Non-Communicable Disease and the Need to Strengthen Prehospital Care: Experience from Kigali, Rwanda

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Abstract

Background Non-communicable diseases (NCDs) are increasing in incidence in low-and middle-income countries (LMICs). Many NCDs present as emergencies which require emergency response. We aimed to review NCDs transported by Service d'Aide Medicale Urgente (SAMU), the public ambulance service in Rwanda.

Methods Descriptive analysis of a REDCap database was performed for medical cases between December 2012 to May 2016 and compared to non-medical cases. Student's t-test, ANOVA, and chi square test were run with $p < 0.05$ considered significant.

Results A total of 832 patients were seen. 51% were female, and the average age was 57 years old + 22. Cardiac indications were most common (52%) followed by diabetic complications (22%), cancer (16%) and stroke (10%). Patients with NCDs were more likely to be tachycardic, HR>100 bpm (OR 2.61 [P<0.001]), hypoxic with SPO2 <90% (OR 3.28 [P<0.0001]), hypotensive with blood pressure <100 mmHg (OR 2.65 [P<0.0001]), and tachypneic with respiratory rate >20 breaths per minute (OR 2.06 [P<0.0001]).

Conclusions Access to emergency services is essential for NCD management. Compared to other emergencies treated by SAMU in Kigali, Rwanda, the NCD cohort had a higher acuity despite being a smaller proportion. As NCDs increase, investment in robust prehospital care will have substantial value in LMICs.

Background

Non-communicable diseases (NCDs) are the leading cause of death globally with 41 million deaths per year and rising.[1] All but one of the ten leading causes of death in high-income countries (HIC) are related to NCDs.[2] Cardiovascular diseases, cancers, respiratory diseases, and diabetes account for over 80% of premature NCD deaths, those aged 30 to 69 years of age, worldwide.[1]

An epidemiological transition from communicable infectious diseases to NCDs is occurring in low-and middle-income countries (LMICs), as the incidence of NCDs in LMICs is rising.[3] Annually, 85% of all premature deaths in the world from NCDs occurred in LMICs.[1] By 2020, NCDs are estimated to contribute to 7 out of every 10 deaths in LMICs.[4] On the African continent, NCDs are estimated to become the most common cause of death by 2030.[5] This is leading to an impending crisis for many African LMICs which have made great strides in addressing communicable diseases but have not addressed NCDs.

Specific to Rwanda, NCDs are an increasingly important cause of morbidity and mortality, accounting for an estimated 36% of all deaths annually.[6] As of 2013, NCDs accounted for at least 52% of district hospital outpatient consultations and 22% of district hospital admissions according to the Rwanda Health Management Information Systems. The probability of premature death from one of the four major NCDs (cardiovascular disease, diabetes, cancer, and chronic respiratory diseases) in Rwanda is 19%.[7]

These NCDs result in life-threatening emergencies such as myocardial infarction, sepsis, coma, and seizures as well as significant morbidity, like limb amputation from delayed treatment. However, there is limited literature on management of NCD patients in the prehospital setting in Rwanda or in LMIC settings.

Service d'Aide Medicale Urgente (SAMU) is Rwanda's only public emergency medical service and sees nearly 4,000 patients per year.[8] SAMU has used an electronic prehospital registry since 2013 to track prehospital care in Kigali. In this paper we aimed to describe the incidence of NCD patients managed by SAMU in Kigali, Rwanda.

Methods

Study Context and Setting

Rwanda has a population of nearly 13 million people with 80% living in rural settings.[9] SAMU was established by the Rwandan Ministry of Health in 2007. It receives roughly 3,000 calls per month at the country's only 912 emergency call center located in Kigali.[8] SAMU has its own fleet of 13 ambulances in Kigali, but works with 270 total ambulances located at district hospitals throughout the country to provide emergency and transfer care for the entire population.

Data Collection and Patient Sample

SAMU staff complete a 'run sheet' for every patient encounter consisting of patient information including age, gender, vitals, location of incident, as well as management on the field and during transport. Data from patient run sheets was manually transferred and stored using an electronic registry in REDCap (Vanderbilt University; Nashville, Tennessee, USA) created in collaboration with Brigham Women's Hospital/Harvard Medical School, Virginia Commonwealth University (VCU), and SAMU.[8]

For this study, we evaluated the registry for all available data since inception on all patients with NCDs treated by SAMU. We focused on complaints related to cardiovascular diseases, diabetes, cancer and stroke. This cohort was compared to all-cause emergency patients seen by SAMU.

Variables

The registry captures demographics, disease information, field vital signs, presentation, treatment, and transportation. Additionally, the SAMU dispatch team uses a triage system categorizing urgency for each case as "absolute," "relative," or "no urgency" based on mechanism, clinical presentation and vital signs. We further classified the data using vital signs to determine acuity of illness. Systolic blood pressure (BP) less than 100 mmHg was considered hypotensive and greater than 160 mmHg hypertensive. Blood glucose was less than 60 mg/dL or 3.3 mmol/L was considered hypoglycemic and greater than 300 mg/dL or 11.1 mmol/L as hyperglycemic. Heart rate (HR) greater than or equal to 100 beats per minute was considered tachycardia and oxygen saturation (SpO2) less than 90% as hypoxic. Tachypnea

was a respiratory rate (RR) greater than or equal to 20. Shock index was calculated for all patients and defined as HR divided by systolic BP. Transport destinations used included referral hospitals (highest level of care), district hospitals (mid-level care), and health centers (primary care). Patients undergoing primary transportation were brought to their initial point of contact with the healthcare system while patients undergoing secondary transport were transferred between health facilities.

Data Analysis

The data was analyzed using descriptive statistics performed on SPSS version 25. Student's t-test, ANOVA, and chi square test were run with $p < 0.05$ considered significant. Significant findings were further quantified by calculating odds ratios. The Proportional Mortality Ratio was determined and compared mortality due to NCDs with all-cause mortality of all patients in the SAMU registry. Only patients with recorded values for a given variable were included in analysis.

Ethical Consideration

The Ministry of Health of Rwanda and VCU approved the study plan. The approval included access to patients' medical records. No informed consent was required. This project falls under a Memorandum of Understanding between the Ministry of Health of Rwanda and VCU to build trauma and emergency capacity in Rwanda.

Results

Demographics

SAMU responded to a total of 11,161 patients between December 2012 and May 2016, of which 832 patients (7.5%) had at least one diagnosed NCD. The average age was mean 57 years old (standard deviation ± 22) years and the median was 60 years old (IQR: 60–75). The largest age group was > 70 years, accounting for 32% of the NCD population. This population was significantly older than the average age of SAMU patients that did not have an NCD, which was mean 30.5 years old (± standard deviation 14.5, $p < 0.01$). 52% of patients were female (Table 1).

Table 1
Demographic information for patients with NCDs treated by SAMU

Demographic	N (%)
Age in years (Average, SD)	57 (± 22)
0–4	14 (2)
5–14	11 (1.5)
15–29	74 (9)
30–49	168 (21)
50–59	128 (16)
60–69	148 (18.5)
70+	260 (32)
Gender	
Female	426 (52)
Male	387 (48)

Non-Communicable Diseases

Diabetes and cardiac conditions composed the largest cohorts, representing 444 (53%) and 351 (42%) of all patients seen by SAMU over the study period respectively. Of the 444 patients presenting with diabetes, 96 (35%) were treated for hypoglycemia while 82 (30%) were treated for hyperglycemia. The most common cardiac complaint was hypertension (n = 187, 53%) followed by hypotension (n = 45, 13%) and chest pain (n = 30, 9%). There were 120 (1.0%) patients with cancer treated by SAMU. The most commonly identified cancer was prostate cancer (n = 21, 18%) followed by breast cancer (n = 16, 14%) and liver cancer (n = 15, 12.5%). A minority of patients were treated by SAMU for strokes (n = 67, 8%) (Table 2).

Table 2
Non-communicable disease emergencies treated by SAMU

Non-Communicable Disease	N (%)
Diabetes Mellitus	444 (53)
Heart Disease	351 (42)
Hypertension	187 (53)
Hypotension	45 (13)
Chest Pain	30 (4)
Cardiac Decompensation	11 (1)
Palpitations	9 (1)
Shock	7 (0.8)
Arrhythmia	5 (0.6)
Myocardial Infarction	5 (0.6)
Other	78 (9)
Cancer	120 (14)
Prostate	21 (3)
Breast	16 (2)
Liver	15 (2)
Cervical	11 (1)
Gastric	8 (1)
Colon	7 (0.8)
Lung	6 (0.7)
Throat	3 (0.4)
Skin	2 (0.2)
Uterine	1 (0.1)
Oral	1 (0.1)
Other	33 (4)
Stroke	67 (8)

Presentation

SAMU recorded vital signs upon arrival to the patient, and again depending on travel time to the hospital/health center. These findings, along with overall clinical presentation and stability, helped determine the urgency status of the patent. At the time of presentation there were 223 (28%) patients with tachypnea, 227 (28%) with tachycardia, 128 (16%) with SpO2 less than 90%, and 67 (9%) patients with hypotension. Abnormal vitals were significantly associated with NCDs compared to patients managed by SAMU without diagnosed NCDs ($p < 0.001$) (Table 3).

Table 3
Presentation of patients upon arrival of SAMU

	Presentation		
	NCDs	Non-NCDs	Odds [95% CI], p-value
Hypotension			3.6 [2.7, 4.8], p < 0.001
< 90	67 (9)	202 (2)	
≥ 90	734 (91)	7893 (98)	
Hypoxia			3.2 [2.6, 4.0], p < 0.001
< 90	128 (16)	460 (5)	
≥ 90	693 (84)	7977 (95)	
Tachypnea			2.5 [2.1, 3.0], p < 0.001
≤ 20	568 (72)	7112 (86)	
> 20	223 (28)	1112 (14)	
Tachycardia			2.4 [2.1, 2.9], p < 0.001
≤ 100	594 (72)	7310 (86)	
> 100	227 (28)	1141 (1141)	
GCS			
≤ 8	42 (5)	190 (2)	2.5 [1.8, 3.5], p < 0.001
9–12	165 (21)	446 (5)	
13–14	123 (15)	545 (6)	
15	472 (59)	7584 (87)	
Urgency			
No Urgency	44 (5)	1340 (13)	
Relative	545 (67)	7248 (72)	
Absolute	230 (28)	1534 (15)	2.2 [1.9, 2.6], p < 0.001
Death			
Yes	15 (2)	51 (1)	3.7 [2.1, 6.6], p < 0.001
No	738 (98)	9235 (99)	

Urgency status of each patient was determined by SAMU responders and classified as “Absolute,” “Relative,” or “No Urgency”. The majority of patients seen by SAMU were categorized as “Relative” (n = 545, 67%), but patients with NCDs had greater than 2 times the odds of being assigned an “Absolute” rating compared patients with no diagnosed NCDs (OR = 2.2 [CI 95% 1.9, 2.6], $p < 0.01$) (Table 3).

Treatment and Transport

Upon arriving at the scene, SAMU responders provided a number of interventions and made decisions regarding transportation. Many patients with NCDs underwent primary transportation from somewhere in the public to a health facility (n = 618, 75%). Most patients were transported within Kigali to the University Teaching Hospital - Kigali (CHUK) (n = 309, 40%) followed by Kibagabaga Hospital (n = 174, 22.5%) and King Faisal Hospital (n = 107, 14%). The average distance traveled by a patient was 19 Km (± 13.0) and ranged from 1 to 186 Km (IQR: 10–26). There were 49 (6%) patients who did not require transportation and 15 (2%) patients who died before SAMU arrived or before reaching a hospital (Table 4). The Proportional Mortality Ratio (PMR) of NCDs was 23% and patients with NCDs had greater than 3 times the odds of death compared to patients with no diagnosed NCDs (OR = 3.7 [CI 95% 2.1, 6.6], $p < 0.01$).

Table 4
Transportation Data

Primary Transportation	**618 (75%)**
Secondary Transportation	208 (25%)
Receiving Hospital	771 (92)
CHUK	309 (40)
Hospital Kibagabaga	174 (22.5)
King Faisal Hospital	107 (14)
Rwanda Military Hospital	57 (7)
Other	124 (16)
On Site Care Only	49 (6)
Death	15 (2)
Dead on arrival	6 (40)
Died during transfer	9 (60)

The most common interventions performed in the field by SAMU were the administration of fluids (NaCl 0.9% or Lactated Ringers) (n = 382, 46%) followed by oxygen therapy (n = 342, 41%). Over half had peripheral intravenous lines placed (n = 491, 59%). The medications used most frequently were diclofenac

(n = 29, 3.5%) and paracetamol (n = 20, 2.5%) followed by diazepam (n = 16, 2%) and morphine (n = 16, 2%). A total of 67 (n = 67, 8%) patients received pain medications (Table 5).

Table 5
Information regarding interventions and medications provided by SAMU upon arrival. Percentages based on total population of NCD patients (832).

Interventions	**N (%)**
Peripheral IV	491 (59)
Fluids (NaCl 0.9%, LR)	381 (46)
Oxygen Therapy	342 (41)
Dextrose 5% IV Infusion	150 (18)
Cervical Collar	37 (4.5)
Intubation	31 (4)
Dextrose 50% IV Infusion	25 (3)
Wound Dressing	13 (1.5)
Immobilization	11 (1.5)
Medications	N (%)
Diclofenac	29 (3.5)
Paracetamol	20 (2.5)
Diazepam	16 (2)
Morphine	16 (2)
Phenobarbital	12 (1.5)
Adrenaline	11 (1.5)
Pethidine	3 (0.5)
Buscopan	3 (0.5)
Ibuprofen	2 (0.2)
Chlorpromazine	2 (0.2)
Cimetidine	2 (0.2)
Dexamethasone	2 (0.2)
Ephedrine	2 (0.2)

Interventions	N (%)
Salbutamol	2 (0.2)
Thiopental Sodium	1 (0.1)
Succinylcholine	1 (0.1)
Aspirin	1 (0.1)

Discussion

This is one of the first studies to look at management of NCDs in an LMIC setting. In Kigali, Rwanda, the SAMU prehospital ambulance service routinely manages NCD-related cases, although at a smaller proportion than obstetric and traumatic cases. However, these NCD patients tended to be older and more critically ill and have higher odds of dying than the rest of SAMU patients based on Proportional Mortality Ratio.

SAMU patients with NCDs had more vital sign derangements than other emergency patients. This may be because of delays in recognition of illness, delays in accessing care, and/or delays in availability of quality services. In obstetrics and gynecology, the three delay model describes delays: deciding to seek appropriate medical help for an obstetric emergency, reaching an appropriate obstetric facility, and receiving adequate care when a facility is reached.[10] This model can be translated to delays for NCDs. Patients in many LMICs experience delays in care-seeking generally due to sociocultural factors.[11,12] Lack of awareness of NCDs by the public or by medical staff, cultural practices contributing to delays in accessing care, cost of accessing care, shortages of staff or complexities of the current healthcare system may contribute to challenges for patients with NCDs. The general public may not be aware of the signs and symptoms of NCDs to seek help. The symptoms may be vague; for example, nausea and heartburn are known to be atypical symptoms of myocardial infarction in HIC settings.[13] The medical staff may not be familiar with signs and symptoms of acute NCDs since these are still fairly underrecognized. Lack of training and lack of nurses were previously described as barriers to adequate ICU care in LMICs.[14]

Cultural practices may lead to delays in seeking care. Patients may seek care from traditional healers, for example.[15,16,17] These barriers to care have been noted across a variety of settings, in both HICs and LMICs.[18,19]

The infrastructure of the health care system may also be a barrier. The referral system acts as a gatekeeping mechanism and may limit getting care for emergent conditions since patients need to progress to higher levels through the system. Furthermore, the healthcare system does not currently have advanced capabilities such as a cardiac catheterization lab, neurointerventional operating room, or cardiac surgical care currently – which would be necessary to manage conditions such as myocardial

infarction and stroke. These resources are being discussed at this time but would require time to deploy and only be available in Kigali. The AFRICARDIO2015 team has developed a consensus statement highlighting the need for equipping first line healthcare facilities with electrocardiograms, emergency rooms in large towns to have fibrinolytic therapy and large cities to have percutaneous cardiology intervention facilities.[20] These factors will need to be addressed to decrease the acuity of patients with NCDs and offer them the best chances for good outcomes in Rwanda. Prehospital care is one area of investment that may be low-hanging fruit since these staff can address all causes of emergencies, including NCDs. The Ministry of Health's investment in SAMU since 2007 is noteworthy and likely to increase in necessity over time.

SAMU patients with NCDs were much older than patients without NCDs. However, deaths between the ages of 30 and 69 years old are considered premature and therefore potentially preventable. Globally, 15 million deaths are attributed to NCDs in this age group.[1] SAMUs largest cohort of NCD patients was over 60 years old suggesting that the increase in life-expectancy over the last two decades in Rwanda may have resulted in a population that is aging and therefore at risk for developing NCDs. Another possible explanation may be that younger patients with NCDs may access care differently compared to this older cohort – whether that means taking private transport to the hospital instead of calling the ambulance service or seeking care outside the country. Economy recovery in the last 25 years may have contributed to a well-to-do portion of the population that does not use the public emergency system. These are all areas that require further research in Rwanda.

Lastly, public education on NCDs and their risk factors will be increasingly important as NCDs displace communicable diseases. In 2017, NCDs had the largest risk-attributable burden of any disease globally.[21] As primary health care in Rwanda improves, a health-literate population may be more likely to incorporate risk reduction strategies to decrease the incidence of NCDs. Risk factors of NCDs such as tobacco use, physical inactivity, excessive use of alcohol, and unhealthy diet are becoming more common as countries urbanize.[5,21] The Ministry of Health of Rwanda is working towards a national goal to reduce 80% of premature deaths caused by NCDs or by injury in people under 40 years of age by the year 2020 through two initiatives: car-free day and "80 × 40 × 20".[22,23] Car-free day occurs twice a month, where parts of the city of Kigali close their roads and hold physical activities for the public to encourage a healthy lifestyle. 80 × 40 × 20 is These are valuable long-term strategies to decrease the incidence of NCDs and their attendant emergencies.

Our study has several limitations. This study was limited to the prehospital setting. Patients were not followed through the emergency department or hospital stays because no infrastructure exists yet to connect data across these settings. This study, therefore, did not aim to study patient outcomes or whether patients received the correct treatment for their complaint. The data collection and entry process may have limitations from entry errors as well as omission and transcription errors. SAMU holds daily morning meetings to discuss patients seen during the last 24 hours which provides an internal check on the information logged into the run sheets, but no formal audit has been conducted of this data set.

Finally, the patients with NCDs represented a small subset of the overall population therefore subgroup analyses are limited due to insufficient sample size to make valid statistical comparisons. Nevertheless, it is valuable to understand the care provided by SAMU for NCDs in Kigali using the best available data. Future directions may include creating data infrastructure to study patient outcomes and intervention studies to determine if prehospital interventions may reduce the mortality and morbidity from NCDs in LMIC settings.

Conclusion

This study shows that LMICs such as Rwanda must be more prepared for the rising tide of NCDs. LMIC health systems will need resources to manage these complicated and critically ill patients as NCDs become more prevalent. Prehospital services such as SAMU will have an essential role in stabilizing these critically ill patients and transporting them to appropriate centers that offer expert care. As the incidence of NCDs increases, investment into emergency departments, cardiac units, and critical care facilities will be vital to address the epidemiologic transition to NCDs.

Abbreviations

BP-Blood Pressure

HIC- High-Income Country

HR- Heart Rate

LMIC- Low-and-Middle-Income-Country

NCD- Non-communicable Disease

RR- Respiratory Rate

SAMU- Service d'Aide Medicale Urgente

SPO2- Oxygen Saturation

VCU- Virginia Commonwealth University

Declarations

Ethics Approval and Consent to Participate

The Ministry of Health of Rwanda and VCU approved the study plan, IRB number HM20011011. The approval included access to patients' medical records. No informed consent was required. This project falls under a Memorandum of Understanding between the Ministry of Health of Rwanda and VCU to build trauma and emergency capacity in Rwanda.

Consent for Publication:

All authors and institutions consent to the publication of this information.

Competing Interests:

None of the authors have any conflicts of interest.

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Authors Contributions:

All authors have made substantial contributions to the design of the study, data analysis and interpretation, drafting the article, critical revisions or final approval of the version to be submitted.

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Availability of Data and Material:

Data can be available upon reasonable request.

References

1. Non communicable diseases. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases. Accessed 19 Nov 2019.
2. WHO | The top 10 causes of death. (2017). https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death Accessed 19 Nov 2019.
3. Islam, S. M. S. *et al.* Non-communicable diseases (NCDs) in developing countries: a symposium report. *Global. Health.* 2014;10:81.
4. Diseases, on N. GLOBAL STATUS REPORT. https://www.who.int/nmh/publications/ncd_report2010/en/ Accessed 19 Nov 2019.
5. Making some noise about noncommunicable diseases in Rwanda | | Blogs | CDC. https://blogs.cdc.gov/global/2017/08/28/making-some-noise-rwanda/. Accessed 19 Nov 2019.
6. *Non Communicable Disease Policy*. http://moh.gov.rw/fileadmin/templates/policies/NCDs_Policy.2015.pdf (2015). Accessed 19 Nov 2019.

7. *Non Communicable Disease (NCD) Country Profiles: Rwanda*. https://www.who.int/nmh/countries/rwa_en.pdf (2018). Accessed 19 Nov 2019.
8. Enumah, S. *et al.* Rwanda's Model Prehospital Emergency Care Service: A Two-year Review of Patient Demographics and Injury Patterns in Kigali. *Prehosp. Disaster Med.* 2016;31:614–620.
9. Size of the resident population | National Institute of Statistics Rwanda. http://www.statistics.gov.rw/publication/size-resident-population. Accessed 19 Nov 2019.
10. Combs Thorsen, V., Sundby, J. & Malata, A. Piecing together the maternal death puzzle through narratives: the three delays model revisited. *PLoS One.* 2012;**7:**e52090.
11. Sikder, S. S. *et al.* Care-seeking patterns for fatal non-communicable diseases among women of reproductive age in rural northwest Bangladesh. *BMC Womens. Health* 2012;12:23.
12. Lopes Ibanez-Gonzalez, D., Mendenhall, E. & Norris, S. A. A mixed methods exploration of patterns of healthcare utilization of urban women with non-communicable disease in South Africa. *BMC Health Serv. Res.* 2014;14:528.
13. Brieger, D. *et al.* Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the Global Registry of Acute Coronary Events. *Chest.* 2004;126:461–469.
14. Haniffa, R. *et al.* Improving ICU services in resource-limited settings: Perceptions of ICU workers from low-middle-, and high-income countries. *J. Crit. Care.* 2018;44:352–356.
15. Pace, L. E. *et al.* Delays in Breast Cancer Presentation and Diagnosis at Two Rural Cancer Referral Centers in Rwanda. *Oncologist.* 2015;20:780–788.
16. Umuhoza, C., Karambizi, A. C., Tuyisenge, L. & Cartledge, P. Caregiver delay in seeking healthcare during the acute phase of pediatric illness, Kigali, Rwanda. *Pan Afr. Med. J.* 2018;30:160.
17. Manzi, A. *et al.* Assessing predictors of delayed antenatal care visits in Rwanda: a secondary analysis of Rwanda demographic and health survey 2010. *BMC Pregnancy Childbirth.* 2014;14:290.
18. Brinton, L. *et al.* Factors contributing to delays in diagnosis of breast cancers in Ghana, West Africa. *Breast Cancer Res. Treat.* 2017;162:105–114.
19. Price, A. J., Ndom, P., Atenguena, E., Mambou Nouemssi, J. P. & Ryder, R. W. Cancer care challenges in developing countries. *Cancer.* 2012;118:3627–3635.
20. Kakou-Guikahue, M. *et al.* Optimizing the management of acute coronary syndromes in sub-Saharan Africa: A statement from the AFRICARDIO 2015 Consensus Team. *Arch. Cardiovasc. Dis.* 2016;109:376–383.
21. Stanaway, J. D. *et al.* Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet.* 2018;392:1923–1994.
22. Car-free day: What is the impact? *The New Times | Rwanda* https://www.newtimes.co.rw/lifestyle/car-free-day-what-impact (2018). Accessed 19 Nov 2019.

23. Binagwaho, A., Muhimpundu, M. A., Bukhman, G. & NCD Synergies Group. 80 under 40 by 2020: an equity agenda for NCDs and injuries. *Lancet.* 2014;383:3–4.