BACKGROUNDER

The Hidden Health Costs of Transportation




PREFACE

Our past and current paradigm of transportation investment has created a transportation system that is focused on road building and the private auto. This system has given our country an unprecedented level of individual mobility and facilitated economic growth from coast to coast. As important as these benefits are, they have come at a high price—costs to our environment and the health of our communities. U.S. residents—especially our children—are more obese and overweight than ever before due in part to sedentary lifestyles and the lack of opportunity for everyday physical activity. Traffic crashes cause close to 40,000 deaths a year, and exposure to air pollution from traffic results in high rates of asthma and respiratory illness. These negative outcomes have the largest effect on those who are most vulnerable—the elderly, children, and traditionally underserved and disadvantaged (low income and non-white/ethnic minority) communities—the most, through greater adverse health impacts and through a relative lack of access to economic, recreational, and social opportunities.

The full costs to public health of transportation are only beginning to be understood. Although health impacts—such as not being able to walk safely to school or breathe clean air—may not seem tangible, they can in fact be valued. These costs are as real and in certain instances as measurable as the costs of steel and concrete. It has often been said that "what gets measured gets done." To date, the costs of public health impacts have been "externalized"—that is, they are not accounted for in the current framework of planning, funding and building highways, bridges and public transit. No doubt, different decisions about transportation investments would be made if health-related costs were incorporated into the decision-making process.

A look at our cities and towns confirms that sidewalks, bikeways do not compete well against cars for lane space—and transit funding is a fraction of what is spent on roads. For many years, public transit, bicycle lanes, and trails and sidewalks have suffered from a lack of investment. A more balanced transportation system is needed, or these costs will continue to grow and undermine the country's economic health and quality of life. Fortunately, there are plenty of models illustrating how to engineer physical activity and safety back into everyday lives, and plenty of opportunities to create the political support, funding systems and evaluative methods to do so. This document outlines some of those pathways and opportunities, and the role the public health community can play.

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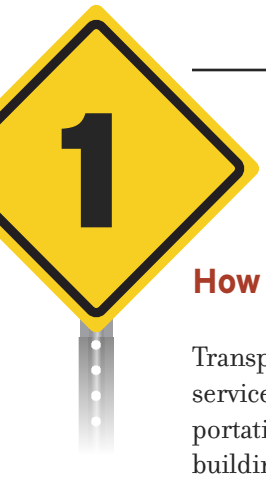


Introduction

How Transportation Investment Impacts Health Costs

Transportation investments shape lives and communities. Highways, sidewalks, bike paths, trains and bus services connect people to friends and family, jobs, shopping, school, and countless other activities. Transportation investments, and the transportation systems that emerge from those investments, also shape the buildings and neighborhoods that they link together. The combination of transportation systems and land use patterns—known as the built environment—influences the relative speed, out-of-pocket cost, convenience, and comfort of different travel options. These factors impact how individuals choose to get around on a daily basis—and whether they do so via active or sedentary, polluting or non-polluting modes of travel.

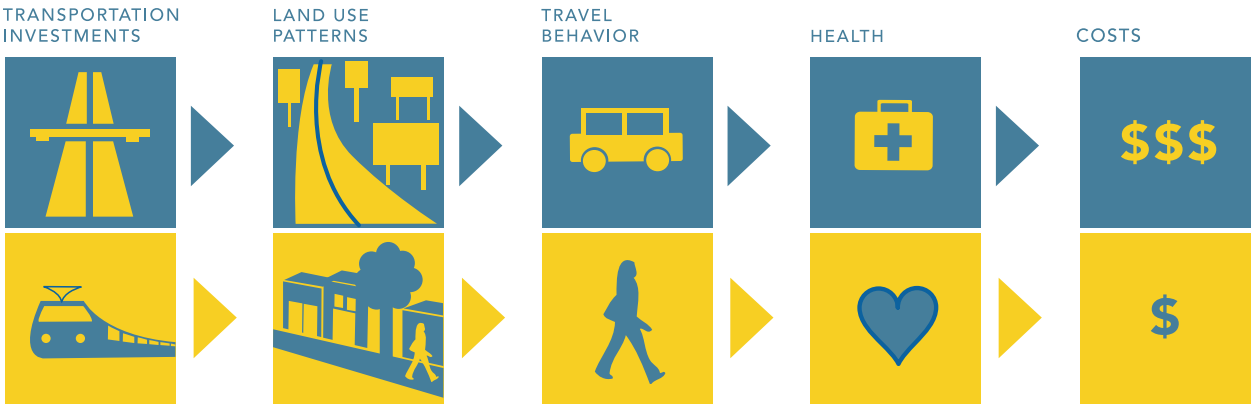
This report outlines how the connection between health and the built environment impacts the pocketbook; it also provides a summary of the process of planning, funding and building transportation systems, and discusses key opportunities for public health professionals to get involved in the process.

The health impacts of transportation investment involve costs and benefits that are often unaccounted for in the current system of transportation planning and funding. These costs and benefits can be personal—for example, the weight loss that occurs when one moves to an area where it is easy and pleasant to walk and bicycle or to take transit to work may mean fewer, and less costly, visits to the doctor. Costs can also be societal—the health impacts of physical inactivity increase the costs of health care for everyone, not just those who aren't getting enough exercise.

HOW TRANSPORTATION IMPACTS HEALTH COSTS. Transportation investments impact health directly, and also indirectly through their impact on land use. Investments in transit, walking and bicycling facilities support transit use, walking and bicycling directly; they also support the formation of compact, walkable, transit-oriented neighborhoods that in turn support more walking, bicycling and transit and less driving. These built environments have repeatedly been associated with more walking, bicycling and transit use,[1-3] more overall physical activity,[4-7] and lower body weights;[8-10] lower rates of traffic injuries and fatalities, particularly for pedestrians;[11-12] lower rates of air pollution[13-14] and greenhouse gas emissions;[15] and better mobility for non-driving populations.[16-18] Slower modes such as walking and biking can be integrated with transit and create healthier travel options. Increased transit use is associated with greater odds of getting required levels of physical activity in turn reducing the chances of chronic disease onset.[19]

On the other hand, an "auto-oriented" paradigm of transportation investment leads to auto-oriented land use patterns, where neighborhoods and buildings are built to accommodate the car. Not only is the design of these places less friendly and efficient for non-auto travel, but the sheer distances that must be overcome to get from place to place means the near exclusion of transit, bicycling and walking. Because the people living in these auto-oriented places then have little choice but to continue to drive, a vicious cycle is created: More money is spent on roads to ease congestion, which fuels more auto-oriented land development, which then generates demand for yet more roads. Auto-oriented neighborhoods are thus associated with more driving,[20-22] less physical activity,[23-26] higher rates of obesity,[27-29] chronic diseases[30] and traffic injuries/fatalities,[31-32] higher rates of air pollution[33-34] and the economic and social marginalization of non-driving populations.[35-37]

TABLE 1 HOW TRANSPORTATION IMPACTS HEALTH AND EQUITY COSTS



PHYSICAL ACTIVITY AND BODY WEIGHT. Auto-oriented built environments necessitate more time spent driving, a sedentary (and often stressful) activity, while taking away time that might otherwise be used for health-promoting activities such as exercise or time with friends and family. Investments in transit, pedestrian and bicycling facilities allow us to build moderate physical activity into our daily lives, by walking, bicycling or taking transit[38] to work, school, shopping or other everyday activities. They also help to shape walkable, transit-oriented communities that essentially allow larger concentrations of people to walk, bicycle and use transit for more of their trips.

AIR POLLUTION. Because vehicle transportation is polluting, built environments that result in more driving will generate more air pollution per capita. Depending on the pollutant and the specific climate / weather patterns in a region, air pollution impacts can be global (in the case of greenhouse gases and climate change), regional (in the case of ozone) or local (as with fine particulate matter). Exposure to air pollution can result in asthma and other respiratory illnesses and trigger cardiac events—particularly among sensitive populations such as youth and the elderly. Because they concentrate people and traffic into smaller areas, communities that are more walkable may have more residents who are exposed to hazardous air pollution.[39] Even though residents in a walkable neighborhood may be polluting less per capita, the total amount of pollutants may be higher than in low-density neighborhoods, especially for localized pollutants such as fine particulate matter. It is important to consider each individual case carefully, especially where vulnerable populations (children, low-income groups, the elderly) are concentrated—in medical centers, schools, play fields and senior centers. Additional measures that physically separate vehicle traffic from people and encourage cleaner-burning cars, buses and trucks (particularly those that run on high-polluting diesel) should be a priority in high-risk areas.

TRAFFIC SAFETY. Traffic crashes killed nearly 35,000 people in 2008, and over 10 percent of those killed were pedestrians[40]—an enormous toll on our society. Crashes also tend to kill or disable people at a fairly young age—for Americans under age 34 traffic crashes are the leading cause of death.[41] The connection between the built environment and traffic safety works in several ways. For example, the more people drive, the more likely they are to be in a crash.[42] Wide roads that are designed to move as much traffic and at the highest speed possible increase both the likelihood and the severity of a crash—especially for cyclists and pedestrians.[43-46] The presence of sidewalks and design of streets, intersections and other crossings can also support or undermine

pedestrian safety. Narrower streets with sidewalks, bicycle lanes and prominent crossings for pedestrians can slow traffic and reduce the number of severe crashes.[47]

HOUSEHOLD EXPENSES AND EQUITY. Homebuyers and renters frequently trade off less expensive housing for a longer commute, and then find themselves trapped into spending more hours behind the wheel and more money on gas and vehicle maintenance. For low-income households, accessing jobs and services from a lower-cost home location may mean trying to get by on the lower quality public transportation in rural or suburban areas or deferring other household expenses in order to continue to get to work by car. Once the expenses of vehicle ownership are accounted for, close-in, walkable and transit-oriented neighborhoods may actually be less costly than suburban locations[48-49] because they allow families to reduce auto ownership or just drive less. The Center for Neighborhood Technology has created a mapping tool that calculates housing and transportation affordability for some of the large US cities, helping to illustrate this phenomenon.[50] Investments in improving transit service to neighborhoods that are already centrally located and walkable can therefore benefit low-income households, especially when these improvements are made in combination with strategies to provide affordable housing.

Walkable Communities: A Triple Win

Because health care costs are a serious policy concern on their own, it becomes even more important to recognize preventive measures as a solution. Working together, urban planners and public health professionals can help people to maintain a higher level of personal health through their everyday surroundings. Walkable, transit-oriented built environments, especially those that are centrally located, can be a win-win-win, producing benefits to the environment, to the efficiency and equity of the transportation system, and to public health. Making a neighborhood more walkable can also create a safer, lively and more interesting place, give a region's residents more housing and lifestyle choices, and reduce the personal costs of transportation and housing. In compactly developed areas, providing essential infrastructure such as water and sewers; garbage and recycling services, fire and police services; schools will be more efficient and less expensive per capita than in large, sprawling areas. One study estimated that if the U.S. grew in a more compact way between 2000 and 2025, the country could save $110 billion in local road costs.[51] The Sacramento Area Council of Governments estimated that a compactly developed Sacramento region would save the region $9.4 billion in infrastructure costs through 2050, compared to continuing with a "business-as-usual" land use pattern.[52]

WALKABLE COMMUNITIES: A TRIPLE WIN

Recent research has documented that many people prefer to live in walkable neighborhoods. Consumer surveys,[53-54] demographic trends,[55] and construction trends[56] indicate a substantial and growing market for homes in walkable places. One study in Atlanta showed that many people are

currently living in less walkable neighborhoods than they would prefer.[57] By simply accommodating the demand that exists for walkable neighborhoods, those people who choose to live in them can be more active. This will benefit health as well as lowering health care costs for all. Making underserved neighborhoods more walkable can also increase access to goods and services at no cost to residents.

Calculating the Costs to Health

The consequences of inactivity, obesity, exposure to air pollution, and traffic crashes in the U.S. are staggering when viewed in terms of cost. Tragically, these costs are also largely preventable. The cost of obesity/overweight has been estimated at $142 billion (2008 dollars) in medical expenses, lost wages due to illness and disability, and the future earnings lost due to premature death.[58] A 2002 study estimated obesity-related healthcare costs to be as much as 9.1 percent of the country's total health care spending.[59] The health costs associated with poor air quality from transportation are estimated to range from $50 to $80 billion per year (2008 dollars), when accounting for healthcare costs and premature death.[60] The cost of traffic crashes reaches about $180 billion annually (2008 dollars), including health care costs, lost productivity and wages, property damage, travel delays due to traffic crashes, administrative and legal costs, and costs due to pain, suffering and lost quality of life.[61]

TABLE 2 THE COST OF TRANSPORTATION-RELATED HEALTH OUTCOMES

The consequences of inactivity, obesity, exposure to air pollution, and traffic crashes in the U.S. are staggering when viewed in terms of cost. Fortunately, with certain policy changes, these costs are largely preventable.

The National Health Costs of…	$$ (Billions)	Estimate Includes	Source
Obesity and overweight	$142	• Healthcare costs • Lost wages due to illness & disability • Future earnings lost by premature death	National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. Statistics Related to Overweight and Obesity: The Economic Costs. Available at: http://win.niddk.nih.gov/statistics/index.htm
Air pollution from traffic	$50-80	• Health care costs • Premature death	Federal Highway Administration. 2000. Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Available at: www.fhwa.dot.gov/policy/hcas/addendum.htm
Traffic crashes	$180	• Healthcare costs • Lost wages • Property damage • Travel delay • Legal/administrative costs • Pain & suffering • Lost quality of life	AAA. Crashes vs. Congestion? What's the Cost to Society? Cambridge, MD: Cambridge Systematics, Inc.; 2008. Available at: www.aaanewsroom.net/assets/files/20083591910.crashesVscongestionfullreport2.28.08.pdf

All cost estimates adjusted to 2008 dollars.

More work is needed to develop "health cost analysis" and to ensure that health is considered in the cost-benefit analysis of transportation planning, policy and decision making. Several models have been developed and are being used, and a large amount of data and research exists that can be used as the basis for the analysis. However, there are no standard methods, models or specific guidelines for these calculations, although federal agencies frequently have standards for impacts (for example, the Clean Air Act standards are health based) and costs that can be applied to a cost analysis. With any assessment, a number of assumptions will need to be made.

Calculating health costs of changes in investment or policy decisions will require different sets of data, models and considerations for each scenario. There are three basic steps to a cost analysis:

1. **DETERMINE THE POPULATION THAT IS EXPOSED OR AFFECTED.** For example, this can be the percentage of obese and overweight individuals in an area; the percentage of people exposed to unsafe levels of air pollution; or the number of deaths or serious injuries due to traffic crashes.

2. **DETERMINE THE HEALTH IMPACT TO THE EXPOSED POPULATION.** To do this requires determining the health impact associated with a certain environmental condition or change in conditions. In this step it will typically be necessary to apply the results obtained by other researchers who have examined the health impact of the change being considered.

3. **DETERMINE THE COSTS ASSOCIATED WITH THAT HEALTH IMPACT.** These costs can include the costs of medical care or hospitalization, absenteeism from work or school, and costs due to pain and suffering, premature death or disability. The costs that are included in the analysis will vary depending on the type of impact being estimated. Intangible costs such as pain and suffering and value of life may or may not be appropriate to include—however, documenting these costs may actually be the more conservative approach. Again, in this step it will be necessary to apply the work of other researchers; government agencies also may publish recommendations on cost standards. Whenever possible, costs should be adjusted so that they reflect local cost of living and inflation.

The following examples are conceptual and show how health costs or benefits can be calculated for changes in pedestrian safety, air pollution and physical activity. These examples are drawn from work of other researchers, detailing the methods and approaches they used to arrive at the estimates.

CASE STUDY :: *Traffic Safety*

The San Francisco Department of Public Health estimated how plans for growth in five San Francisco neighborhoods would impact pedestrian injuries from motor vehicle collisions.[62-63]

Method:

1. **DETERMINING AFFECTED POPULATION:** The population in five San Francisco neighborhoods which were being studied for increased residential development.

2. **DETERMINING HEALTH IMPACTS:** A citywide analysis was used to determine which factors were most highly correlated with pedestrian-vehicle injury collisions.[64] These factors included traffic volume, proportion of arterial streets without public transit service, land area, proportion of households without cars, proportion of residents commuting via walking or public transit, and total number of residents.

Findings were applied to projected increases in population and traffic in each of the neighborhood plans in order to estimate the change in pedestrian injury collisions, resulting in a projected increase of 17 percent, or 32 additional collisions in those five neighborhoods each year. These results were largely due to high existing traffic volumes and high pedestrian crash rates in the five neighborhoods, exacerbated by the planned increases in residential population. To estimate the health impacts of these pedestrian injury crashes, the distribution of pedestrian collisions by severity for the city of San Francisco over a five-year period was applied to the additional projected crashes (see first column in Table 3).[65]

3 **DETERMINING HEALTH COSTS:** California Highway Patrol estimates of traffic injury costs were the basis of the health costs calculation, as shown in the table's second column. The cost factors which included cost of property damage, lost earnings, medical and legal expenses, and costs of pain and lost quality of life, were adjusted for inflation.[66] The estimates are conservative in that they assume only one pedestrian is injured per vehicle collision.

The potential costs of these health impacts are nearly $3.5 million per year—on top of the more than $116 million in existing pedestrian injury costs. This makes additional public investment in pedestrian safety measures, such as traffic calming and reducing local vehicle traffic volumes, seem exceptionally prudent.

TABLE 3 THE COST OF TRAFFIC CRASHES IN FIVE SAN FRANCISCO NEIGHBORHOODS

	Citywide Crash Distribution (5 year average)	CHP value per accident	Estimated existing crashes	Estimated cost of existing crashes	Projected additional crashes with new development	Estimated cost of additional crashes with new development
Fatalities	3%	$ 2,709,000	28.3	$ 76,664,700	0.96	$ 2,600,640
Severe injuries	10%	$ 180,000	94.2	$ 16,956,000	3.2	$ 576,000
Visible injuries	36%	$ 38,000	339.1	$ 12,885,800	11.52	$ 437,760
Pain complaints	51%	$ 20,000	480.4	$ 9,608,000	16.32	$ 326,400
Total	100%	--	942	$ 116,114,500	32	$ 3,422,400

CASE STUDY :: *Air Quality and Exposure to Air Pollution*

Researchers from California State University—Fullerton calculated the health cost savings of meeting federal standards for fine particulates and ozone in California's South Coast and San Joaquin Valley regions.[67]

Method:

1 **DETERMINING AFFECTED POPULATION:** Researchers used a computer model to estimate the population currently exposed to unsafe levels of air pollution in both regions.

2 DETERMINING HEALTH IMPACTS: Research results from the scientific literature on air pollution were used to estimate the health impacts on the affected population. The researchers calculated impacts both for current conditions and for a scenario in which air quality standards were met.

3 DETERMINING HEALTH COSTS: In the cost estimating step, other research findings and federal standards were used to calculate the cost of premature death, medical expenses due to illness and hospitalization, and lost wages and the value of avoided illness (where possible, these rates were adjusted for California income levels and current year [2007] dollars). These rates were applied to each of the health impacts that would be avoided by meeting the standards.

The study did not separate out the impacts of motor vehicle air pollution from other sources of air pollution—however, we know vehicles contribute significantly to air pollution. In the San Joaquin Valley, on-road motor vehicles make up 58 percent of oxides of nitrogen (NOx) emissions, one of the major contributors to ozone, and 11 percent of fine particulates. In the South Coast region, on-road motor vehicles make up 53 percent of NOx emissions and about 15 percent of fine particulates.[68] Both regions have severe air quality problems, and so meeting the air pollution standards will require a significant and coordinated effort. However, the analysis clearly establishes the value of doing so.

TABLE 4 HEALTH SAVINGS FROM MEETING AIR QUALITY STANDARDS

	San Joaquin	South Coast (Los Angeles, Orange, Riverside and San Bernardino counties)
Costs of air pollution (per year)	$1,600 per person	$1,250 per person
Savings if air quality standards are met (per year)	$6 billion regionwide	$22 billion regionwide

CASE STUDY :: *Physical Activity and Body Weight*

Researchers from the University of California-Irvine, University of Wisconsin-Milwaukee and University of Texas-Austin calculated cost savings from reductions in coronary heart disease deaths and overall mortality due to increases in walking inspired by more pedestrian urban design.

Method:

1 DETERMINING AFFECTED POPULATION: Portland, Oregon metro region

2 DETERMINING HEALTH IMPACTS: Using travel diary data for the Portland, Oregon region, researchers first determined which of the following urban design characteristics were significant predictors of physical activity: street connectivity, retail employment density, total employment density, population density and proximity to downtown Portland. The analysis accounted for sociodemographic traits (age, race, gender, income and housing tenure) and potential self-selection bias (i.e., persons who were more predisposed

to walking would choose to live in more walkable neighborhoods), making the results more conservative. The findings of the analysis were applied to two scenarios: a "low change" scenario increasing each urban design value from the regional median to the 75th percentile, and a "high change" scenario that increased each to the 95th percentile. To calculate health benefits, researchers assumed that a change in urban design would impact 5,000 people—a significant but not unusual change roughly the size of a transit station area or a neighborhood. Existing research on the impact of physical activity on mortality rates[69] was used to calculate the number of lives saved per year for each scenario and each design characteristic.

3 **DETERMINING HEALTH COSTS:** To estimate the health cost savings, monetized values of human life from previously published sources were applied. The lower value of human life ($2.47million[70]) was applied to the "low change" scenario, whereas the higher value ($7.98million[71]) was applied to the "high change" scenario. The final values therefore had a wide distribution because they reflected both the differing assumptions for value of life and the differences in lives saved for each scenario.

In addition to demonstrating that there are substantial monetary benefits due to additional physical activity associated with more walkable urban form, the results show the potential value of changing a single urban form characteristic (for instance, a regulation that increases allowable development densities), or making a combination of changes (for example, adding the benefits of increasing street connectivity and retail development together). These results can therefore be useful for policy analysis by incorporating the potential benefit from reduced mortality into existing methods for benefit/cost analysis.

TABLE 5 ESTIMATED COST SAVINGS FROM WALKABLE URBAN DESIGN

Land Use/Urban Design Characteristics	Change in Amount of Walking (Miles, Over a Two-Day Period)		Number of Persons Who Will Move from First to Second Tertile of Physical Activity		Annual Lives Saved		Present Discounted Value (in Dollars)	
	Low (median—75th percentile)	High (median—95th percentile)	Low	High	Low	High	Low	High
Street connectivity (intersection density)	0.3816	1.1844	22.79	78.59	0.0456	0.1572	$2,255,107	$23,205,007
Retail employment density (retail jobs/ 0.0652 square mile	0.0652	0.9734	4.72	62.09	0.0094	0.1242	$466,574	$18,331,955
Total employment density (jobs/1.0648 square mile)	0.0019	1.0648	1.57	66.02	0.0031	0.1320	$155,525	$19,492,206
Population density (persons/square mile)	0.2581	0.549	15.72	28.29	0.0314	0.0566	$1,555,247	$8,353,802
Distance to central business district (miles)	–0.8108	–2.5054	45.58	209.05	0.0912	0.4181	$4,510,215	$61,725,318

CASE STUDY :: *Housing and Transportation Costs*

People who are able to live in close-in, walkable and transit-oriented communities can realize savings from transportation. Researchers recently documented these costs for the Atlanta region. Based on research results from the SMARTRAQ study, an average two-car household in a highly walkable neighborhood was estimated to use 25% less gasoline per year than a similar household in one of the region's least walkable neighborhoods. At a cost of $3 per gallon, this is an estimated savings of $786 per year in gasoline costs alone. If a household is also able to reduce car ownership, its savings increase to $4,600 per year, even when factoring in the additional cost of public transportation.[72] There also may be health benefits from reduced car ownership, as found in one study on youth that was based on the same Atlanta region data set.[73]

The Transportation Investment Process—The Current Paradigm

With all of the health and environmental benefits they offer, why is it so difficult to make large-scale investments in sidewalks, transit, and bicycle facilities? Our current paradigm of transportation planning and investment has been a tremendously successful system for building streets, roads and highways, but works less well for expanding and improving other modes of travel. This paradigm is slowly changing in many urban areas, but current planning and funding practices are still biased toward car mobility and road expansion—making it difficult to implement a larger shift toward investment in transit, pedestrian and bicycling infrastructure.

Current practices frequently emphasize reductions in congestion or travel time, and the movement of vehicles over the movement of people. A "supply-side," capacity-oriented approach has been the norm, and only recently have demand-side or behavioral approaches to transportation investment been considered more seriously. While there are many instances where transit investments are prioritized, our current system tends to favor investments that show near term gains in congestion. Most often, that means more roadway capacity.

Today's system of planning and funding is a holdover from the initial structure set up to implement the U.S. interstate highway system in the Eisenhower era. This system established the current system of state departments of transportation (DOTs) and gave these agencies the funding, and broad discretion, to build what is now the interstate system. The federal government also set up the Highway Aid Trust Fund (known as the HTF or Title I) and the federal gas tax was established as a funding stream for the HTF. Although HTF funding has recently dried up due to declines in driving and increases in fuel efficiency, until recently it provided a consistent, dedicated funding stream for transportation investments. Project funding is blended between federal and local sources. For most major projects, the federal match is 80 percent and the local match is 20 percent. The local share is often derived from the gas tax as well; many state constitutions require that gas tax funds be spent only on roads and bridges. Other transportation modes do not have as much, if any dedicated funding. The Federal Transit Administration, founded in 1964 by President Lyndon Johnson, has no dedicated funding source and is reliant on yearly congressional appropriations, guided by the federal transportation bill. Federal investments in bicycle and pedestrian facilities are similarly reliant on congressional appropriations.

Additionally, under the current paradigm, the analytical methods used to select and prioritize projects for funding are limited in scope and simply do not account for many of the costs of road building. The methods used to select transportation projects typically provide, at best, an incomplete accounting of a project's potential health costs and benefits. A Government Accountability Office survey of state DOTs and transit agencies found

that although assessments of costs and benefits often play some role in the decision-making process, formal cost-benefit analysis is rare, and "not necessarily the most important factor" in project selection.[74] Although the report includes no data on how frequently health costs and benefits are incorporated into cost benefit analysis, its results indicate that more thorough accounting systems are needed to bring health into the decision-making process.

Although the methods used in the transportation planning process vary a great deal from place to place, they typically rely on similar analytical processes to weigh and prioritize potential projects: alternatives analysis, cost-benefit analysis and environmental impact assessment. We discuss each of these processes in more detail below. For public health professionals, participating in these processes can be another important way to make sure public health is properly considered in decisionmaking.

Alternatives Analysis. The core of the transportation planning process is the alternatives analysis. Alternatives analysis, also known as scenario planning, is used to identify the best set of transportation investments within a given corridor or area. An alternatives analysis can be triggered by specific deficiencies or complaints (for example, high rates of pedestrian accidents or growing vehicle congestion), by a long-range planning process, or by a desire to revitalize or further develop an area. Alternatives analysis typically includes public input throughout the process, especially for larger or federally funded projects. Whether it is large or small, an alternatives analysis generally involves the following steps.

1. **DEFINE THE PURPOSE AND NEED FOR THE STUDY** (reduce congestion; improve safety, streamline freight traffic, etc.). The purpose and need statement will frame all subsequent parts of the analysis, so health concerns should be included at this stage to ensure that health concerns are considered as appropriate.

2. **DEFINE THE SCOPE OF THE ALTERNATIVES TO BE MEASURED** (Will the project consider mass-transit alternatives or only roadway alternatives? Will all or some of the alternatives be multimodal?). From a public health perspective, alternatives should be explicitly multi-modal or focused on active modes of transportation.

3. **FURTHER DEFINE THE SPECIFICS OF EACH ALTERNATIVE.** Typically, alternatives are refined in an iterative process with the subsequent step—as impacts are estimated, the alternatives are refined to better support the project's goals.

4. **MEASURE THE IMPACT OF EACH ALTERNATIVE.** Numerous methods are used to weigh the relative impacts (positive and negative) of each alternative, including transportation and land use modeling, cost-benefit analysis, and environmental impact assessment. Transportation planners rely heavily on transportation and land use models to understand how an alternative will impact traffic congestion and travel overall. However, these models can have numerous limitations, particularly in how they react to bicycle and pedestrian improvements.

5. **SELECT AN ALTERNATIVE AS THE "PREFERRED ALTERNATIVE."**

Environmental and Health Impact Analysis. The National Environmental Policy Act (NEPA) requires documentation of the environmental impacts of federal actions or projects receiving federal funding. The resulting Environmental Impact Statement (EIS) is presented to Congress when related funding or legislation is sought,

and the impact statement is made available to the public. Although the findings of an EIS are not legally binding, they can have a major impact on a project's ability to be funded or receive other means of legislative support.

When the requirements of NEPA are read through a lens of public health and welfare, its intent is clear. Promoting "health and welfare" is part of the Act's stated purpose.[75] NEPA's language and requirements consistently extend beyond non-human environmental impacts to social, cultural, and health concerns—direct, indirect and cumulative in scope.[76] Since 1996, NEPA has required EISs to address environmental justice impacts—potentially disproportionate "human health and environmental effects" on low-income or minority populations.[77] However, the explicit consideration of health is often left out of the EIS process.

Since federal funding is frequently used for transportation projects, EISs can be an important opportunity to integrate health into an existing decision-making process. Again, systematic considerations of public health impacts in EISs have been rare,[78-79] and limited in scope.[80] The growing interest in Health Impact Assessment (HIA) in the U.S. has, however, led to some recent successful examples of HIA's used to evaluate transportation projects in the San Francisco Bay Area[81-82] and the Seattle region,[83] among others.[84] An HIA can and should be conducted as a part of the EIS process, or as a stand-alone analysis.

Many states also have environmental review statutes that essentially parallel NEPA for projects that may have an environmental impact but are not subject to NEPA review. Projects governed by these so-called "little" NEPAs can range from infrastructure facility citing to private development proposals. In some states, such as California, health impacts may already be explicitly required as part of state-level environmental review. In others, requirements may be less clear or nonexistent, and health professionals may need to advocate for the inclusion of health as part of an environmental review.

Cost-Benefit Analysis. Cost-benefit (also referred to as benefit-cost) analysis attempts to translate both "hard" and "soft" project costs and benefits into monetary terms, and is frequently used during the analysis of potential project alternatives. The scope of costs and benefits measured in the process varies, but typically a large array of impacts are left out of the analysis, or "externalized." These externalized costs are large and, in the case of health care costs, are growing at a rapid rate. Cost-benefit analysis is by nature a flawed and incomplete analytical method, particularly if one considers the difficulty of assigning a monetary value to intangible benefits such as clean air or safe streets. However, an effort to monetize and quantify any of the following impacts will have great value, even if the effort must remain qualitative or at an order-of-magnitude level.

The scope and process for cost-benefit analysis and project selection will vary widely depending on the project and its location. Typically any cost-benefit analysis for transportation will include the costs of construction, right of way acquisition, operation and maintenance, travel time savings, and any revenues generated such as tolls or fares. The monetary costs and benefits to safety, air pollution and noise are sometimes included. However, far more health-related costs are not evaluated. The decision to leave out any single impact may be made because of budget and time constraints, because those impacts are difficult to measure, or because evidence is new or limited. However, these decisions have the result of inflating the benefits of auto-oriented projects and underestimating the benefits of transit, bicycle and pedestrian projects. It is safe to assume that if even some of the costs listed below were to be internalized into the transportation planning process, the decisions we make would be very different.

- **INDIRECT IMPACTS AND INDUCED TRAFFIC.** The longer term, indirect impacts of transportation investment on land development (for example, a new road that fuels development on the fringes of an urban area) and transportation ("induced traffic") are typically externalized. Short-term indirect impacts

are also typically externalized. Often when a new roadway is built, travelers will change their driving behavior to take advantage of what they might perceive as a benefit, such as a shorter drive to commercial services. However, short-term effects, the positive benefit will be limited because as more people take advantage of the roadway, any benefits realized by the new road will likely be offset by increased congestion, air pollution and other outcomes. For roadway construction and expansion projects, impacts will likely be quantified as negative, since they result in more auto oriented fringe development and more driving. For transit projects, indirect impacts are more likely (but not certain) to generate benefits—reductions in driving and, potentially, infill and/or transit-oriented development around transit stations.

The exclusion of indirect land use and traffic costs also means the exclusion of a number of other costs: the impacts of indirect land development on physical activity and obesity; the cost of the additional infrastructure (local roads, water and sewers, schools, fire, police services) necessary to serve indirect land development; and the impact of induced traffic on health and the environment (incremental air pollution, noise, climate change and water pollution costs).

- **SCOPE OF COSTS ESTIMATED.** The scope of costs that are included in estimates may be limited. For example, the costs of pain and suffering and other intangible costs are frequently left out of cost-benefit analyses due to the desire for a more "conservative" approach. However, an approach that uses the precautionary principle to avoid harmful action[85]—and therefore accounts for all potential costs of an action—may actually be the most conservative and health-protective approach.[86]

- **OBESITY AND PHYSICAL ACTIVITY IMPACTS, COSTS AND BENEFITS.** Because the research on the link between transportation, the built environment and physical activity/obesity is relatively new, there have been limited opportunities to integrate it into current transportation planning processes, and there are no requirements within the planning process to do so. However, there is a large and growing body of available evidence linking transportation and land use patterns to physical activity and obesity, and physical activity and obesity to costs.

- **OTHER HEALTH IMPACTS, COSTS AND BENEFITS.** Other health impacts of transportation investment can include noise, water quality, mental health and/or stress, equity and social capital or social cohesion. Noise and water quality impacts are typically documented in a project's environmental impact assessment, but impacts on health in particular, and the costs/benefits of those impacts are not usually calculated. The link between transportation investment and mental health, stress and social cohesion impacts is less-established, with little research on which to base cost estimates. It may be reasonable to recognize and discuss potential impacts qualitatively while continuing to perform research and develop best practices on which impacts and costs can be based. In terms of equity impacts, analytical and accounting methods should examine the population directly affected by the investment, as well as the potential for differential impacts on different vulnerable subgroups within the larger study area population. Evaluations should consider impacts, costs and benefits with respect to not only low-income and ethnic minority groups, but to young, elderly and disabled people who are typically left out of impact assessments.

- **TRAFFIC CRASHES AND AIR POLLUTION EXPOSURE.** Although the analytical methods and tools exist to measure the impacts and costs of traffic crashes and air pollution exposure, these factors are not always accounted for in cost-benefit analysis. The stronger the evidence of the need and for the benefits/costs of a particular investment, and the more that planners are able to conceive, articulate, and promote investments that address an array of established concerns, the greater the chance that health-promoting projects will be funded.

EXAMPLES & OPPORTUNITIES

INTEGRATING HEALTH INTO TRANSPORTATION INVESTMENT PLANNING & PRACTICE

There are a number of examples where public health has been linked to transportation-related legislation, funding or planning processes. This section discusses those examples, highlighting opportunities to further integrate health impacts into transportation decision making and support a transportation system that is more balanced, sustainable and health promoting.

Federal Level

CLEAN AIR ACT AMENDMENTS OF 1990. Originally passed by Congress in 1970, the Clean Air Act directs the EPA in its efforts to protect the nation's air quality. The 1990 amendments to the Clean Air Act set stringent limits on the major components of urban air pollution: ozone, carbon monoxide and particulate matter (PM10—particulates of 10 microns or smaller). These limits, known as the National Ambient Air Quality Standards (NAAQS) are developed by the EPA and expressly linked to the level needed to protect human health, particularly for "sensitive" populations such as asthmatics, the elderly and children. Urban areas that do not meet the standards for one or more of these pollutants are required to take steps to reduce pollutant levels and eventually comply with the standards. Those that fail to take those steps are subject to sanctions.

The Clean Air Act forced regions to reconsider their transportation decisions, and in some cases to take a serious look at the interaction between transportation and land use. If an area is in "non-attainment" status, transportation plans and programs must not increase the severity of pollution in the area (by creating violations for additional pollutants, increasing the frequency of non-attainment instances, or increasing the time needed to comply with the standards). The Atlanta region had its federal transportation funding frozen in the late 1990s because it failed to produce a Transportation Improvement Plan (TIP) that would result in compliance with the Clean Air Act.

By tying transportation funding to health-based standards, the Clean Air Act sets a potentially intriguing precedent for public health professionals. Where the evidence is sufficient, future legislation could include additional outcomes, such as physical activity or climate change. For example, in regions whose average resident gets below the recommended daily amount of physical activity, federal transportation funding could be made contingent on plans and investments estimated to increase that amount.

THE FEDERAL TRANSPORTATION BILL. The federal transportation bill is reauthorized approximately every five to seven years, and is one of the largest pots of discretionary funding the federal government debates. The next bill, which will be negotiated over the next year or two, is estimated to designate close to $500 billion for our transportation systems.

Historically, the share of funding for transit, bicycling and pedestrian improvements in transportation has been small compared to the funding for roadway maintenance and expansion. Although the last several iterations of the federal transportation bill (ISTEA, TEA-21 and SAFETEA-LU) have devoted vastly larger shares of federal dollars to mass transit, pedestrian and bicycle investments than previous bills, dollars for these modes remain a fraction of what is spent on highways. The current transportation bill, SAFETEA-LU designates about one-fifth of its $244 billion budget to transit and safety programs.

FEDERAL TRANSPORTATION GRANT PROGRAMS. In addition to the discussions of major transportation reform, a number of successful programs exist under current federal transportation legislation that directly benefit public health and safety goals - including the Highway Safety Improvement Program ($5.1 billion), the Congestion Mitigation and Air Quality Improvement Program (CMAQ; $8.6 billion), the Transportation Enhancements Program, and the Safe Routes to Schools program ($612 million).[87] Funding in these programs adds up to only a small percentage of the total federal transportation spending, and all of these programs would benefit from additional funding. For example, the most recent federal transportation bill designated $612 million for the Safe Routes to Schools program. Once that total amount is divided by the five year time frame of the legislation and by all 50 states, it is enough only to fill small gaps in the network—not to fund the larger scale retrofits that are needed in many areas.

Federal Level Policy Recommendations

- Refocus the planning and funding prioritization process toward transit, bicycle and pedestrian investments, safety improvements, and maintenance/repair of existing roadways.
- Require multimodal planning and programming for any new project receiving federal funding.
- Incentivize HIAs for any project receiving federal transportation funding.
- Require all federally funded projects to accommodate all modes, users and physical abilities (Complete Streets).
- Require integrated regional transportation / land use planning (US DOT / HUD). The recently created Sustainable Communities partnership between DOT, HUD and EPA is a crucial step towards encouraging more holistic, data-driven regional planning. To more fully ensure that health is considered, HHS should be a partner in this effort.
- Adopt physical activity and safety objectives for transportation projects receiving federal funding similar to what exists in the Clean Air Act (the NAAQS).

State, Regional and Local Levels

TRANSPORTATION PLANNING AND PROGRAMMING CRITERIA. Federal transportation flows out across the U.S. through state departments of transportation and metropolitan planning organizations (MPOs, made up of local government representatives, direct transportation planning for regions of 50,000 people or more). Long-range plans based on a 20-year time frame set the broad "menu" of potential transportation projects in a state, metropolitan region or local government. These plans are implemented through the state or regional TIP (Transportation Improvement Program), a short-range (3-5 year), frequently updated "short list" of high-priority projects. The TIP generally signifies the intent to fund and build a project. Projects are nominated by state and local jurisdictions for inclusion in the TIP, and must be consistent with the state or regional longrange plan to be eligible. Once funding is obligated for a project, it rolls off the TIP.

Like state and regional agencies, local governments typically compile their own long range plans and shorter range CIPs, or capitalimprovement programs. Local governments can compete for federal grant funding or use locally generated revenues for transportation improvements. Local funding is particularly important for small-scale improvements such as bike lanes, sidewalks, and local streets, since these projects are less likely to receive federal funding.

State, regional and local governments and federal grant programs all have their own sets of criteria that determine which projects will be put into the TIP/CIP or selected for funding. The process and criteria that determines how these agencies prioritize their transportation funding can therefore be quite important to review from a public health perspective, and the public health community should be involved in the process of determining TIP criteria. TIP and CIP criteria are revised periodically, often at the beginning of the yearly TIP process.

STREET DESIGN, COMPLETE STREETS POLICIES AND CONTEXT-SENSITIVE DESIGN. Standards for street widths, turning radii, on-street parking, and other roadway design elements may be determined by local transportation planners but are frequently adopted wholesale from national guidelines, resulting in solutions that may not be appropriate for the particular context. Context-sensitive design, therefore, is the opposite—street design that carefully considers the context of the surrounding built environment in order to implement a solution rather than imposing one-size-fits-all standards. "Complete Streets" policies explicitly require road projects to accommodate access by all modes of transportation, ages and abilities. State and local governments from every part of the country have recently adopted Complete Streets policies, among them Florida, South Carolina, Hawaii, and California and such cities as Jackson, Mississippi and Chicago, Illinois.

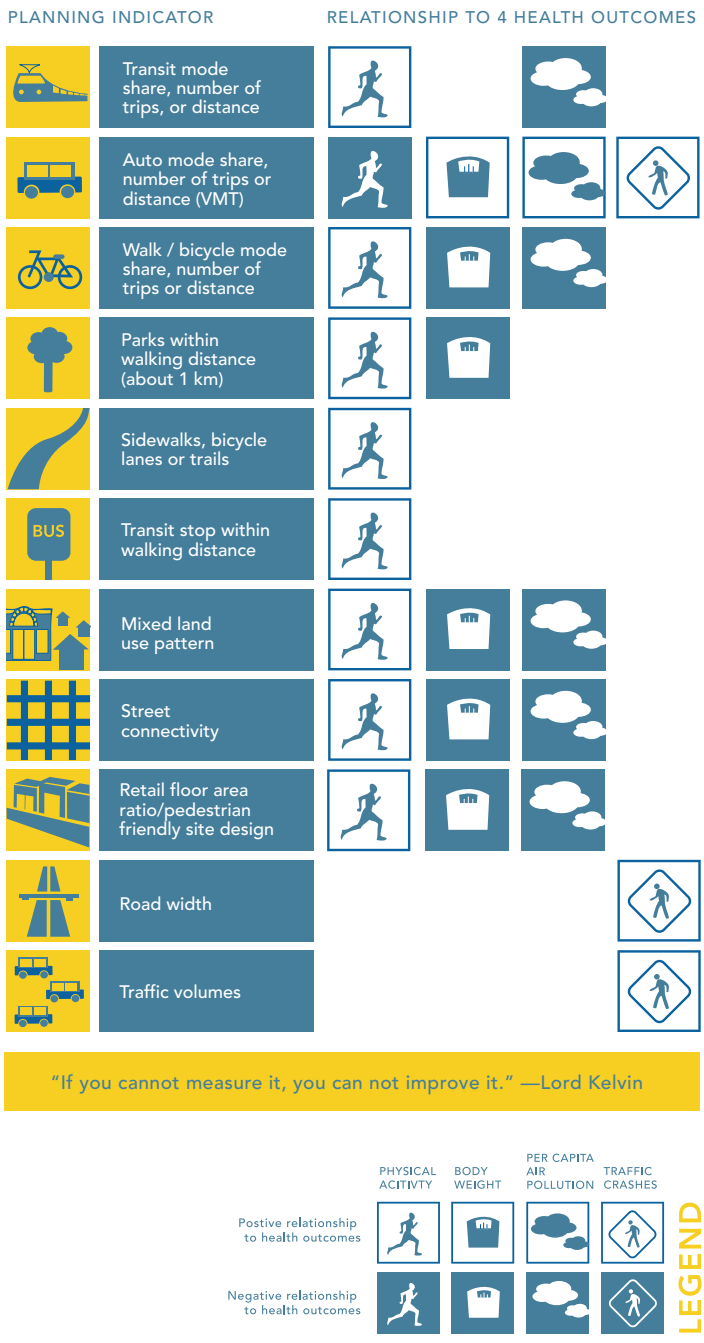
DEVELOPMENT PROPOSAL REVIEW. Cities use zoning and development regulations to control site design, density, mass or bulk of buildings, land uses permitted within a given area, parking requirements, and any other requirements for building design, amenities or affordable housing. Through development fees and taxes, cities also have the power to encourage or discourage development with certain features or in certain places. Cities also control the review process as well, meaning they can also choose to expedite reviews or provide incentives in exchange for other features—for instance, allowing a developer to build at a higher density in exchange for building affordable housing. Health professionals should be included in the review process for certain proposals, particularly large-scale development or development of key parcels. In some cases, it may be appropriate to work with planners to conduct an HIA of a proposal.

USE OF EXISTING TOOLS FOR EVALUATIVE PURPOSES. Standard tools in the planning field can be used to test exposure to air pollution, measure changes in land development and transportation, and understand the population potentially impacted by an action. These instruments include land use and transportation models, and tools that measure air pollution generation, dispersion and exposure.

In addition, a couple of tools have been developed recently specifically to measure impacts on health. The Healthy Development Measurement Tool (www.thehdmt.org) was produced by the city of San Francisco's Department of Public Health allows the user to evaluate how a project performs along an extensive set of indicators. The I-PLACE3S scenario planning tool was recently enhanced as part of the King County Healthscape project so that it can assess the impacts of land development and transit changes on air pollution and greenhouse gas emissions, physical activity and obesity, and transportation (see www.http://www.kingcounty.gov/transportation/HealthScape.aspx, or http://places.energy.ca.gov/places).

MEASUREMENT OF PROGRESS. Good measurement is a key to tracking success. In the absence of detailed health information, existing planning indicators of the built environment and transportation can be used. Because the indicators have been linked to health outcomes (shown in Table 6), they can be effective proxy measures for such outcomes.

TABLE 6 THE COST OF TRAFFIC CRASHES IN FIVE SAN FRANCISCO NEIGHBORHOODS



State, Regional & Local Level Policy Recommendations

- Enact Complete Streets legislation.
- Require the inclusion of health care costs from physical inactivity, obesity, air pollution and traffic crashes in cost-benefit analysis.
- Adopt transportation programming criteria that specifically address health, safety, equity and environmental issues.
- Include health as an explicit requirement in state level environmental impact assessment.
- Connect existing planning indicators to health outcomes as a way to gauge progress.
- Include public health professionals in the process of developing and revising TIP/CIP criteria.

SUMMARY AND CONCLUSION

The current process by which transportation funding decisions are made generally does little to consider the long-term costs and benefits to health. Advocating health-supportive planning, design and funding can help to create healthier built environments for generations to come. Success will mean designing approaches and practices that result in health-supportive decisions, and creating systems that measure, track and account for health outcomes.

Opportunities exist at every level of government to encourage transportation investments that benefit health. Negotiations over the federal highway transportation bill will shape transportation spending from top to bottom, and every indication is that the bill is a key opportunity not just to get more funding for health and safety programs, but to rethink the transportation funding process.

At the state and local levels, health-based funding criteria should include an evaluation of the health impacts of individual projects. Impacts can be analyzed as part of the environmental review process or as a stand-alone HIA. Costs of these impacts should be included in cost-benefit analysis. In many cases, existing legislation or operating procedures can be strengthened to make requirements clear and ensure that health considerations are a part of everyday business. Participation in long-range planning processes and the review of large-scale development proposals will help produce more health-supportive outcome and will also serve to educate others about the importance of health in the planning process.

> *"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof."*
>
> –Wingspread Conference on the Precautionary Principle, 1998.

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About APHA

The American Public Health Association is the oldest and most diverse organization of public health professionals in the world and has been working to improve public health since 1872. The Association aims to protect all Americans and their communities from preventable, serious health threats and strives to assure community-based health promotion and disease prevention activities and preventive health services are universally accessible in the United States. APHA is committed to health equity and a healthy global society. The Association's broad array of public health professionals are champions of and advocate for healthy people and communities.

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