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The Burden of Urban Ill-Health from Road Transport in Developing Countries

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Johns Hopkins University
Outline

- Framework for exploring health and transport interactions
  - Information systems
  - Global burden of disease

- Examples of transport-health interactions
  - Air pollution
  - Noise pollution
  - Lead pollution

- Case study on road traffic injuries
Section A

Building Blocks to Understand Health-Transport Interactions
Health and Transport Framework

Road transport and/or policy

Linkage or association often causal

Intermediate outcomes

Indicators
Health and Transport Framework

Road transport/policy

Intermediate outcome

Transport policy indicator
Health and Transport Framework

Road transport/policy → Transport policy indicator → Health outcome

Intermediate outcome → Intermediate outcome indicator

Health outcome
Health and Transport Framework

Road transport/policy ➔ Transport policy indicator ➔ Intermediate outcome indicator ➔ Health outcome indicator ➔ Health outcome

Health, policy, and development analysis ➔Intermediate outcome indicator
Global Burden of Disease

- Population and BOD by country income level

<table>
<thead>
<tr>
<th></th>
<th>Low-middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population in thousands</td>
<td>4,976,748 (85%)</td>
<td>907,828 (15%)</td>
</tr>
<tr>
<td>Total DALYs in thousands</td>
<td>1,274,259 (92%)</td>
<td>108,305 (8%)</td>
</tr>
</tbody>
</table>
Distribution of Global Deaths

- Distribution of global deaths by broad cause group, 2000

Data source: World Health Organization
Global Burden of Disease in DALYs, 2000

Global burden of disease in disability-adjusted life years, 2000

- Non-communicable conditions (43.2%)
- Communicable diseases, maternal and perinatal conditions, and nutritional deficiencies (42.8%)
- Injuries (13.9%)

Data source: World Health Organization
## BOD Rate by Country Income Level in 1999-2000

- Burden of disease rate (DALYs per 100,000 population) by country income level in 1999-2000

<table>
<thead>
<tr>
<th></th>
<th>Low and middle income</th>
<th>High income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicable diseases (including maternal and perinatal conditions and nutritional deficiencies)</td>
<td>11,206</td>
<td>863</td>
</tr>
<tr>
<td>Non-communicable diseases</td>
<td>10,200</td>
<td>9,664</td>
</tr>
<tr>
<td>Injuries</td>
<td>4,198</td>
<td>1,403</td>
</tr>
</tbody>
</table>
But …

- What proportion of this global burden can be attributed to transport?

- What diseases/conditions are part of the health outcomes from road transport?

- What are the pathways from road transport to specific health conditions?

- How many such pathways can you list?

- Spend five minutes individually before you go to the next section!
Section B

Pathways from Road Transport to Health Outcomes
<table>
<thead>
<tr>
<th>Factor</th>
<th>Output</th>
<th>Indicators</th>
<th>Health Outcome/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased vehicle emissions</td>
<td>Air pollution</td>
<td>Suspended particles, CO, PM, CO₂, lead, temperature</td>
<td>Asthma, CHD, cancer, IQ</td>
</tr>
<tr>
<td></td>
<td>Global warming</td>
<td>Temperature, natural disasters</td>
<td>Infectious diseases</td>
</tr>
<tr>
<td>Increased traffic congestion</td>
<td>Vehicle crashes</td>
<td>Miles traveled, vehicles registered, vehicles/capita, population density</td>
<td>Injuries</td>
</tr>
<tr>
<td></td>
<td>Stress</td>
<td>Population density</td>
<td>Mental health</td>
</tr>
<tr>
<td>Increased noise</td>
<td>Noise pollution</td>
<td>Mean decibel levels</td>
<td>Auditory disorders</td>
</tr>
<tr>
<td>Increased access to transport</td>
<td>Increased mobility</td>
<td>Geographical distribution of disease rates</td>
<td>HIV, STDs</td>
</tr>
<tr>
<td></td>
<td>Inactivity</td>
<td></td>
<td>Obesity, CHD, DM</td>
</tr>
<tr>
<td>Decreased access to transport</td>
<td>Decreased mobility</td>
<td>Transport wait time, maternal mortality</td>
<td>Obstetric emergencies</td>
</tr>
</tbody>
</table>
Air Pollution

- Expanding urban populations in developing countries with high exposure to ambient levels

- Combustion-derived sources are major contributors, including transport

- Include
  - Particulate matters of differing size
  - Gases of nitrogen, sulfur, etc.
  - Lead (separate consideration)
  - Ozone (separate consideration; global warming)
Particulate Matter Air Pollution (1)

- Analysis based on PM only for mortality shows that globally it causes (WHR 2002):
  - 5% of trachea, bronchus, lung cancer
  - 2% of cardiopulmonary mortality
  - 1% of respiratory infection mortality

- This means that globally PM-AP causes
  - 0.8 million deaths (1.4%)
  - 7.9 million DALYs (0.8%)
Of the burden of disease from PM-AP, 61% occurs in the Southeast Asia and Western Pacific regions.

Within the Western Pacific and European regions, up to 1.5% of the disease burden is related to PM-AP.

This is an underestimate of the PM-AP burden:
- Limited to PM
- Limited to mortality
Global Distribution of Mortality: 20 Risk Factors

Distribution of Attributable Burden by Age

- Most or all among children 0-4 years
  - Underweight and micronutrient deficiencies, unsafe water, indoor smoke, lead, climate change

- Most or all among adults 15-59 years
  - Unsafe sex, tobacco, alcohol, illicit drugs, occupational injuries, unsafe health care injections, and childhood sexual abuse outcomes

- About half under 60 years, about half over 60 years
  - Diet-related CVD risks and physical inactivity, urban air pollution, occupational carcinogens and airborne particulates
Air Pollution in Kuala Lumpur

- 100% of hydrocarbons and CO, and 70% of NO$_2$ attributable to transport in Klang valley (1992)

- Increasing levels of SO$_2$ due to increasing use of diesel fuels

- Increasing levels of suspended particulate matter in Kuala Lumpur (WDR, 2002)

- Health effects, but also acid rain!
Air Pollution in Calcutta

- Increasing air pollution since the 1970s
- Suspended particulate matter (SPM) increased fourfold over 20 years
- It’s estimated that 1,300 tons of pollutants discharged into the air each day, of which 30% is of “vehicular” origin
- Studies of SPM near major traffic junctions show 4-10 times the overall levels for the city, suggesting high-pollution spots
Noise Pollution in Calcutta

- Fifty percent of the city population exposed more than 40 hours per week

- Levels in city center reach twice (85 db) the limit of sound intensity for humans (45 db)

- Major role for transport (and intra-city industry, especially near roads)

- Central Pollution Control Board has laws, but they’re not implemented or obeyed
Lead Pollution

- Multiple sources such as house paint, water pipes, kitchen ceramics, and petrol (very important contributor)

- Sixty countries have phased out leaded petrol; 85% of petrol sold worldwide is lead-free

- Worldwide
  - 120 million people with 5-10 ug/ml (fewer >10ug/ml)
  - 40% of children with >5 ug/ml
  - 97% of children affected live in the developing world
Lead Pollution—2

- Health outcomes include
  - Reduced IQ
  - Increased blood pressure
  - Developmental delays
  - Severe poisoning as well

- Globally this results in
  - 234,000 deaths (0.4%)
  - 12.9 million DALYs (0.9%)
Lead Pollution—3

- Of the currently estimated burden ...
  - 20% in Southeast Asia
  - 20% in the Western Pacific

- This is an underestimate due to lack of data on several outcomes
Lead Pollution—4

- Phasing out leaded fuel—top priority of the World Bank (declared in 1997); in process, but greater impact for LMIC

- E.g., Dhaka, Bangladesh: one of the highest concentrations of airborne lead

- E.g., Africa: highest concentration of lead in petrol

- Bangkok, Jakarta, Santiago, Taipei, and Mexico city: all notable for lead pollution
Section C

Case Study on Road Traffic Injuries
# Road Fatalities and Vehicles: Regional Distribution

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage of all RT fatalities</th>
<th>Percentage of all motor vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central/East Europe</td>
<td>12%</td>
<td>6</td>
</tr>
<tr>
<td>Africa</td>
<td>11%</td>
<td>2</td>
</tr>
<tr>
<td>Middle East</td>
<td>6%</td>
<td>2</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>44%</td>
<td>16</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>13%</td>
<td>14</td>
</tr>
<tr>
<td><strong>Highly motorized countries</strong></td>
<td><strong>14%</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

Mercedes Benz

Benz adopted the four-wheel system as soon as he had patented 'a steering mechanism for a car with steering circles set on a tangent to the wheels.' In 1893, he called his first four-wheel model Viktoria to celebrate his triumph over steering problems.
“This should never happen again”

— Coroner, London (1893)
It did happen again ...

... tens of millions of times
Leading Causes of Death, Both Sexes, Worldwide, 2000

- Road traffic injury is the second leading cause of death among people aged between 5 and 30 years.
- It is the third leading cause of death among people aged 30 to 45 years.
- It is among the top ten leading causes of death among all ages.
## Disease Burden (DALYs Lost) for 10 Leading Causes

<table>
<thead>
<tr>
<th>1998 Disease or injury</th>
<th>2020 Disease or injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lower respiratory infections</td>
<td>1. Ischemic heart disease</td>
</tr>
<tr>
<td>2. HIV/AIDS</td>
<td>2. Unipolar major depression</td>
</tr>
<tr>
<td>3. Perinatal conditions</td>
<td>3. Road traffic injuries</td>
</tr>
<tr>
<td>5. Unipolar major depression</td>
<td>5. Chronic obstructive pulmonary disease</td>
</tr>
<tr>
<td>6. Ischemic heart disease</td>
<td>6. Lower respiratory infections</td>
</tr>
<tr>
<td>7. Cerebrovascular disease</td>
<td>7. Tuberculosis</td>
</tr>
<tr>
<td>8. Malaria</td>
<td>8. War</td>
</tr>
<tr>
<td>9. Road traffic injuries</td>
<td>9. Diarrheal diseases</td>
</tr>
<tr>
<td>10. Chronic obstructive pulmonary disease</td>
<td>10. HIV/AIDS</td>
</tr>
</tbody>
</table>
Road Traffic Fatalities/100,000: Australia, 1961-2001

Data source: World Health Organization, 2002
Road Traffic Fatalities/100,000: U.S., 1966-2001

Data source: World Health Organization, 2002
India: Road Traffic Fatalities, 1971-1998

Malaysia: Road Traffic Fatalities, 1982-1998

Data source: World Health Organization, 2002
Global Road Traffic Injury Mortality, 2000

Legend*
- No data
- 29.2 - 34.5
- 18.9 - 29.1
- 16.2 - 18.8
- 11.2 - 161

<table>
<thead>
<tr>
<th>Region</th>
<th>HIC†</th>
<th>LMIC‡</th>
<th>HIC</th>
<th>LMIC</th>
<th>HIC</th>
<th>LMIC</th>
<th>India</th>
<th>Other LMIC</th>
<th>HIC</th>
<th>China</th>
<th>Other LMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>26.3</td>
<td>15.0</td>
<td>18.1</td>
<td>34.1</td>
<td>18.7</td>
<td>11.2</td>
<td>16.1</td>
<td>29.2</td>
<td>26.6</td>
<td>15.9</td>
<td>18.9</td>
</tr>
<tr>
<td>Mediterranean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.2</td>
</tr>
</tbody>
</table>

*Rate per 100,000 population  †High income countries  ‡Low/middle income countries

Inequalities and Inequities in RTI

- Affect vulnerable road users

- Often occur where ...
  - Pre-hospital care is poor or lacking
  - There is poor access to hospitals
  - Hospitals are overloaded with admissions
  - Health care service budgets are drained
Pedestrian, Bicycle, MTW Fatalities in LMCs and HMCs

Death by Type of Road User

Data source: World Health Organization
Pre-Hospital Case Fatality for Serious Injuries

Data source: World Health Organization

<table>
<thead>
<tr>
<th>GNP per capita:</th>
<th>Kumasi, Ghana</th>
<th>Monterrey, Mexico</th>
<th>Seattle, U.S.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$310</td>
<td>$3,900</td>
<td>$25,000</td>
</tr>
</tbody>
</table>

Case fatality
Role of Public Health

- Promoting sustained solutions for negative health-transport interactions in LMIC

- **Research** and development: creation of an evidence base to inform action

- Continued **monitoring** to ensure that efforts are facilitating reduction in adverse health outcomes (such as road traffic injuries)

- Stimulating the **health sector** to recognize, own, and act on transport-related issues