GEETAM TIWARI, MELECKIDZEDECK KHAYESI, WINNIE MITULLAH,
OLIVE KOBUSINGYE, DINESH MOHAN & MARK ZUIDGEEST

POSITION PAPER: THE EXTENT OF THE CHALLENGE

ROAD TRAFFIC INJURY AND TRANSPORT-RELATED AIR QUALITY IN SUB-SAHARAN AFRICA

A VREF PROGRAMME

MOBILITY & ACCESS in African Cities

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The Volvo Research and Educational Foundations, VREF

c/o Volvo Stiftelseförvaltning
Dept 1512, M2.7
SE-405 08 Gothenburg
Sweden
www.vref.se
secretariat@vref.se

Tel: +46-(0)31-66 22 72
Fax: +46-(0)31-66 16 61

Authors

Geetam Tiwari, Transportation research and Injury Prevention Program, Indian Institute of Technology Delhi, India (main author)

Meleckidzedeck Khayesi, World Health Organisation, Geneva, Switzerland (co-author)

Winnie Mitullah, University of Nairobi, Kenya (co-author)

Olive Kobusingye, Makerere University, Uganda (co-author)

Dinesh Mohan, Transportation research and Injury Prevention Program, Indian Institute of Technology Delhi, India (co-author)

Mark Zuidgeest, University of Cape Town, South Africa (co-author)

Editor

Gail Jennings, Research Consultant, South Africa

Design

Infestation Design, South Africa

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- Schalekamp, H., Saddier, S. (2020). *Emerging business models and service options in the shared transport sector in African cities. The state of knowledge and research.*
- Tiwari, G., Khayesi, M., Mitullah., Kobusingye, O., Mohan, D., Zuidgeest. (2020). *Road traffic injury and transport-related air quality in Sub-Saharan Africa. The extent of the challenge.*
- Venter, C., Barrett, I., Zuidgeest, M., Cheure, N. (2020). *Public transport system design and modal integration in Sub-Saharan African cities. The state of knowledge and research.*

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MOBILITY & ACCESS in African Cities

EXECUTIVE SUMMARY

Purpose

The overall purpose of the position papers in this series is to provide an overview of current knowledge on specific issues related to mobility and access in Sub-Saharan African (SSA) cities, as well as to inform Volvo Research and Educational Foundations (VREF) and researchers in developing a research agenda in this area. One of the core themes identified for future research is the public health impact of transportation in SSA cities, which is the topic of this position paper.

Objectives of this paper

- To describe the extent of the burden of road traffic injuries in SSA cities, in terms of the current state of knowledge;
- To describe the state of air quality in SSA cities, in terms of the current state of knowledge;
- To highlight gaps in knowledge that might be addressed by future research;
- To indicate where key research capacity currently resides within SSA.

State of research capacity

A review of the main publication outputs within SSA regarding the public health impact of air quality and road traffic injuries suggests that research capacity largely resides in universities in South Africa, Uganda, Kenya, Ghana, and Tanzania. This work is undertaken largely at university departments of public health, health sciences, and engineering. There is also a large number of international agencies that work in the area of road safety in SSA, although most do so without significant involvement of the academic sector.

Key research gaps

The paper identified the following research gaps:

- Few systematic reviews on road traffic injuries and air pollution in SSA;
- Limited interdisciplinary studies;
- Very limited data on air quality to serve as a basis for analysis;
- Very limited data on road fatalities and road user type;
- Unreliable road traffic crash data;
- Limited studies based on hospital data;
- Limited data for emissions modelling;
- Lack of involvement with the academic sector by international agencies working on road safety in Africa.

ACKNOWLEDGMENTS

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INTRODUCTION

Background and objectives

The overall purpose of the position papers in this series is to provide an overview of current knowledge on specific issues related to mobility and access in Sub-Saharan African (SSA) cities, as well as to inform Volvo Research and Educational Foundations (VREF) and researchers in developing a research agenda in this area. One of the core themes identified for future research is transport and health concerns in SSA cities, which is the topic of this position paper.

The objectives of this paper are:

- To describe the extent of the burden of road traffic injuries, in terms of the current state of knowledge;
- To describe the state of air quality in SSA cities, in terms of the current state of knowledge;
- To highlight gaps in knowledge that might be addressed by future research;
- To indicate where key research capacity currently resides within SSA.

Scope

Transport affects human health in several ways. It does this directly as a road safety issue, as well as through noise and air pollution. Transport also affects human health indirectly – for example, increased dependence on motorised transport often leads to a lack of adequate physical activity. High emissions from transportation also contribute to global climate change, while limited access to transport and mobility can be linked to inequity, injustice, and poverty.

Although active transport and social exclusion are important elements of a discussion on transport and human health, these areas are largely excluded from this paper, in order to reduce overlap with other papers in this series.

This paper focuses on urban Africa. Currently about 49.9% of SSA's population lives in urban areas, and the number of urban dwellers is projected to increase rapidly from 491 million in 2015 to 1.48 billion in 2050. The population of cities in SSA is projected to surpass the 50% urban tipping point around 2035 (UN DESA, 2018).

As many countries in Africa experience increased urbanisation, ensuring safe mobility and access to all has become an important objective for all stakeholders.

In this paper, some data is presented in relation to the World Health Organisation's (WHO) African Region (rather than in relation to countries within SSA, which includes 49 of the 54 African states). For purposes of reporting, analysis and administration of data, WHO divides the world into six regions, where the African Region excludes Somalia, Sudan and Eritrea (all of which are part of SSA) but includes Algeria (which is not part of SSA).

Method

The study was conducted through internet searches (e.g. Google Scholar) of research publications in the area of road traffic injuries, air pollution, and active transport (non-motorised transport) from journals, conferences, and reports that are available in the public domain. The focus of these searches was publications from 1994 to 2018.

The search included the broad categories of Road Traffic Injuries (RTIs) and Ambient Air Pollution (AAP) in Africa. The key words for RTI included traffic crash, traffic accidents, road accidents, and road traffic injuries in Africa. Key words used for AAP included ambient air pollution, vehicular pollution, vehicular emissions, and traffic emissions in Africa. In this way, 123 papers were found for RTIs and 36 for AAP.

A further 88 publications from conference proceedings (mostly the annual Southern African Transport Conference, SATC) were sourced from the previous 18 years, mostly relating to road traffic injuries in South African cities.

These papers and conference proceedings are not referenced in the text as part of the position paper itself, but served to inform the assessment of the state of research capacity.

The review was guided by these research questions:

1. Who is publishing studies related to Road Traffic Injuries (RTIs) and Ambient Air Pollution (AAP) in Africa?

2. What type of data is available for studies related to RTIs and AAP in Africa?

3. What are the major gaps in previous and current studies related to RTI and AAP in Africa?

Outline of this paper

This paper does not constitute a comprehensive review of the literature or state of the knowledge regarding the topic, but instead presents an overview of the status of road traffic injuries and transport-related air quality in SSA cities and their implications on population health. The paper also briefly describes the research capacity within SSA, with a view to overcoming the challenges outlined above, and summarises the key research gaps emerging from the review.

OVERVIEW OF TRANSPORT AND HEALTH CHALLENGES IN SSA CITIES

While the Sub-Saharan African region has shown some economic growth over the past decade (Pieterse et al., 2018), the extremely limited infrastructural footprint presents a serious constraint to continued and high growth (AFDB, 2016). Most acute is the energy deficit, which is reinforced by shortfalls in mobility infrastructure, water systems, information and communication technology (ICT), and cabling (Panel, 2015). Even when correcting for low- or middle-income status, the degree of infrastructure deficit is exceptional in SSA relative to other regions, despite the improvement of infrastructure in recent years (Panel, 2015). At the same time, because SSA countries are expected to invest in strengthening the transport infrastructure to meet the Sustainable Development Goals (SDGs), there are likely to be substantial adverse impacts that can occur as a consequence of expanding transport infrastructure and urbanisation. These impacts include an increase in road traffic injuries, as well as an increase in vehicular pollution and associated health impacts. These anticipated adverse health effects need to be addressed.

Half of the SSA population is expected to live in urban areas by 2035, and SSA will host five of the world's 41 megacities by 2030, including Lagos, Kinshasa, Johannesburg, Dar es Salaam, and Luanda. However, the urban population boom in SSA is occurring in a context of slow structural transformation, violence, and poverty (Bello-Schünemann et al., 2017). Further, SSA's rapid urbanisation is and will undoubtedly be associated with high ambient air pollution. Industrial activities, household consumption, and transport activities emit a mixture of air pollutants, many of which are harmful to human health. Of all of these pollutants, fine particulate matter (PM) has the greatest effect on human health. Most PM emanates from fuel combustion, both from mobile sources such as vehicles and from stationary sources such as power plants, industry, households, or burning of biomass. In 2016, ambient air pollution was responsible for 4.2 million deaths globally. Worldwide, ambient air pollution is estimated to cause about 16% of lung cancer deaths, 25% of chronic obstructive pulmonary disease deaths, about 17% of ischaemic heart disease and stroke, and about 26% of respiratory infection deaths (WHO, 2018a).

The SSA region continues to face additional major health concerns. The region had the lowest healthy life expectancy at birth in 2015 (52.3 years), which is about eight years lower than that of Eastern Mediterranean and South East Asia, and about 16 years lower than the healthy life expectancy in the Americas, Europe and Western Pacific Regions (WHO, 2018a). Low life expectancy is largely related to poverty and prevalence of communicable diseases, although the burden of non-communicable diseases (NCDs), such as heart diseases, stroke, cancer, chronic respiratory diseases, and diabetes, is growing in SSA and across the world. These NCDs have evident links to transport provision and impacts. However, because the major health burden emanates from communicable diseases, the priority accorded to adverse impacts from transport in the form of road traffic injuries and air pollution remains low.

SSA countries are committed to improving the quality of life for their citizens, particularly in terms of modernised infrastructure and access to basic necessities such as shelter, water, sanitation, energy, public transport, and information communication technology (Pieterse et al., 2018). To do so requires focused, sustained strategies that at the same time have the least adverse impacts. These strategies must also recognise the diverse socio-economic conditions within SSA (see figure 1), and the importance of expanding transport infrastructure, paying particular attention to the majority of people who do not have access to personal vehicles, while also having a commitment to rural access and mobility.

Transport can either facilitate or inhibit individuals and communities in accessing their economic and social needs. Sustainable transport is thus not limited to the development of infrastructure and services, but the level to which transport enables people to overcome the social, economic, political, and physical barriers to movement

Figure 1. Socio-economic diversity in SSA countries (Source: Pieterse et al., 2018).

- GDP in 38 SSA countries ranges from USD7,000 to -250; only four countries have GDP > 5,000 and 50% of the countries' GDP is less than USD1000.
- Urbanisation ranges from 61% in Southern Africa to 25% in East Africa.
- There are hugely divergent traditions of urban regulation, massively varied biophysical conditions, relative levels of wealth and poverty vary, and so too is the scale of projected infrastructure and service demand in African cities.
- Urban settlements size varies: 47% population in cities with fewer than 300,000 inhabitants, 9% in >10 million (megacities).

and access. The importance of transport in stimulating economic and social development is also reflected in its cross-cutting presence among multiple SDGs.

Transport has, however, often been handled as infrastructure and service, without close attention being paid to understanding its public health dimensions. This situation has contributed in part to transport not being given, for instance, a dedicated space in the 2000/2015 Millennium Development Goals. The MDGs – despite their focus on critical issues such as poverty, education, and gender – did not include a recognition of the strong links between these issues and transport. In addition, inclusion in transport has become a major concern in Africa, as population growth and urbanisation take place in most cities. Poor management of rapid urbanisation and growth over many years has also undermined delivery of services such as transportation, housing, water and sanitation, and health.

An expansion of transport infrastructures, along with rapid urbanisation, can have substantial adverse health impacts. These impacts include an increase in road traffic injuries, as well as an increase in vehicular pollution and associated health problems. Deaths from road traffic injuries are on the rise in SSA. While in 2000, road traffic injuries accounted for 1.93% of deaths due to all causes in SSA, in 2017 this proportion had risen to 2.32%. Similarly, in 2000, road traffic injuries were the 13th most common cause of death, but by 2015, such injuries occupied the 10th position (WHO, 2018a).

This paper does not include a discussion of issues related to inclusion and inclusive mobility, which are important human health dimensions of transport but which are the focus of another position paper in this series (Porter, et al., 2020). This paper focuses on other key intersections between transport and public health, specifically the extent of road traffic injuries (RTIs) and ambient air pollution (AAP) in urban SSA. The purpose is to highlight the challenges faced by SSA in its endeavours to reduce the adverse health effects of these transport impacts.

Road traffic injuries (RTIs)

The 2018 Global Status Report on Road Safety (WHO, 2018b) reports that in 2016, the WHO African Region had the highest rate of estimated RTI deaths per 100 000 population, compared to other WHO regions. The data also shows that there was a slight increase in the death rate between 2013 and 2016. Figure 2 shows the ratio of the death rates as reported by 37 Sub-Saharan countries and the WHO estimates for the same counties. The data in Figure 3 shows that except for four countries (South Africa, Namibia, Botswana, Eswatini), the death rate as estimated by WHO was more than two times that reported by all other countries, while for 70% of the countries, this ratio was greater than four (WHO, 2018c).

Figures 2 and 3 show estimated and reported road traffic fatality rates of different countries by population and per-capita income respectively, as reported by WHO in 2018. These data clearly indicate that the official statistics from a vast majority of the countries regarding RTI fatalities probably suffer from significant underreporting. The level of underreporting does not seem to be strongly influenced by per-capita income levels or populations of different countries.

Most of the urban poor in SSA rely on walking for travel, which largely restricts them to where they live and to surrounding areas (Vanderschuren et al., 2017, UNEP, 2016, Olvera, et al., 2013; Amoh-Gyimah and Aidoo, 2013). While walking, cycling, and other non-motorised modes

Figure 2: The ratio of country-reported death rates, and WHO estimates, for traffic fatalities in Sub-Saharan African countries (Source: WHO, 2018b).

Country	GNI per capita US$	Number reported deaths	Ratio of WHO estimate/ Reported	Country	GNI per capita US$	Number reported deaths	Ratio of WHO estimate/ Reported
South Africa	5,480	14,071	1.0	**Cote d'Ivoire**	1,520	991	5.6
Namibia	4,620	731	1.0	**Rwanda**	700	593	6.0
Botswana	6,610	450	1.2	**Senegal**	950	604	6.0
Eswatini	2,830	203	1.8	**Ethiopia**	660	4,352	6.3
Lesotho	1,210	318	2.0	**Mozambique**	480	1,379	6.3
Angola	3,440	2,845	2.4	**Burkina Faso**	640	878	6.5
Sao Tome and Principe	1,730	23	2.4	**Equatorial Guinea**	6,550	41	7.3
Uganda	660	3,503	3,4	**Guinea**	490	458	7.6
Chad	720	1,122	3.6	**Mali**	750	541	7.7
Cameroon	1,200	1,879	3.8	**Nigeria**	2,450	5,053	7.9
Ghana	1,380	1,802	3.9	**Central African Republic**	370	193	8.0
Gambia	440	139	4.4	**Gabon**	7,210	193	8.0
Sudan	2,140	2,311	4.4	**Comoros**	760	23	9.2
Kenya	1,380	2,965	4.5	**Liberia**	370	175	9.5
Congo	1,710	308	4.6	**Eritria**	520	130	9.6
Guinea-Bissau	620	122	4.6	**Somalia**		165	23.5
Benin	820	637	4.7	**South Sudan**	820	112	28.1
Malawi	320	1,122	5.0	**Burundi**	280	112	32.6
Niger	370	978	5.5	**DR of the Congo**	420	385	68.9

Figure 3. Road traffic fatalities in Sub-Saharan Africa by income (Source: WHO, 2018b).

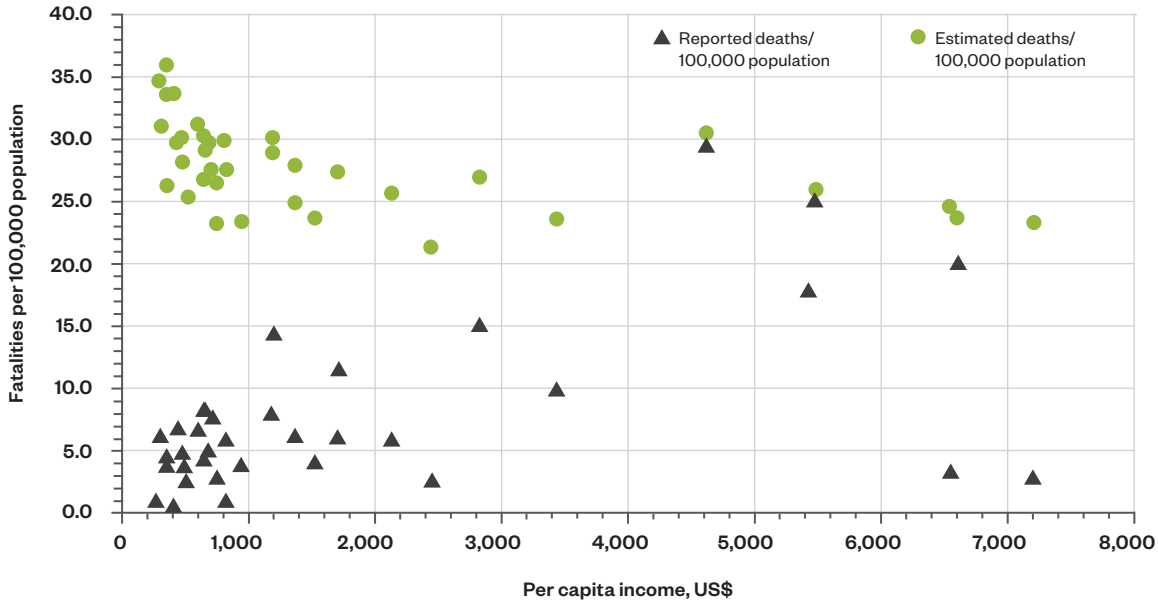
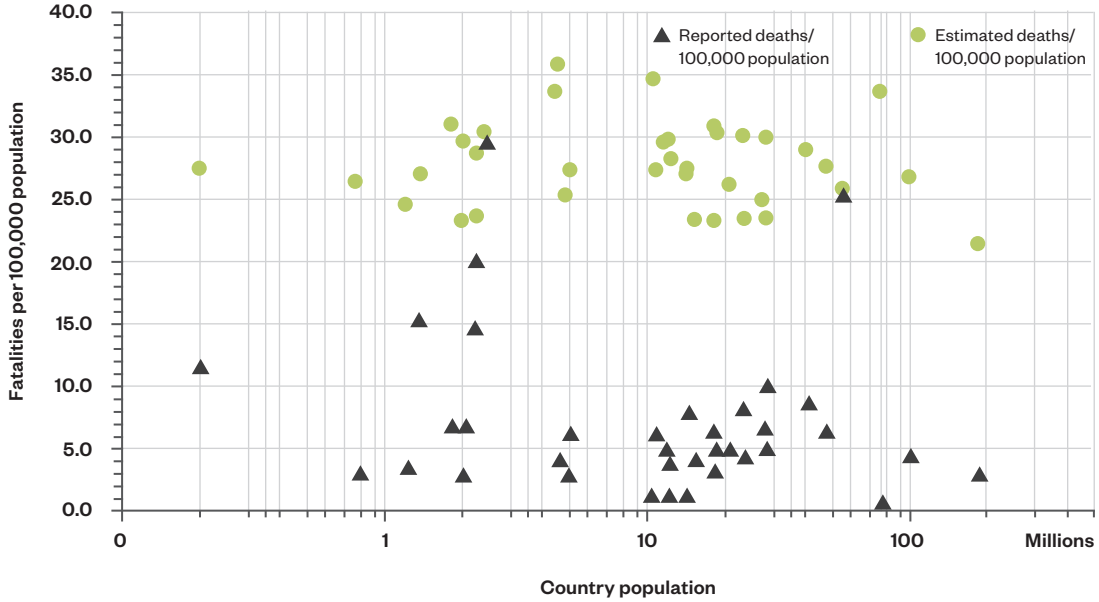


Figure 4. Road traffic fatalities in Sub-Saharan Africa by country population (Source: WHO, 2018b).



are cost-effective and sustainable, they pose a particular risk to health, as travellers using non-motorised modes are most likely to be impacted by road injuries.

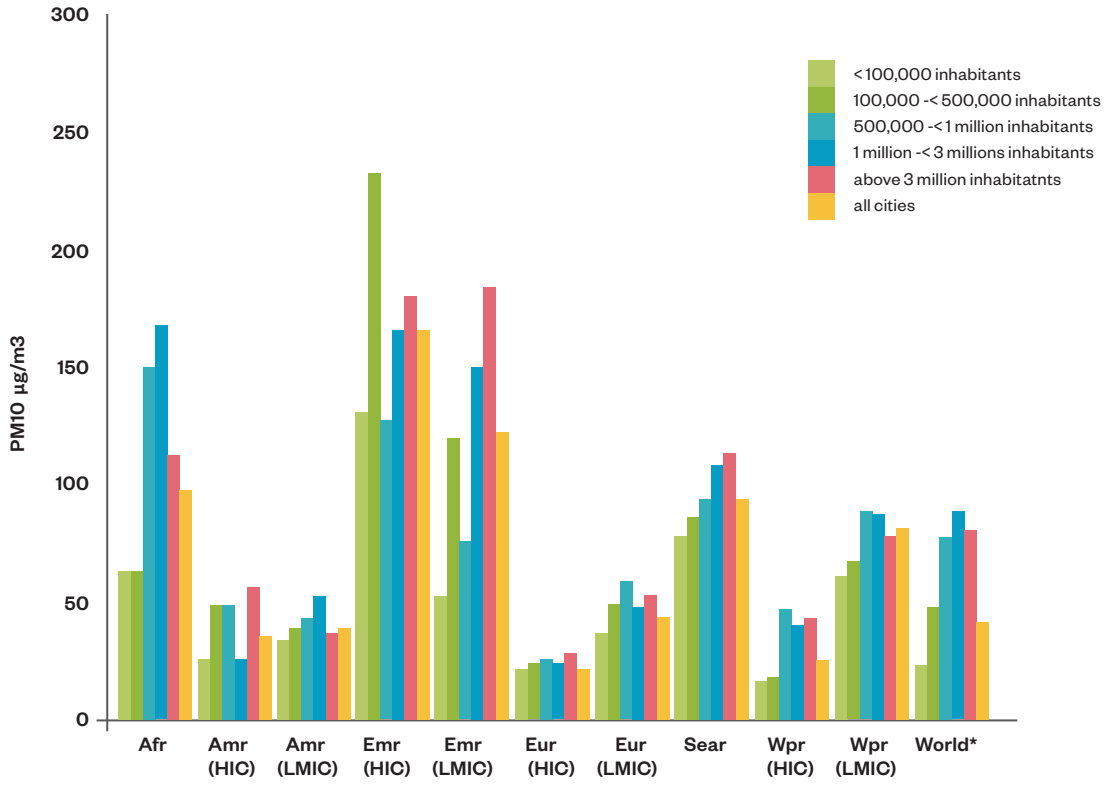
The WHO report documents the proportion of deaths by road user type as recorded by governments of different countries, and reports that vulnerable road users (specifically pedestrians, cyclists, and users of motorised two-wheelers) comprise 53% of total road fatalities. However, these numbers are based on road-user data provided by only 34% of the countries in the region, which indicates that the number may be an underestimate, as suggested by other reports from Africa (Damsere-Derry et al., 2017, Adeloye et al., 2016, Solagberu et al., 2015). These reports also indicate that motorised two-wheeler and bicycle use vary significantly across countries.

Urban air pollution

Air quality in SSA cities has deteriorated with population growth, increased motorisation, and industrial expansion. Exposure to ambient air pollution (AAP) is a major threat to human health in SSA, with WHO attributing 176,000 deaths in the WHO African Region to AAP exposure in 2012 (WHO, 2014). A study by Chafe et al. (2014) attributed 626,000 Disability Adjusted Life Years (DALYs)[1] to ambient PM2.5 exposure in 2010. These estimates are likely to be much higher than reported due to the limited air pollution epidemiological data emanating from the region.

In most regions of the world, mean annual PM2.5 and PM10 across global regions as defined by WHO between

Figure 5. PM10 levels by region and city size, for available cities and towns in the latest year in the period 2010-2016. (Source: https://www.who.int/airpollution/data/cities-2011/en/).



PM10: Particulate matter of 10 microns or less: Afr: Africa; Amr: Americas; Emr: Eastern Mediterranean; Eur:Europe; Sear: South East Asia; Wpr: Western Pacific; LMIC: low and middle income countries; HIC: high income countries.*PM10 values for the world are regional urban population weighted.

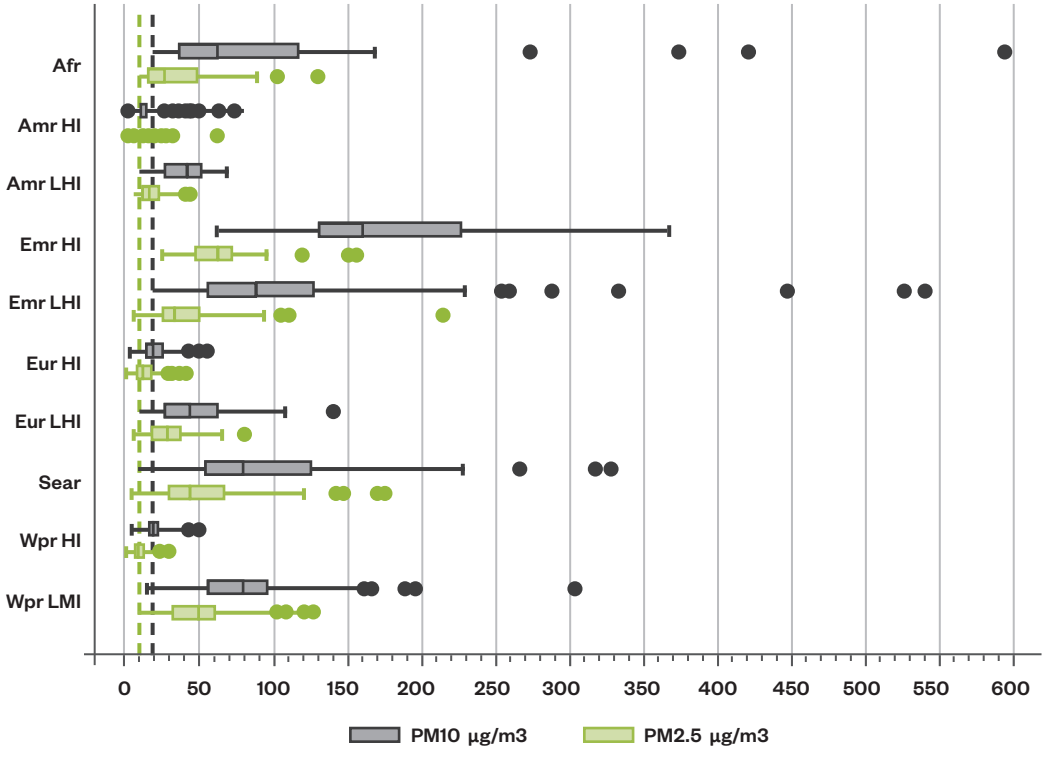
1 The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.)

2011 and 2016 shows high levels of pollutants (Chafe et al., 2014). Among 39 cities with available mean annual data, 5-8 cities were situated at approximately around WHO limits for PM2.5 and PM10, while other cities were 10-20 times higher than these WHO limits (Katoto et al., 2019).

However, some of the highest fine particles levels in the world have been recorded in cities of SSA and other developing regions (Brauer et al., 2012). Katoto et al. (2019) has noted that people from SSA appeared to be exposed to higher levels of PM2.5 and PM10 than people from high-income countries. PM2.5 concentrations in SSA cities have been estimated at around 100 ~g/m3, compared to <20 ~g/m3 in most European and North American cities (Brauer et al., 2012). Figure 5, above, shows PM10 levels in cities of different sizes in world regions. The African and Eastern Mediterranean regions have much higher levels than the other regions of the world.

Figure 6 shows mean annual PM2.5 and PM10 (g/m3) across global regions as defined by WHO between 2011 and 2016. Box plots represent medians with 25th–75th percentiles and 10th–90th percentiles for whiskers; dots are outliers. Grey and green vertical dotted lines at 10 and 20g/m3 correspond to WHO annual standards for PM2.5 and PM10 respectively. The WHO African Region thus shows that PM10 and PM2.5 both exceed the limits set by WHO.

Figure 6. Mean annual PM2.5 and PM10 (µg/m3) across global regions as defined by WHO between 2011 and 2016.



Afr: Africa, Amr: America, Emr: eastern Mediterranean, Eur: Europe, Sear: South-East Asia, Wpr: western Pacific, LML: Low and middle income, HI: High income, Source: WHO, 2015 database; WHO_AAP_ data May2016_v3web.

STATE OF RESEARCH CAPACITY

This section offers a brief review of research capacity in the fields of road traffic injury and air quality particularly in SSA universities and other institutions. The study undertaken for this paper found the most productive research environments (in terms of peer-reviewed, scholarly publications) to be academic institutions, which were concentrated in South Africa. The most productive research environments are found within universities in Cape Town, Dar es Salaam, Ibadan, Johannesburg, Nairobi, Pretoria, and Stellenbosch (Behrens et al., 2015), while various universities in Uganda and Ghana also have a relatively high output of scholarly work.

Active research centres/institutes and government departments that specifically study road traffic injuries (RTIs) exist in the following countries: South Africa, Kenya, Uganda, Tanzania, Cameroon, Ghana, and Ethiopia. Similarly, research centres and government departments that are active in air quality research can be found in South Africa, Ghana, Kenya, Nigeria, Uganda, and Cameroon. Research environments that publish the most research results on non-motorised transportation were identified in the following countries: South Africa, Ghana, Nigeria, Zimbabwe, and Kenya.

In view of the growing burden of health impacts from the transport sector in SSA, consistent efforts by the research community are required to generate new knowledge in close cooperation with those responsible for investments and implementation of relevant policies and projects. Interactions among academics and practitioners are important for strengthening dissemination of dissemination. Existing networks such as Partnership for African Social and Governance Research (PASGR)[2], which works with universities across Africa offering Master of Research and Public Policy degrees, also offer a number of professional development training programmes.

Another existing resource is The East African GEO-Health Hub, which is a research and capacity-building programme focusing on air pollution, child health, occupational health, and climate change. This project aims to establish a regional hub for training and research excellence in East Africa, specifically Ethiopia, Kenya, Rwanda, and Uganda. The primary focus is to reduce the effects of indoor and outdoor air pollution, which is responsible for high and rising rates of disease and death in the region. The project also addresses emerging occupational health and safety problems from climate change in agriculture. The long-term objectives of the project are to build capacity and leadership in East Africa for conducting cutting-edge multidisciplinary health research, extending a solution-oriented research portfolio to other countries, and addressing key priority problems in the region on environmental and occupational health. The project is being implemented under the Global Environmental and Occupational Health initiative led by the Fogarty International Center of the US National Institutes of Health in collaboration with Canada's International Development Research Centre. The overall research component of the hub is led by Ethiopia's Addis Ababa University in collaboration with Uganda's Makerere University, Maasai Mara University and Great Lakes University of Kisumu in Kenya, and the University of Rwanda.

In early 2020, a large three-year EU project titled Safer-Africa was completed, which involved a number of European Research Institutions (Università di Roma, National Technical University of Athens, Belgian Road Safety Institute, IFSTTAR, Loughborough University, SWOV, Chalmers University of Technology, and others) partnering with African countries. The project website[3] includes road safety knowledge and data with the specific objective of setting up the African Road Safety Observatory, road safety and traffic management capacity reviews, capacity building and training, and sharing of good practices and other reports.

Other international agencies with road safety activities in SSA include the World Bank, World Health Organisation, the French Institute of Science and Technology for Transport, Development and Networks (IFFSTAR), SweRoads, irAP International Road

2 www.pasgr.org

3 www.saferafrica.eu/en/

Federation, Foreign, Commonwealth and Development Office, Bloomberg Philanthropies Initiative for Global Road Safety, and the FIA Foundation. In addition, the European Union and other NGOs also work in the area of road safety; examples are the Global Alliance of NGOs for Road Safety (Africa Chapter), Global Road Safety Partnership South Africa, and Safe Kids Worldwide.

Many international agencies that work on road safety issues do so, however, without much involvement of the academic sector. This means that evaluations of their interventions and outcomes are seldom included in academic publications. Therefore, it would be useful if the influence and outcome of these inputs by various agencies could be evaluated by research departments in SSA institutions.

KEY RESEARCH GAPS

The following key research gaps and concerns emerged from the review and may assist in drafting a research agenda regarding transport and health challenges in SSA:

- Few systematic reviews on road traffic injuries and air pollution in SSA;
- Limited interdisciplinary studies;
- Very limited data on air quality for analysis;
- Very limited data on road fatalities and road user type;
- Unreliable road traffic crash data;
- Limited studies based on hospital data;
- Limited data for emissions modelling;
- Lack of involvement with the academic sector by international agencies working on road safety in Africa.

Limited interdisciplinary studies and systematic reviews

Research activities have increased in the areas of road traffic injury, air pollution, and non-motorised transport since 2000, although researchers working in these areas seldom undertake interdisciplinary studies. A large proportion of road traffic injury studies are based on either hospital data or secondary sources, whereas a significant number of air pollution studies are based on data from local experiments. There are very few systematic reviews on road traffic injuries, air pollution, or non-motorised transport.

One way in which to attend to this gap is to conduct and make easily accessible a comprehensive synthesis of research on urban transport, extending or adding to the literature reviews that exist. This resource, which can take the form of a 'living literature review', would be a useful starting reference for researchers to identify what has been done and what they can add. For example, the Campbell Collaboration[4] has been supporting preparation of Evidence Gap Maps and Systematic Reviews in identified areas of social sciences. Such collaborations can be encouraged in the near future for topics specific to SSA.

Key institutions in SSA could be identified for strengthening interdisciplinary research teams in ways that include natural science, engineering and social sciences. These institutions could be asked to form an advisory committee for specific thematic areas involving researchers from reputable institutes beyond SSA as well. The advisory committee could guide them towards a common methodology that will address the most pressing research gaps identified. Similarly, a steering committee could be established that would coordinate the process of sourcing funding, commissioning studies, and conducting studies.

Limited data on air quality for analysis

A World Bank study (Schwela, 2012) has noted that air quality monitoring programmes are weak in many SSA cities. In cities and countries where monitoring networks existed in the past, these networks broke down after a short period of existence. A more recent (2013) review of studies monitoring particulate air pollution in urban areas of Africa also indicated that routine air quality monitoring is limited across Africa, with many countries lacking air quality standards (Petkova et al., 2013).

Only South Africa and Senegal have a continuous and real-time monitoring network coverage. A recent systematic review of air pollution studies (Katoto et al, 2019) summarised the findings of published studies on exposure measurements and found that data were available from 18 out of 47 SSA countries. The distribution was un-

4 https://campbellcollaboration.org/

even across political and linguistic regions, with six countries in West Africa, six in East Africa, four in Southern Africa, and one in Central Africa. Measurements were largely performed in the country capitals or the largest cities, and data were collected for brief periods only. Evidence is limited and should be strengthened by primary studies with a much larger geographical coverage than has been the case.

Strengthening air quality monitoring in SSA would provide data for (1) developing a national response to the air pollution problem and (2) making health impact assessments to reduce the burden of disease attributable to air pollution and for communicating risk.

Limited and unreliable road crash and fatality data

There are few studies that look specifically at crash impacts in an urban Sub-Saharan African setting, for example looking at shares of non-motorised transport, state of infrastructure and/or state of the maintenance and inspection of vehicles, as well as at linkages between crashes and the built-environment in the form of e.g. crossing facilities and land-use distributions. For example, in SSA, only 34% of all countries have provided data on road user type to the WHO road safety reports. Similarly, only 5 out of 39 countries (13%) have a ratio <2 for estimated:reported fatality rates. Only Namibia, South Africa, and Botswana seem to have reasonable data in which estimated data is similar to reported data (WHO, 2018b).

Behrens et al. (2015) summarised published studies on RTIs and noted the absence of specific trends in the general road safety literature over the past decade. However, most studies on road safety in SSA dealt with either (1) road safety statistics; (2) behavioural, demographic or socio-cultural explanatory variables; or (3) mitigation measures.

There is limited literature (see eg Adeloye et.al., 2016b) available to enable a nuanced description of the extent of road traffic crashes, injuries, and deaths in Africa. Modelling based on scarce and variable information may not necessarily provide a reliable estimate. Moreover, registry based reports may grossly underestimate the burden of road traffic crashes; Adeloye et al. (2016b) conclude that there is an underestimation of fatalities, as population-based studies consistently report a higher fatality rate. Improved road traffic injury surveillance across African countries may be useful in identifying relevant data gaps and developing contextually feasible prevention strategies in these settings.

The results from the literature review indicate that most of the existing studies consist largely of descriptive work and analysis of secondary data. A significant proportion of the descriptive studies originate in hospital settings, and thus may not be representative of the actual situation in the region studied. This is particularly true in situations where medical care is not free, and where different hospitals cater to different socio-economic groups. The hospitals may also have varied facilities in terms of expertise and equipment. There are, however, very few studies based on primary data from hospitals. Seventy five percent of the studies reviewed for this paper are not based on hospital-based data, and 25% are based on retrospective data. Only 14% of studies are review studies.

The above discussion suggests that it would be important for researchers in SSA to undertake detailed assessment of fatal crashes in selected cities to obtain a better epidemiological grasp of the prevailing situation.

Inadequate interdisciplinary approaches

Understanding the impacts of road traffic injuries, non-motorised transport, and air pollution on human health is a complex task that requires a scientific approach based on interdisciplinary collaborations. Stoop, de Kroes, and Hale (2017) provide a detailed discourse on safety science in general and its application to transportation safety. They highlight the development of three basic concepts as the cornerstones for safety science as a scientific discipline, regardless of the domain it is related to: interdisciplinarity; problem-solving orientation; and systems approaches.

There are not enough studies in SSA that are interdisciplinary, or that take a systems approach. For example, there is little work on system-oriented approaches to traffic safety: we found an insignificant number of studies that investigated the impact of different road safety interventions on road safety, such as changes in road design, law and policy changes, or more effective enforcement.

Limited and unnuanced data for emissions modelling

Behrens et al. (2015) noted that the issue of transport-related greenhouse gas emissions, climate change and mitigation is primarily seen through the perspective of global comparative studies. In most cases, SSA is treated as one (or almost one) entity, which in terms of the heterogeneity of urban transport systems is definitely not the case. Specific contributing factors such as the typical vehicle mix, age of vehicles, types of fuels, as well as maintenance and inspection policies in Africa, are rarely considered in the scientific literature. Neither are issues such as how the built-up environment including infrastructure (both formal and informal) is influencing mode choice and use, hence air pollution and emissions, explored in the existing literature. Only one publication that looked at vehicle use in a typical African setting was found: in this case two-stroke two-wheel vehicles in West Africa (Assamoi and Liousse, 2010). These authors demonstrate the need for having up-to-date emission models and data, especially given rapid motorisation in many areas of the continent.

A lack of academic–practitioner collaboration

Academic-practitioner interactions are important for facilitating knowledge sharing. One approach is to establish specific funding mechanisms for a Professor of Practice, as well as support for senior post-graduate researchers (who are also practitioners) in academic institutes as a means to attract suitable professionals to academic institutions for short periods. Appointees as Professors of Practice are usually distinguished professionals, either practicing or retired, and mostly not from a traditional academic background. Such professorships contribute to promoting the integration of academic scholarship with practical experience.

Other tested ways to foster collaboration among academics and practitioners are building thematic working groups, creating short-term residential institutes, funding senior and junior research projects, and publishing joint monographs, books and journal articles.

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