Measuring the impacts of transport systems on health

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This presentation covers

1. Transport as a driver of health
2. Healthy transport indicators – capturing key nodes of interaction
3. Using health transport indicators to drive policy change
4. Indicators in the evaluation of BRT systems
5. Towards global, harmonized 'healthy transport' indicators
A quarter of the BOD due to Environmental Risk Factors

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Related diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor air pollution</td>
<td>Respiratory infections, selected cardiopulmonary diseases, lung cancer</td>
</tr>
<tr>
<td>Indoor air pollution from solid fuel use</td>
<td>COPD(^a), lower respiratory infections, lung cancer</td>
</tr>
<tr>
<td>Lead</td>
<td>Mild mental retardation, cardiovascular diseases</td>
</tr>
<tr>
<td>Water, sanitation and hygiene</td>
<td>Diarrhoeal diseases, trachoma, schistosomiasis, ascariasis, trichuriasis, hookworm disease</td>
</tr>
<tr>
<td>Climate change</td>
<td>Diarrhoeal diseases, malaria, selected unintentional injuries, protein-energy malnutrition</td>
</tr>
<tr>
<td>Selected occupational factors:</td>
<td>Unintentional injuries</td>
</tr>
<tr>
<td>injuries</td>
<td>Hearing loss</td>
</tr>
<tr>
<td>noise</td>
<td>Cancers</td>
</tr>
<tr>
<td>carcinogens</td>
<td>Asthma, COPD</td>
</tr>
<tr>
<td>airborne particulates</td>
<td>Low back pain</td>
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<tr>
<td>ergonomic stressors</td>
<td></td>
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</tbody>
</table>

Need to focus on other sectors to prevent main causes of ill health - Chronic diseases

- Cardiovascular disease, mainly heart disease, stroke
- Cancer
- Chronic respiratory diseases
- Diabetes
Health risks of transport (per annum)

- Outdoor urban air pollution → 1.2 million deaths
- Physical inactivity → 3.2 million deaths; 19 million healthy life years lost
- Traffic injuries → 1.3 million deaths
- Traffic noise → stress, memory loss and analytical impairment
- Climate change → over 150 000 deaths
- Access to vital goods and services, social networks/equity/cohesion → profound and under-reported.
Transport can be a 'facilitator' or a 'burden' on health

- Transport systems offer vital access to health-essential goods, services, education and employment – and to physical activity and social networks.
- Poorly designed transport systems create a health burden directly (injury risks) and indirectly (equity, access, social cohesion, etc.).
- Conventional transport indicators fail to capture the full range of positive & negative health impacts.
Large global investments being made in new transport systems

...but with little measurement of their real health impact on most of the world's population
For instance, investments in transit, cycling and pedestrian infrastructures are not well tracked.

**World Bank lending by mode**

**Average Annual Lending (2002-2004)**

- Roads & highways: 66%
- General Transportation (including urban transport): 17%
- Railways: 9%
- Aviation: 5%
- Ports and waterways: 3%
A 'vicious cycle' of health impacts

More vehicles = more road space/construction for vehicles = greater air pollution, noise and physical activity risks

*Hanoi, 1993*

*Hanoi, 2001*

*Hanoi, 2002*
The vicious cycle: Part II

Increased traffic injury risks

Parents drive their children to school by car

Traffic increases

Streets are even more dangerous

More children are physically inactive and obese
We know about the risk factors: 30 minutes a day of physical activity:

- Reduce risk of coronary heart disease – by 50%.
- Reduce risk of non-insulin-dependent diabetes and obesity – by 50%.
- Reduce hypertension risk – by 30%.
- Reduce colon and breast cancer (50% reduction in colon cancer in Shanghai study).
- Help maintain bone mass and protect against osteoporosis.
- Improve balance, coordination, mobility, strength and endurance.
- Increase self-esteem, reducing levels of mild to moderate hypertension and promote overall psychological well-being.
Busy road environment puts pedestrians and cyclists at risk

<table>
<thead>
<tr>
<th></th>
<th>Holland</th>
<th>Germany</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking share of urban trips</td>
<td>18%</td>
<td>22%</td>
<td>6%</td>
</tr>
<tr>
<td>Biking share of urban trips</td>
<td>28%</td>
<td>12%</td>
<td>1%</td>
</tr>
<tr>
<td>Pedestrian fatality rate</td>
<td>2.5</td>
<td>4.4</td>
<td>14.0</td>
</tr>
<tr>
<td>(deaths/100M km)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Bicyclist fatality rate</td>
<td>2.0</td>
<td>3.2</td>
<td>7.2</td>
</tr>
<tr>
<td>(deaths/100M km)</td>
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</tbody>
</table>

Evidence: physical activity and health linked to urban modal split

<table>
<thead>
<tr>
<th>Factor</th>
<th>Studies finding improved outcomes</th>
<th>Studies finding worse outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use of different travel modes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More active transport (walking, cycling)</td>
<td>Increased physical activity\textsuperscript{38,185–197}</td>
<td>Increased stress and psychological distress\textsuperscript{198}</td>
</tr>
<tr>
<td></td>
<td>Reduced BMI or obesity\textsuperscript{35,109,118,148,188,199–205}</td>
<td>Increased road traffic injury\textsuperscript{23}</td>
</tr>
<tr>
<td></td>
<td>Reduced air pollution-related effects\textsuperscript{23}</td>
<td></td>
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<tr>
<td></td>
<td>Improved quality of life or reported health status\textsuperscript{167,183,206}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reductions in specific health problems\textsuperscript{188,206}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower mortality / higher life expectancy\textsuperscript{36,37,207}</td>
<td></td>
</tr>
<tr>
<td>More use of public transport</td>
<td>Increased walking, cycling or active transport\textsuperscript{208}</td>
<td>Increased air pollution-related effects\textsuperscript{185}</td>
</tr>
<tr>
<td></td>
<td>Increased physical activity\textsuperscript{185,209,210}</td>
<td>Increased risk of tuberculosis\textsuperscript{211}</td>
</tr>
<tr>
<td></td>
<td>Reduced BMI or obesity\textsuperscript{148,203,212}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduced air pollution-related effects\textsuperscript{70,213}</td>
<td></td>
</tr>
<tr>
<td>Lower car use, car ownership and traffic volumes</td>
<td>Increased walking, cycling or active transport\textsuperscript{94,129,132,154,141–143,149,150,152,178,179,214–217}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased physical activity\textsuperscript{160,181,191,218}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduced BMI or obesity\textsuperscript{73,109,148,164,218–221}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved reported health status\textsuperscript{166}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reductions in specific health problems\textsuperscript{222}</td>
<td></td>
</tr>
</tbody>
</table>
...and to mode of infrastructure investment

<table>
<thead>
<tr>
<th>Infrastructure for different travel modes (including presence and proximity of infrastructure)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>More infrastructure facilitating walking</strong> (including general assessments of “walkability” of neighbourhoods as well as presence of specific features, e.g. pavements)</td>
</tr>
<tr>
<td>Increased walking, cycling or active transport&lt;br&gt;Increased physical activity&lt;br&gt;Reduced BMI or obesity&lt;br&gt;Reduced air pollution-related effects&lt;br&gt;Improved reported health status&lt;br&gt;Reduced obesity or overweight&lt;br&gt;Improved reported health status&lt;br&gt;Lower mortality / higher life expectancy</td>
</tr>
<tr>
<td>Less active transport</td>
</tr>
<tr>
<td><strong>More infrastructure facilitating cycling</strong></td>
</tr>
<tr>
<td>Increased walking, cycling or active transport&lt;br&gt;Increased physical activity</td>
</tr>
<tr>
<td><strong>More infrastructure facilitating public transport use</strong></td>
</tr>
<tr>
<td>Increased walking, cycling or active transport&lt;br&gt;Increased physical activity&lt;br&gt;Reduced BMI or obesity&lt;br&gt;Reduced air pollution-related effects</td>
</tr>
<tr>
<td>Less walking, cycling or active transport</td>
</tr>
<tr>
<td><strong>Less infrastructure facilitating car travel</strong> (including parking, motorways)</td>
</tr>
<tr>
<td>Increased walking, cycling or active transport&lt;br&gt;Reduced BMI or obesity</td>
</tr>
</tbody>
</table>

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Review of studies on infrastructure investment, physical activity and health – WHO/Health in Green Economy (forthcoming)
What happens to health overall following Traffic policies change?
Surprisingly little is being documented

- Pedal cycle movements have increased by about 20%
- Bus and coach movements have increased by over 20%
- Van and lorry movements have reduced by about 10%
- Powered two-wheeler movements have increased by 10-15%
- 8% reduction in personal injury accidents in the charging zone during charging hours compared to the same period last year.
- 6% fewer pedestrians were involved in accidents,
  (Based on the first 6 months of provisional data since charging began)

Bogota: urban space to public transport and pedestrians – some evidence of reduction in traffic injuries and air pollution before... after
2. Need for healthy transport indicators to inform policy change

- Evaluation of baseline across diverse settings.
- Assess costs of business as usual
- Estimate health impacts of policies projects before major new investments are made.
- Prioritize investments in transport (maintenance and infrastructure).
- Evaluate efficiency of implemented interventions.
- Evaluate progress.
Healthy transport indicators can…

Provide policymakers with arguments for a more "virtuous" policy cycle leading to:

- Less cardiovascular and respiratory diseases from air pollution
- More opportunities for physical activity
- Safer movement by pedestrians/cyclists
- Greater access for the majority of people – who do not own or regularly use a motor vehicle, including: (most women, children, elderly & middle income as well as poor).
Healthy transport indicators – capturing key “nodes” of interaction
Pathways of health impact

Transport interventions
- Economic
- Regulatory
- Infrastructure
- Information
  - Technology
  - Land use/planning
  - Equity

Travel behaviour in system

Geo-spatial features of transport system

Environmental pollution – air, noise, water

Traffic injuries

Access

Physical activity

Health
Current transport indicators measure how well transport systems move vehicles.
Transport indicators that might better link to health are missing from the puzzle.
Healthy transport indicators should track four measurable domains of impacts

- Access/equity of access
- Physical activity
- Pollution (air, noise and water)
- Traffic injury

Measure **access/physical activity** - key health *benefits* of transport.

Measure **pollution and injury** - key health *risks* of transport systems.

Substantial epidemiological evidence exists about health outcomes in all four domains.
## Access (Domain 1: examples)

<table>
<thead>
<tr>
<th>ACCESS/Equity</th>
<th>Target POPULATION</th>
<th>HEALTH HAZARD/ RESOURCE</th>
<th>INDICATOR (examples)</th>
<th>DATA/ METHOD</th>
</tr>
</thead>
</table>
| Neighborhood cohesion | Neighborhood or other sub-area; Vulnerable groups, e.g. children, elderly, women, disabled | Land use/transport barriers to access | • Neighborhood integrity index; arterial streets/dividing highways  
• % health-essential goods and services in walking distance.  
• Pedestrian environment quality index (PEQ) – level of service metric reflecting hazards per/km sidewalk.  
• No. of weekly social interactions in neighborhood | • Mapping of health-essential goods and services within walking distance.  
• Mapping major street/highway barriers  
• Mapping hazards, e.g. lack of sidewalks/obstacles/unsafe crossings  
• Social mapping of acquaintances/friends |
| Neighborhood connectivity | Community or sub area; vulnerable groups, e.g. children, elderly, women, disabled | Lack of access to essential services public transport networks | • % transit modal share  
• Daily travel time/distance  
• New BRT/cycle lanes vs. new road lanes  
• Kilometres of bike lanes/kilometres of roads | • Household survey/model of travel behaviors  
• Travel surveys/model for specified destinations via transportation model |
| Access to jobs; schools; parks/recreation/green spaces | Simulated or sample individual-level | Absence or fragmentation of parks/recreational areas. | • Volume/frequency of transit service  
• % group within 10 minute walk to park.  
• % group within 30 minute walk to work/school  
• m²/acres of green space per m² of built pace. | • Surveys using land use maps  
• Mental mapping/use surveys |
## Physical activity (Domain 2: examples)

<table>
<thead>
<tr>
<th>PHYSICAL ACTIVITY</th>
<th>Target POPULATION</th>
<th>HAZARD /Resource</th>
<th>INDICATOR (examples)</th>
<th>DATA AND METHODS</th>
</tr>
</thead>
</table>
| Active transport (use of cycling and walking as a travel mode) | Pedestrians and cyclists | - Lack or absence of networks for active travel  
- Lack of connectivity between active travel networks and public transport to key urban destinations |  • Ratio of pedestrian/cycle network: road vehicle network  
• % of trips by public transport (which can be a proxy for active travel)  
• % of population that walks and cycles sufficient for fitness and health (15 minutes or more daily).  
• Life expectancy gain/loss attributed to routine physical activity/active transportation | % pedestrian/cycle network/road vehicle network from regional travel model:  
Modal split surveys to include data on pedestrians/cycle travel  
Calculation of Disability-Adjusted Life Years from data meta-analysis |
| Recreational cycling/walking  
For play, exercise social activity/social interaction | Children; adult subgroup | - Lack or absence of network  
- Safety, social, environmental pollution barriers to recreational mode use | Pedestrian Environmental Quality Index (PEQ - Level of Service Metric);  
Bicycle environmental quality index (BEQ)  
Same as above  
Children’s travel mode to school  
% of children's playtime spent walking/cycling/moving outdoors  
% children obese  
% engaging in daily physical activity | Standardized observational surveys of physical features/barriers to system use;  
Bicycle/pedestrian counts  
Travel diaries  
Standardized physical activity/obesity surveys |
Health indicators for urban transport should be...

- Already available or measurable with sparse resources
- Specific to transport policies
- Robust and relevant to different scales/contexts
- Meaningful and motivating
- Actionable – can be modified by changed transport policies.
Getting the right data for building healthy transport indicators

Requires coordinated action by all partners:

- MINISTRY OF TRANSPORT - modal split indicators - *transit, walking, cycling*.
- DEVELOPMENT BANKS - investment indicators - *transit, walking/cycling infrastructure*.
- CITY – indicators of *traffic injuries* involving pedestrians/cyclists.
- AIR POLLUTION - key air quality indicators, e.g. PM$_{10}$.
- HEALTH SYSTEMS - incidence/costs of treatment for injury and pollution-related conditions.
- NGOs/RESEARCHERS – Simple field surveys of spatial and human factors (e.g. bicycle count, pedestrian environment quality; social interactions), using standardized observational/reporting methods easily repeated over time, and in diverse locales.
Researchers: keep in mind that simple surveys can yield rich data

People on heavily-trafficked streets reported fewer neighbourhood friendships - Appleyard, 1981
‘Healthy transport’ indicators can inform:

a. Monitoring, reporting, verification (MRV) systems; e.g. for development financing, carbon credits, etc.

b. Health and environment impact assessment; e.g. mortality/morbidity impacts of a transport change.

c. Modeling/mapping health impacts, real-time or simulation, in data-scarce settings.

d. Economic assessment – e.g. comparison of transport indicators with data on insurance costs/ health expenditures for injuries/air pollution/obesity related diseases.
a. Monitoring, reporting and verification

- MRV may become increasingly important for transport systems to financing with carbon credits, etc.
- Transport systems currently find it difficult to demonstrate their added value in CDM context.
- Climate Investment Funds consider co-benefits
- Integrating health indicators onto transport would provide a point of “added value”.

[Image of a transport system]
b. Health and environment impact assessment of specific projects

Key transport indicators can be integrated with/assessed against health indicators to assess impact of a transport project on population:

- Burden of disease (deaths, DALYs) from injuries, air pollution, physical activity
- Modal split!!!
- Investments in sustainable transport (cycling/walking, PT)
- Health expenditures for treatment of injuries and pollution-related conditions
- Insurance-related expenditures on accidents/injuries)
c. Modeling/mapping

- Modeling can offer more detailed pictures at different scales.
- Integrated risk modeling can integrate different data sets to project the results of alternative policy scenarios.
- Integrated transport, spatial/exposure and epidemiological modelling can yield data on aggregate health impacts from changes in: air pollution exposures, traffic accidents and physical inactivity.
- WHO's HEARTS (Health Effects and Risks of Transport Systems) is an example of a GIS-based model of transport impacts on: injuries, air pollution, and noise. (www.euro.who.int/__data/assets/pdf_file/0013/91102/E88772.pdf)
HEARTS: Florence case study

noise

Night level differences in receptors (coloured dots) between 2010 and 2003 scenarios

A comparison of noise levels in 2010 vs 2003 scenario shows a marked reduction of Lnight levels
Simulating time-activity patterns: exposure to benzene in a polluted Italian urban area
d. Economic assessment

- Systematic collection of relatively few, robust indicators can support health-economic assessment tools, such as WHO's Health Impacts of Active Transport (HEAT).*

- HEAT allows 'health' to speak in the language of financial stakeholders.

- Economic valuation of impacts strengthen the health argument.

- It can allow health actors to weigh in on debates such as:
  - The health economic benefits of investments in cycling, pedestrian infrastructure
  - Congestion pricing; pay-as-you-drive; parking cash-out schemes, etc.

Example: a systematic evaluation of BRT

- BRT's impact on health likely extends well beyond the commuter corridor.
- Measuring the long-term or broader impacts of BRT on health, other simple indicators to consider would be:
  - Shift in modal split over time to more/less PT/walking/cycling in and beyond the BRT corridor.
  - Change in average PM10 levels in the neighbourhoods near the corridor, and city-wide.
5. Towards global, harmonized 'healthy transport' indicators
What IS a 'healthy' transport indicator?
Proposed definitions

- Any single (or group) of statistical values that together give an indication of the system's functionality for health benefit.

- A standardized measure of change/progress in the transport system that reflects impacts health:
  - over time
  - in comparison to other groups/settings with similar characteristics.
Choosing the best data as an indicator

Only a few indicators can be measured routinely; they should reflect:

- Most robust evidence on health impacts – preferably in one or more “domains”
- Potential for routine, continued use
- Ease of collection in data-sparse settings
- Ease of integration into health-oriented modelling/burden of disease assessment.
How do we proceed?

- A partnership between Development Banks/key cities and WHO, harnessing WHO's broad experience on transport, environment & health.
- Pilot test set of indicators
- Review and agree on a core set of indicators that can be used evaluate investments and report back on health, climate change and other benefits:
  - Globally
  - Systematically
  - Over time
Next steps

1. Complete WHO literature review of transport indicator systems and conceptual frameworks.

2. Establish a working group of health and transport experts, development banks, and country stakeholders.

3. Working group develops a proposed framework and set of ‘healthy transport indicators’ – including six ‘most key’ healthy transport indicators for most data-scarce regions.

4. Regional consultations with MOT and MOH on adoption & use.

Next steps

6. Adapt WHO modeling tools to support indicator collection and use in pilots in data-scarce regions.

7. Validate pilot findings, finalize harmonized indicator set and guidance.

8. Implement strategy for wide uptake and use of indicators and supporting software.


**FINAL RESULT:** Improved and harmonized global monitoring/reporting/valuation of the health impacts of transport system improvements.
WHO is ready to travel with you

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