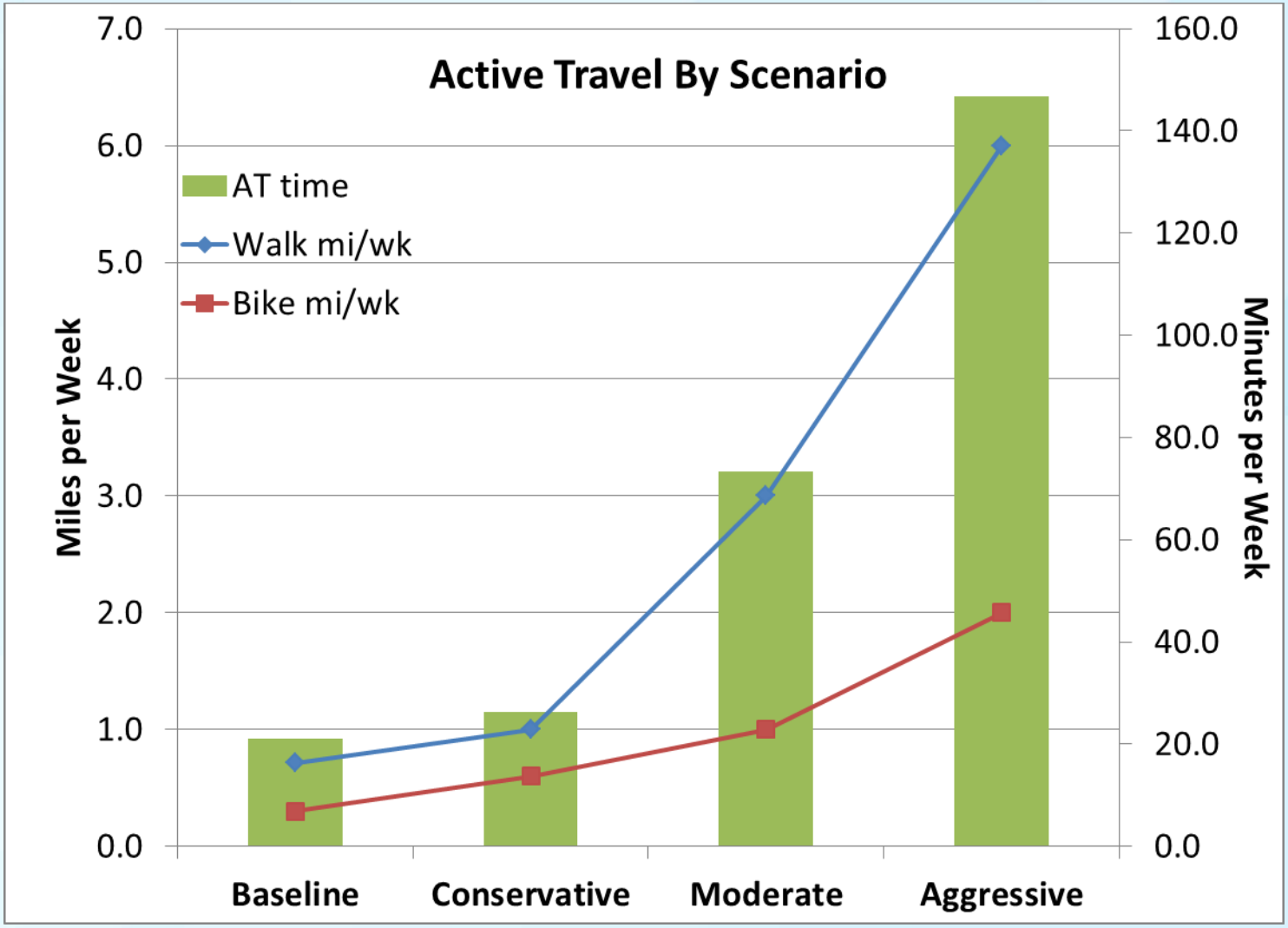
- Low Income
- Minority
- Older Adults (over 65)

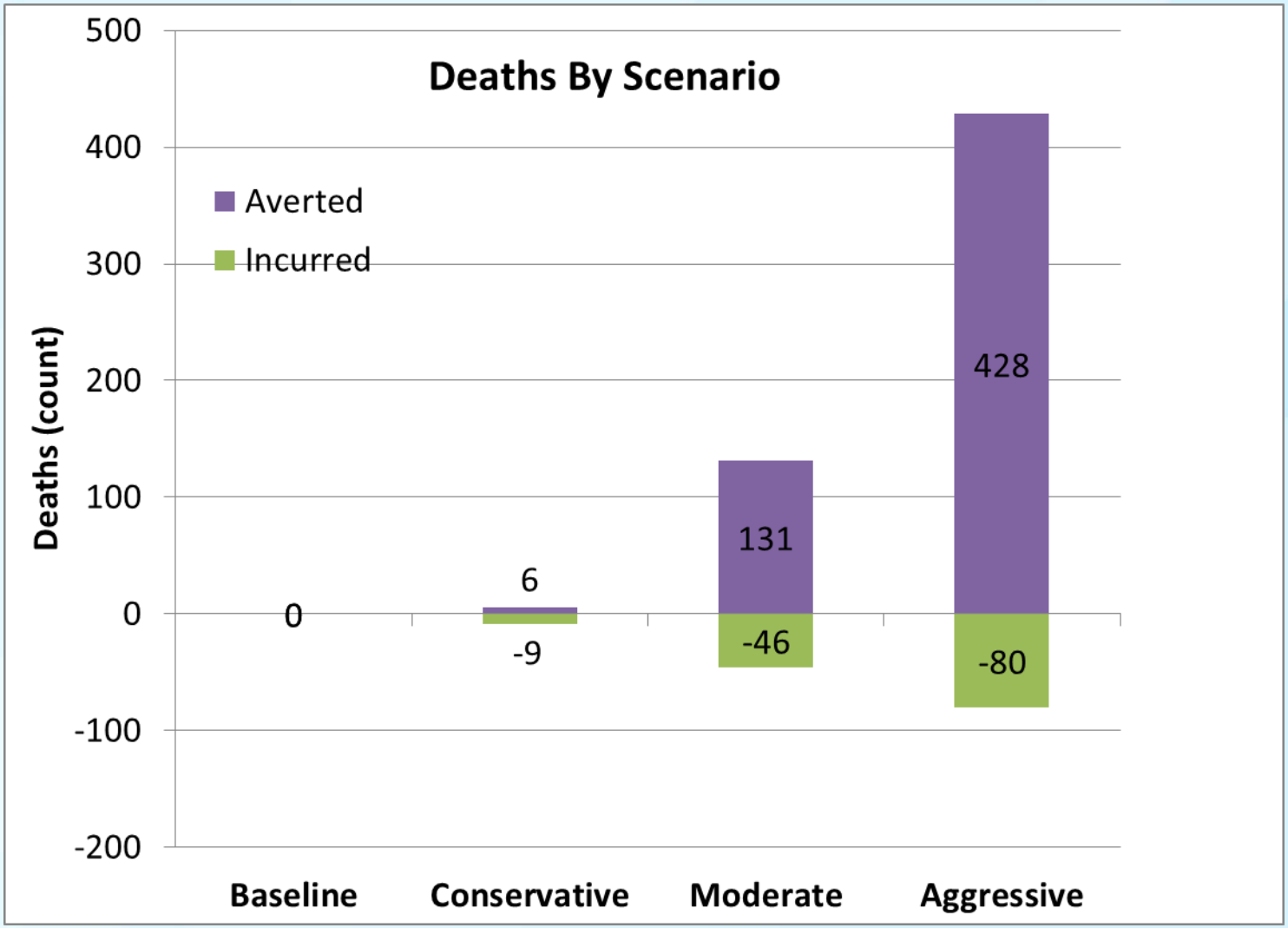


Example – Physical Activity and Ischemic Heart Disease

		% of Pop at PA Level	
PA – min/day	Relative Risk	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:			(0.79-0.40)/0.79 = 0.49
Change in Disease Burden:		0.49 * Current DALYs	

Courtesy of Neil Maizlish, California Department of Public Health


Active Travel By Scenario
AT time
Walk mi/wk
Bike mi/wk
Miles per Week
Minutes per Week
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Baseline
Conservative
Moderate
Aggressive


Deaths By Scenario
Deaths (count)
500
400
300
200
100
0
-100
-200
Averted
Incurred
0
6
-9
131
-46
428
-80
Baseline
Conservative
Moderate
Aggressive

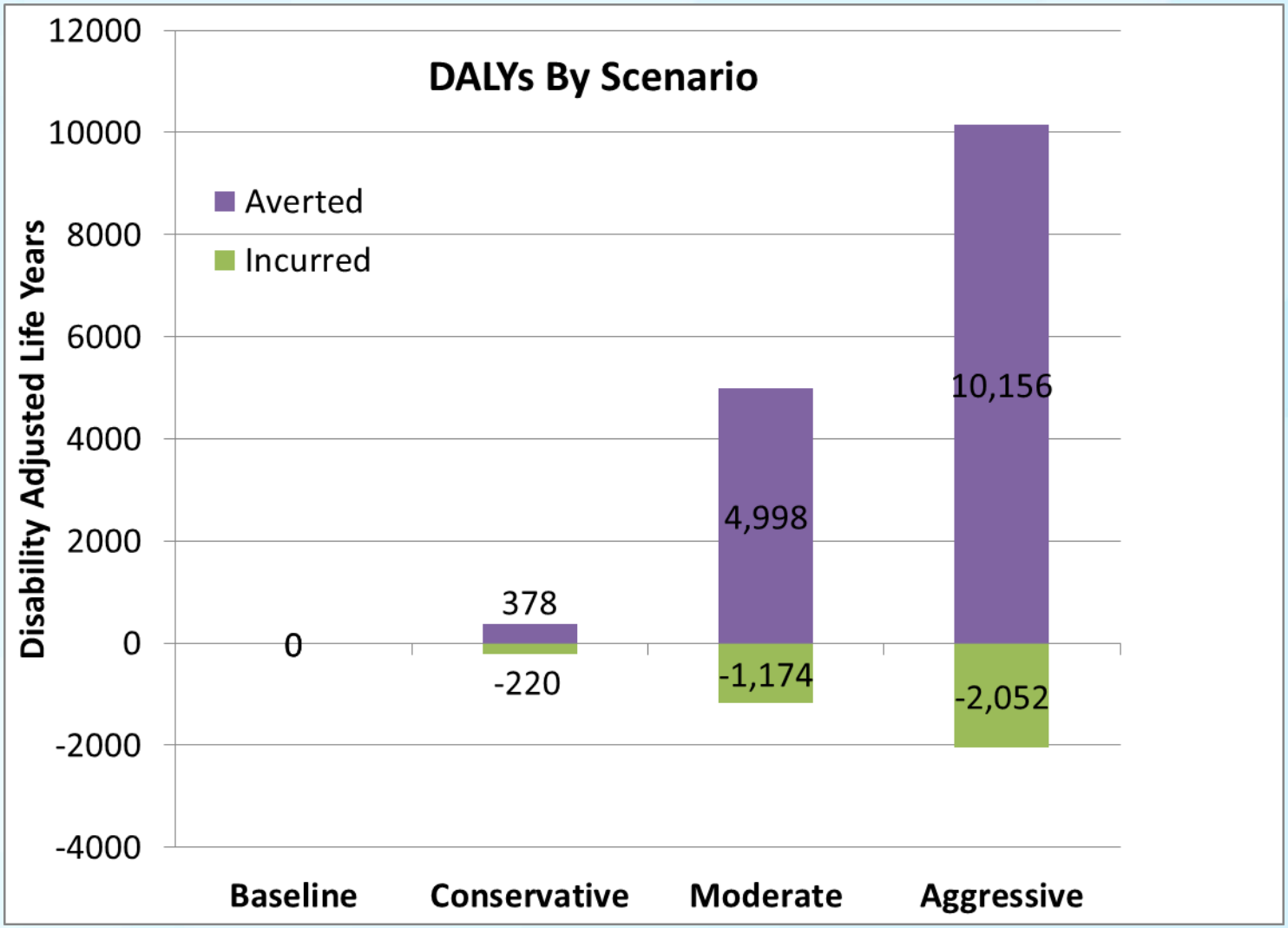
Comparative Risk Assessment

For each disease (and by age and sex), ITHIM uses comparative risk assessment:

$$PAF = \frac{\int_{Xmin}^{Xmax} RR(x)B(x) - \int_{Xmin}^{Xmax} RR(x)S(x)}{\int_{Xmin}^{Xmax} RR(x)B(x)}$$

Extensive data on baseline diseases and exposures is critical!

PAF = Population Attributable Fraction. RR= Relative Risk. B=Baseline. S=Scenario


DALYs By Scenario
Disability Adjusted Life Years
12000
10000
8000
6000
4000
2000
0
-2000
-4000
Averted
Incurred
0
378
-220
4,998
-1,174
10,156
-2,052
Baseline
Conservative
Moderate
Aggressive