CONCLUSION AND POLICY RECOMMENDATIONS

This report presents comprehensive global estimates of the health effects of road injuries. It marks the first attempt to estimate the disease burden attributable to pollution as well as injuries from motorized road transport. Previous estimates of the global burden of road injuries have relied on relatively little local data from most countries. In this report, estimates of road injuries are constructed by analyzing a large number of measurements from even the regions that are considered information-poor. Notably, we incorporate many sources of epidemiological data from sub-Saharan Africa, including data from urban mortuaries, rural health and demographic surveillance sites, and cause-specific mortality measured in national household censuses. Most of these data sources have never been used before to generate national estimates of road injuries.

This report also presents the first global estimates of nonfatal road injuries. We constructed these estimates by combining information derived from more than 100 household surveys, hospital records from 28 countries, and estimates of long-term disability from four follow-up studies. We used a much greater number of data sources than ever before and combined them using a strategy designed to harness the strengths of available information. Despite these advances, there is an urgent need for continued work in this area to improve analytical models for combining available epidemiological data and to improve measurement, especially in quantifying the long-term outcomes from injuries.

Similarly, the Global Burden of Disease due to pollution from vehicles has never been estimated before. It should be noted that our estimates of the health burden due to overall air pollution are much higher than previous estimates. For instance, in our previous comparative risk assessment[20], we estimated that overall air pollution accounted for 0.4% of the Global Burden of Disease, while our current estimates (3.1%) are almost an order of magnitude higher. This is partly because we are able to characterize the population exposure to air pollution more precisely due to the inclusion of populations in rural areas and advances in satellite-based remote sensing and global chemical transport models. In addition, we now have access to a much larger pool of epidemiological studies about diseases caused by air pollution, allowing us to include more health outcomes than before.

Despite the increasing availability of data on exposure to air pollution and robust evidence linking air pollution to diseases, we believe our analysis underestimates the burden of air pollution from transport. This stems primarily from limitations inherent in existing data. For example, the data available on air pollution exposure worldwide underestimate emissions from vehicles in urban areas. Because a large and growing population resides in urban areas, this prevents us from fully assessing many people's exposure to this risk factor. In addition, data limitations prevented us from estimating the number of people around the world who live near busy roads

and are therefore exposed to higher levels of air pollution. Residing near heavily trafficked roads is associated with poor health outcomes including asthma in children.

There are three additional reasons why we believe our estimates of the burden of disease from vehicle pollution are too low. First, it is unlikely that the data we use to estimate air pollution exposure globally capture emissions from all types of vehicles. Second, our estimates of the burden of disease from vehicle pollution do not include ozone, which is a pollutant formed in the atmosphere that comes from transport and other sources. Ozone pollution is linked to death and disability from chronic lung diseases such as COPD. Finally, because the relationship between air pollution and mortality is nonlinear, other approaches to the statistical analysis used to estimate the burden of disease from vehicle pollution may produce somewhat larger estimates. More detailed information about these limitations can be found in Annex 1 and the Web appendix.

Currently, these limitations constrain our ability to quantify premature death and disability from vehicle pollution on a global scale. Improved data and disease burden estimates are possible, however, and will be required to guide governments as they design and implement transportation policies designed to reduce the public health burden of road transport. Development of better data warrants financial support from all concerned with this complex and growing problem.

RECOMMENDATIONS

1) Rapidly scale up road safety programs and crash reporting capacity to save lives and promote economic development

Road injuries are a major contributor to the Global Burden of Disease and are vastly underreported. Governments in many low- and middle-income countries report a substantially lower road injury death toll than our estimates. In the poorest countries of sub-Saharan Africa, which have the highest road injury death rates, official government statistics often report less than one-fifth of road injury deaths. Even in the rapidly developing economies of Asia, such as China and India, official statistics often account for less than half of all road injury deaths. At the global level, the sum of countries' official death counts (641,000 deaths) published by the WHO in their 2013 *Global Status Report on Road Safety* is less than half of our global estimate (1.3 million). Unless accounting of road injuries in official statistics reported to WHO is improved, it is likely that road safety will continue to be neglected in national health and development priorities.

A substantial international effort should address how road injury data are collected and the health burden is estimated. Some low- and middle-income countries already have a relatively strong information infrastructure, such as high-quality national vital registration systems, and underreporting is relatively low. In these countries, strengthening existing systems for recording and reporting road injury statistics will enhance the quality of disease burden estimates. Such efforts should include standardization of definitions and methodologies, such as the use of the OECD/IRTAD

protocol as the reporting standard in the World Bank-financed Ibero-American Road Safety Observatory in Latin America, utilizing twinning partnerships between high- and low-income countries' agencies to help develop statistical capacity.

On the other hand, in countries with the highest underreporting, the existing national health surveillance infrastructure is too weak to reliably track road injury mortality. Although developing such should be an ongoing priority, it is a slow process that will take many years. Immediate attention therefore should be given to using all existing data sources to construct statistical estimates of the national burden of road injuries for guiding safety programs. GBD 2010 takes such an approach with an emphasis on developing global and regional models. Such work needs to be extended further at the national level to better utilize the known strengths and biases of local data sources. In addition to generating immediate evidence to guide policy, this approach also helps identify potential country data systems, such as mortuary surveillance, national household surveys, and hospital registries, that can be strengthened and expanded to build reliable information infrastructure.

As acknowledged earlier in the report, the expansion of the road and transit network has long been viewed as a key strategy for driving economic growth and improving the health and well-being of people. However, unmanaged growth without the requisite capacity and oversight from country agency and regulatory bodies can result, in the case of developing countries, in decades of motorized road transit systems that inflict large amounts of harm on their populations, without government capacity to target interventions correctly. While it took high-income countries decades to reduce their road injury death toll, low- and middle-income countries can greatly reduce this timeframe by rapidly investing in a long-term strategy to actively manage safety and mobility performance, the topic of the next section.

2) Promote strong institutional development for multisectoral collaboration in the emerging sustainable development era of safe and clean mobility

Global health is undergoing a rapid transition away from mostly infectious diseases that affect children to non-communicable diseases and injuries that affect adults. This requires adjustment on multiple fronts on the part of different actors ranging from country governments to the private sector to the NGO community. Development agencies will need to create new comprehensive policy frameworks to implement cross-sectoral change in a logical and sequenced manner in client countries and in their own internal global practice areas. This reflects the complexity of an ever-changing, multidimensional environment that demands a clear accounting of emerging health threats to the planet.

For example, the 2004 *World Report on Road Traffic Injury Prevention*, authored jointly by the WHO and the World Bank, focused on creating empowered lead agencies with statutory responsibility to reduce road injuries. This went hand-in-hand with recommendations to ensure adequate resources for these agencies to manage road safety in a multidisciplinary manner across relevant sectors of government.

Unfortunately, attempts by many actors in the internal community to address road safety in low- and middle-income countries still tend to take an "intervention-first" approach, focusing on individual risk factors such as wearing helmets, using seat-belts, preventing drunk driving, and social marketing campaigns.

While these interventions are needed, sustainability of road safety programs requires a government commitment to systematically invest in building transportation systems that promote safe mobility in a holistic manner. Establishing a lead road safety agency, building reliable data systems, and other system-wide investments that encompass vehicle quality, enforcement, safe infrastructure, and road users in the pre-crash, in-crash, and post-crash stages are key. [21]

Therefore, the overarching new science of delivering effective transfer of road safety knowledge means taking weak existing management capacity within a complex system and creating the ability to shift rapidly to a safe system approach focused on getting results.[21] An example is the case of Argentina, which has made road safety a national priority through investment in its National Road Safety Agency, which itself is the recipient of a standalone project loan for road safety from the World Bank, one of the first of its kind. Cooperation across different ministries, in the transport and health sectors in particular, is central to the lending package, which will undertake systematic, measurable, and accountable investment through targeted programs. Such an example can help provide lessons for other low- and middle-income countries striving to replicate an "agency-first" model as advocated in the *World Report* and the 2013 World Bank *Safe System Projects Guidelines*.

Lowering motor vehicle pollution is also important to reducing non-communicable diseases. Further, encouraging walking, biking, and active lifestyles has emerged as a key strategy because of their cardiovascular health benefits. However, as our report indicates, active modes of transport make people highly vulnerable to road injuries. Thus, partnerships between the transport, health, and urban planning sectors are necessary for developing solutions for healthy mobility. Increasingly, one of the key drivers of 21st-century competitiveness will be how countries – particularly urban centers – design their land use patterns to improve the health of their populations. This represents a fundamental switch toward linking transit to health outcomes. This change is currently being discussed in the context of a post-2015 Sustainable Development Goal world, and is particularly important to protect vulnerable generations in low- and middle-income countries.

3) Commit the resources needed to realize the health and economic gains from a safe and clean transport system

Developing transport solutions that deliver health will require financial commitments to support a wide range of strategies. Although the health impacts of road transport compete for attention with other pressing global health concerns, these occur in a development context that is different from that of many diseases and illnesses. As GBD 2010 illustrates, malnutrition, diarrhea, and many infectious diseases occur in settings of extreme poverty where financial resources are severely limited. However, the disease burden associated with road transport is an outcome

of economic growth and rapid motorization. An appropriate proportion of this economic gain needs to be assigned to managing the negative impacts of the transport sector.

Addressing the enormous and growing health losses from road transport will require large investments in building and managing transport systems that are safe, clean, and affordable. Although this report does not aim to estimate monetary losses, calculations based on the 2001 WHO Report of the Commission on Macro Economics and Health have shown that such losses are substantial – equivalent to 1% to 3% of gross domestic product per annum and calculated in 2014 for road crashes as high as 4.6% for India and 10.1% for Uganda – potentially exceeding the amount of international development assistance flowing into these countries.[21] In comparison, current investments in road safety remain miniscule.[8] Clearly, there is a strong financial case for increasing investments in safe and clean road transport.

Five decades of experience from high-income regions suggests that growth in transport systems can be managed to reduce injuries and air pollution with appropriate investments. In most high-income countries, road safety has steadily improved since the early 1970s despite increasing vehicle ownership rates and continued expansion of highway infrastructure. As noted elsewhere, the policy history of these countries suggests that they established national road safety agencies with legislative powers and a mandate to manage safety in the transport system. These agencies instituted a long series of interventions that targeted highway infrastructure (e.g., by requiring median barriers, guard rails, traffic calming designs), vehicle safety (e.g., by requiring airbags, seatbelts, child seats, crashworthiness standards, crash avoidance technologies), and road users (e.g., through stronger enforcement of and social marketing campaigns for seat-belt use, helmet use, and prevention of drunk driving). Developing countries can utilize new tools and World Bank *Guidelines* to prioritize short-, medium-, and long-term road safety investment and sequence it in a way that makes sense for sustaining gains.[21]

Similarly, as awareness of the health effects of air pollution grew, high-income countries developed comprehensive policies to reduce motor vehicle emissions. This included a range of regulatory strategies, including emissions control technologies, fuel-composition modifications mandated to meet various air quality objectives, and vehicle inspection programs. For developing countries, reduction technologies such as three-way catalysts and particle traps, the elimination of leaded fuel, and agreement on a globally sustainable level of fuel sulfur content will become critical in the coming years.

4) Systematically account for the health impact of road projects

Successfully addressing concerns that are posed by rapid growth in the road sector in low- and middle-income countries requires improved accounting of health impacts. At present, more effort is invested in estimating the economic rate of return of road projects than in estimating either the social benefits (access to health care, education, markets) or social harms (burden of disease, environmental costs) of transport. For example, to obtain a loan to finance road projects from infrastructure

lending agencies, such as multilateral development banks, governments must prove the viability of these loans through careful accounting of the economic returns on investment. To accomplish this, transport planners work in conjunction with transport economists to develop models that can project demand for transport, estimate savings in travel time, monetize savings, identify revenue streams, and estimate rates of return for loans. These analyses are successfully done in complex transportation markets that are shaped by individual behavioral decisions about interrelated choices of residential location, transport modes, trip destinations, and vehicle characteristics, among others.

To fully realize the societal benefit of transport infrastructure, it is important that comparable efforts are made to quantify the full costs and benefits of road projects. We need analytical models of crash causation that can be used to estimate the injuries and deaths that will be caused or avoided by proposed road projects. Importantly, such analysis will require empirical measurement of the risks associated with different types of road infrastructure. Our existing knowledge of causal relationships between road injuries and environmental factors is remarkably weak, especially in low- and middle-income countries where most new road building is currently occurring.

Similarly, analytical models are needed to characterize health impacts of changes in vehicular emissions that accompany road projects. Such analysis requires building spatially refined emission inventories that rely on local driving patterns, fuel types, and vehicle types. In addition, these models need to account for noncombustion sources of particulate matter, such as resuspended road dust, tire wear, and brake wear. These models will need to be validated against actual measurements through field valuation and verification of particulate matter emissions.

Finally, analytical work is needed to characterize the impact of individual transport projects and the broader transport sector on human physical activity and greenhouse gas emissions. In 2010, physical inactivity was the 11th-largest risk factor for years of healthy life lost, accounting for 2.8% of the total disease burden. We were unable to quantify the contribution of motorized transport to physical inactivity due to lack of information. Similarly, vehicular emissions are an important contributor to anthropogenic climate change. However, although the impact of climate change on human health is likely to be large, it acts through complex causal pathways. Our ability to model the diverse effects from greenhouse gases across populations is stymied by the lack of systematic studies in this area.

Improving human health and well-being is ultimately a key goal of all development projects. Health impacts should not be viewed as a potential externality but rather be part of the holistic development objective of transport projects, which aim to support, among other things, healthy, productive lives. This is what we mean with the title of this report, *Transport for Health*.