CHARACTERIZATION OF ROAD TRAFFIC INJURIES AT HOSPITAL TRAUMATOLOGICO NEY ARIAS LORA IN SANTO DOMINGO, DOMINICAN REPUBLIC

by

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ABSTRACT

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Background

Over 1.35 million people die each year due to road traffic accidents (RTAs), and up to 50 million more sustain non-fatal injuries. They are the eighth leading cause of death worldwide, and the primary cause of death in young people between the ages of 15 and 29. Our study focused on RTAs in the second largest trauma hospital in the capital city of the Dominican Republic, Santo Domingo. The country currently claims the fifth spot globally for deaths due to road traffic accidents per capita, and is second globally for fatalities due to motorcycle accidents.

Objective

The objective of this study is to gather pertinent information about RTAs suffered by 362 patients admitted to Hospital Traumatológico Ney Arias Lora (HTNAL) to then inform interventions to decrease RTAs and the severity of their resulting injuries.

Methods

This study involves an analysis of several factors of RTAs suffered by patients admitted to HTNAL. These include gender, age, rural or urban location, the kind of vehicle, the number of passengers per vehicle; whether the patient was a driver, passenger, or pedestrian; the kinematics of the accident, the use and/or availability of 911, the distance from the hospital, time of day, the influence of alcohol, the use of a helmet or seatbelt, length of stay in the hospital, the kind of injury, the severity of the injury, and resulting permanent disability or death. Inclusion criteria were any patient admitted after sustaining injuries in a motor vehicle accident. There were no exclusion criteria.

Researchers performed a retrospective paper chart review on 120 charts from 2013-2014, before the institution of a 911 system, and 125 charts from the beginning of 2017, after a 911 system had been in place for over two years.

Due to lack of much of the data from the aforementioned list of factors within the charts, researchers also interviewed 117 patients and/or their family members who were admitted to HTNAL during July 2017. Verbal consent was obtained prior to each interview.

Results

Of the 362 patients included in this study, 85.4% were male and 14.6% were female. The mortality rate was 11.3% for males and 7.5% for females, for an overall rate of 10.8%. 12.9% of motorcyclists died in the hospital, compared with 2.9% of automobile occupants and 4.3% of pedestrians. Over half of the patients were involved in a traffic

accident in Santo Domingo (52.3%). The average distance travelled for patients who were referred to HTNAL was 90.1 km. The highest frequency of accidents per hour occurred during evening rush hour on weekdays. The overwhelming majority of admitted patients were driving or riding a moto (two-wheel vehicles, such as motorcycles and mopeds), and this trend was more evident among males (81.7% of males, 49% of females). Only 21.8% of motorcyclists were recorded wearing a helmet, and none of the helmet users in this study died. The most common injury among motorcyclists was definite moderate/severe traumatic brain injuries (39.1%). Non-helmet users were 4.6 times more likely to suffer a TBI than those who did (95% CI: [1.4, 15.4]), and patients who suffered a definite moderate/severe traumatic brain injury were 11.6 times more likely to die than those who did not (OR = 11.6, 95%CI: (4.73, 28.22)).

Conclusion

Death due to motor vehicle accidents is a public health crisis in the Dominican Republic. The root of this problem is multifactorial, as are the solutions. In this study, all of the deaths from motorcycle accidents were secondary to TBI in non-helmet users. This highlights one solution that could have a large effect on survivability after accidents—proper helmet usage. This could be done through public health campaigns, more rigorous enforcement of helmet laws, and programs to distribute helmets. Other possible solutions include improving data systems such as trauma registries and medical charting, continual assessment of road quality and identification of hotspots for accidents, and QI evaluations of pre-hospital care and trauma protocols.

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PRIOR PUBLICATIONS & PRESENTATIONS

Reddy S, **Walsh M**, Paulino-Ramirez R, Florenzán J, Fernández J, Nwariaku F, Abdelnaby A. "Neurologic injuries following road traffic accidents in the Dominican Republic: Examining causes and potential solutions." Traffic Injury Prevention, 20:7, 690-695, DOI 10.1080/15389588.2019.1643016

Walsh M, Chang M, Villalon N. "The Epidemiology of Kidney Stone Disease in Saipan from 2015-2018," Poster Presentation and Abstract at Consortium of Universities for Global Health 2019.

Reddy S, **Walsh M**, Paulino-Ramirez R, Fernandez J, Florenzan J, Abdelnaby A. "Analysis of Road Traffic Accidents at Hospital Traumatológico Ney Arias Lora in the Dominican Republic," Poster Presentation and Abstract at Consortium of Universities for Global Health 2018.

Walsh M, Reddy S, Paulino-Ramirez R, Fernandez J, Florenzan J, Abdelnaby A. "Neurological Injuries Sustained in Road Traffic Accidents in Santo Domingo," Poster Presentation and Abstract at Unite for Sight 2018.

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LIST OF DEFINITIONS

DALY – Disability-adjusted life years

LIC – Low-income country

LMIC – Low- and middle- income country

MIC – Middle-income country

Moto – motorized two- and three-wheeled vehicles, including motorcycles, mopeds, and motorized scooters

MTW – motorized two-wheeled vehicle

MVA – Motor vehicle accident

RTA – Road Traffic Accident

RTI – Road traffic injury

YLL – Years of life lost

CHAPTER ONE
Introduction

An estimated 1.35 million people died due to road traffic accidents (RTA) in 2016, and an estimated 50 million more sustained non-fatal injuries. RTAs are currently the 8th most common cause of death worldwide, and the leading cause of death among people ages 5-29 years old. (6). The death and disability resulting from RTAs disproportionately affects low- and middle-income countries (LMICs). Worldwide, the rate of road traffic deaths has stabilized relative to the population of the world and number of vehicles on the road. However, this progress has benefitted only the richer nations of the world; no low-income country has seen a reduction in road traffic deaths since 2013, as opposed to improvements in 48 middle- and higher-income countries between 2013 and 2016. (6) Only 1% of the world's vehicles are found in low-income countries (LICs), yet 13% of road traffic deaths occur here. (6) Without appropriate intervention, these statistics are likely to rise, especially in nations experiencing rapid economic growth. (17) The roots of this problem are multifactorial, spanning infrastructure, law enforcement, public health efforts, and timely access to quality medical care.

Our study focuses on RTAs in the Dominican Republic (DR), a vibrant nation that shares the island of Hispaniola with Haiti. The DR is classified as a middle-income country (MIC), and has the largest economy in the Caribbean. The World Bank estimates that 30.5% of the Dominican population lived below the DR's national poverty line in 2016 (13). The DR, like much of the rest of the world, has experienced a major population shift from rural areas to urban ones. From 1960 to 2014, the percentage of the

population living in rural areas dropped from 70% to 20%. 27.63% of the Dominican population lives within its capital city of Santo Domingo (14). This trend towards urbanization, combined with a growing economy, contributed to an increased density of vehicles in urban areas.

On a global scale, the Dominican Republic fares poorly in terms of road safety. It currently ranks 5th for the most road traffic deaths per capita, with 34.6 deaths per 100,000 people according to the Global Status Report on Road Safety (2018) (6). This figure is an increase from the reported 29.3 deaths per 100,000 people from the 2015 Global Status Report on Road Safety (7). The largest proportion (67%) of these motor vehicle accidents involve motorcycles. The DR ranks second worldwide for motorcycle deaths, with 23.2 deaths per 100,000 people. Of the approximately 3.9 million registered vehicles in the DR, motorcycles comprise 2.1 million of them (6.) Motorcycles are less expensive than automobiles, and are often the only feasible mode of transportation for Dominicans navigating to and from work.

Of note, men account for 88% of these fatalities. Road traffic accidents are responsible for 18.9% of the total deaths of men between the ages of 15 and 49 in the Dominican Republic (5). Men in this age range are also in their peak earning years and are often the breadwinners of their household. Therefore, in addition to being an enormous personal tragedy, RTAs harm the economic prosperity of the Dominican Republic. The World Bank estimates that halving the number of road traffic injuries (RTIs) would result in a 7-22% increase in a middle-incomes GDP (17).

The data collected in this study is from patients admitted to Hospital Traumatológico Ney Arias Lora (HTNAL), one of two trauma centers in the capital city

of Santo Domingo. The third and last trauma center in the Dominican Republic is located in the second most populous city, Santiago. As a result, this hospital serves a large percentage of the Dominican population and receives referrals from all over the country. The death and disability resulting from RTAs is a public health crisis in the Dominican Republic. This study aims to contribute to the body of research that must be done in order to reduce the heavy burden of this issue.

CHAPTER TWO
Methods

This study involved gathering data about road traffic accidents suffered by patients admitted to HTNAL. Factors that were analyzed include gender, age, rural or urban location, the kind of vehicle, the number of passengers per vehicle; whether the patient was a driver, passenger, or pedestrian; the kinematics of the accident, the use and/or availability of 911, the distance from the hospital, time of day, the influence of alcohol, the use of a helmet or seatbelt, length of stay in the hospital, the kind of injury, the severity of the injury, and resulting permanent disability or death. Inclusion criteria included patients admitted to HTNAL for management of RTIs. There was no exclusion criteria.

HTNAL is a tertiary referral center and trauma center located in Santo Domingo. It has 177 inpatient beds, 20 of which are in the ICU, an emergency department, and 10 operating rooms for neurosurgery, orthopedic surgery, and general surgery. This study was approved by the IRB at UT Southwestern and the Comite de Etica at Universidad Iberoamericana (UNIBE). Dr. Jaime Fernandez, academic subdirector at HTNAL, also gave his formal approval for this project.

There were two components of data collection. The first involved a retrospective paper chart review of patients admitted to HTNAL for management of their RTIs. The informatics department identified these patients by searching the patient database for "accidente de tráfico" and related identifiers. A subset of these patient's charts were located in cardboard boxes, and researchers gathered as many of the aforementioned factors listed above. Ultimately, information was gathered from 120 charts from 2013-

2014, before a 911 system had been instituted in June 2014, and 125 charts from the beginning of 2017, once the system had been running for approximately 2.5 years.

Some of the desired information was not routinely included in patient documentation, such as helmet usage or drink driving, so researchers decided to include a prospective component to the study. Researchers interviewed 117 patients, and/or their medical guardians, who were admitted to HTNAL in July 2017. Verbal consent was obtained prior to inclusion in the study.

In total, 362 patients were included in this study. Information gathered from the separate methods of data collection were analyzed together when applicable, and apart when not possible – for example, data about patient behavior and specifics of the accident which could only be gathered through interviews.

The vehicles involved in crashes were categorized as either "automobile" or "moto". "Automobile" includes four-wheel vehicles, such as cars, SUVs, and pickup trucks, as well as vehicles with more than two axles, such as 18-wheelers or buses. There was not enough data to subdivide this group further. "Moto" describes two-wheel vehicles, such as motorcycles and mopeds. Motorcycles in the Dominican Republic are more likely to be smaller motorbikes than the typical image of a Harley Davidson.

To approximate the extent of traumatic brain injury (TBI), researchers utilized the Mayo Classification for Injury Severity. This TBI classification system was utilized rather than older classification schemes that rely on a single metric, because information regarding the Glasgow Coma Scale (GCS) and loss of consciousness was often not recorded. In addition, many patients arrived under sedation, rendering a GCS non-assessable. In the cases of these sedated patients, the soonest recorded GCS was used.

Statistical analysis was calculated using Microsoft Excel and R-Studio. Statistical significance was set as $p < 0.05$.

CHAPTER THREE
Results

DEMOGRAPHICS

As mentioned, this study includes information from 245 patient charts, and 117 patient surveys. All patients were admitted to HTNAL for management of injuries following a motor vehicle accident. 309 patients (84.4%) were male, and 53 patients (14.6%) were female. . The mortality rate was 11.3% for males and 7.5% for females, for an overall rate of 10.8%. The average age for all patients was 34.6, with an average age for men at 34 and women at 37.9. The modal age group of 15-30 years accounted for 48.1% of the patients. There was a sharp contrast between the age groups involved in RTAs for each mode of transportation. Motorcycle drivers were on average 31.1 years old, which was 17.3 years younger than the average pedestrian (95% CI (11.4, 23.2)) and 7.6 years younger than the average automobile occupant (95% CI (0.8, 14.34)). Among male and female patients, the most common vehicle involved in an accident was a motorcycle (77%), with pedestrian being second most common (13.4%), and automobile being last (9.7%). A higher percentage of male patients (80%) were involved in motorcycle accidents compared to female patients (47%).

The location where an accident occurred was identified for 258 patients. 141 of the accidents (54.7%) occurred in an urban environment, which is defined as a population density greater than 300 people per kilometer. The remaining 45.35% of accidents occurred in a rural environment. Patients from rural areas had on average a lower initial GCS score (12.8), than patients from urban environments (13.3). However, this finding was not statistically significant. Out of the known locations of the accidents, a majority of

accidents occurred within Santo Domingo (31.7%), followed by San Cristobal (7.2%), Bani (7.2%), and Barahona (4.1%). 156 patients (43%) initially presented at another hospital, 41 of whom initially went to another hospital within Santo Domingo. The average distance travelled for referred patients was 90.1 km.

	Male	Female	Total
Gender	309 (84.4%)	53 (14.6%)	362
Vehicle Type			
Pedestrian	38 (10.8%)	9 (2.6%)	47 (13.4%)
Moto	246 (69.9%)	25 (7.1%)	271 (77%)
Automobile	32 (9.1%)	2 (0.6%)	34 (9.7%)
Unknown	8 (2.2%)	2 (0.6%)	10 (2.8%)
Average Age	34 (SD=15.0)	37.9 (SD=15.4)	34.6 (SD=15.1)
Pedestrian	51 (SD=17.5)	46.1 (SD=18.8)	49.5 (SD=17.8)
Moto	31.2 (SD=12.9)	32.4 (SD=11.5)	31.3 (SD=12.8)
Vehicle	39.4 (SD=14.8)	37.5 (SD=14.1)	38.7 (SD=14.6)
Location			
Santo Domingo	93 (25.6%)	22 (6.1%)	115 (31.7%)
San Cristobal	21 (5.8%)	5 (1.4%)	26 (7.2%)
Bani	15 (4.1%)	0 (0%)	15 (7.2%)
Barahona	11 (3.0%)	1 (.3%)	12 (4.1%)
Other	78 (21.5%)	13 (3.6%)	92 (25.3%)
Unknown	91 (25.1%)	12 (3.31%)	103 (28.4%)

Figure 1: Gender Breakdown of Vehicle Type, Age, and Location of Accident

In June 2014, a 911 system was instituted in the Dominican Republic. 120 patients had their accidents prior to this time. 242 patients, from both the retrospective

and surveyed patients, had their accidents once 911 was in place. 911 is available in Santo Domingo, San Cristobal, San Gregorio de Nigua, and Bajos de Haina (1). Out of the patients who had their accidents once 911 was instituted in the Dominican Republic, 62 (30.4%) of patients used 911. 66 (32.4%) of those patients were living in areas where 911 was not available, and 76 (37.3%) of those patients lived in one of the above cities with 911 access and did not use it. The average Glasgow Coma Scale (GCS) score for patients who used 911 was 14.1, and the average GCS for patients who did not use GCS was 13.0. There was not a statistically significant difference between these scores.

ACCIDENT DETAILS

The most common type of accident was between a motorcycle and an automobile, followed by two motorcycles, and then single motorcycle crashes. Although pedestrian-automobile accidents only accounted for 3.9% of accidents, they had the highest all-cause in-hospital

	Number (n=353)	Mortality Rate
Motorcycle Accidents	271 (76.8%)	36 (15%)
Moto-Moto	57 (16.1%)	11 (19.3%)
Moto-Auto	87 (24.6%)	11 (12.6%)
Single-Moto	50 (14.2%)	2 (4.0%)
Moto-Pedestrian	0 (0%)	0 (0%)
Vehicle Accidents	34 (9.6%)	3 (8.8%)
Auto-Auto	11 (3.0%)	1 (9.1%)
Auto-Pedestrian	0 (0%)	0 (0%)
Auto-Moto	3 (0.8%)	0 (0%)
Single-Auto	15 (4.2%)	2 (13.3%)
Pedestrian	45 (12.4%)	3 (7.1%)
Pedestrian-Moto	28 (7.9%)	0 (0%)
Pedestrian-Auto	14 (3.9%)	3(21.4%)

Figure 2: Mortality Rates and Vehicle Type

mortality rate at 21.4%. The second highest all-cause in-hospital mortality rate was among accidents with two MTWs.

Nearly half of the accidents occurred on the weekends (48.2%). Saturday and Sunday were associated with 65% of alcohol-related accidents. The time of day with the highest frequency of accidents per hour was the late afternoon/early evening (4:00 pm to 8:00 pm).

	Males (n=93)	Females (n=24)	Total (n=117)	Died	Mortality Rate
Motorcycle Accidents	76 (87.4%)	11 (12.6%)	87 (74.4%)	10	11.5%
Helmet Use - Yes	18 (23.7%)	1 (9.1%)	19 (21.8%)	0	0%
Helmet Use - No	57 (75.0%)	10 (90.9%)	67 (77.0%)	9	13.4%
Helmet Use - Unknown	2 (2.6%)	0 (0%)	2 (2.3%)	1	n/a
Automobile Accidents	9 (60.0%)	6 (40.0%)	15 (12.8%)	3	20%
Seatbelt Use - Yes	4 (44.4%)	0 (0%)	4 (26.7%)	0	0%
Seatbelt Use - No	2 (22.2%)	6 (100%)	8 (53.3%)	3	37.5%
Seatbelt Use - Unknown	3 (33.3)	0 (0%)	3 (20.0%)	0	n/a
Alcohol Usage					
Yes	24 (25.8%)	2 (8.3%)	26 (22.2%)	2	7.7%
No	58 (62.4%)	15 (62.5%)	73 (62.4%)	9	12.3%
Unknown	11 (11.8%)	7 (29.2%)	18 (15.4%)	3	n/a

Figure 3: Helmet, Seatbelts, and Alcohol Usage

Helmet use among patients who were involved in motorcycle accidents was 21.8%. A larger percentage of male patients wore a helmet than female patients. The

mortality rate among patients who didn't use a helmet was 13.4% of motorcycle accidents from data collected in the prospective component of the study. The mortality rate of helmet users was 0%. The non-helmet users had a mortality rate of 13.4%. Injuries sustained by non-helmet users were more severe than helmet users. Non-helmet users were 4.6 times more likely to suffer a TBI than those who did (95% CI: [1.4, 15.4]), and non-helmet users had an initial average GCS that was 1.6 points lower than those who did not (95% CI: [0.6, 2.6]).

Alcohol use was reported among 22.2% of surveyed patients. Men had a higher percentage of alcohol use in their accidents than women. Mortality rates were 7.7% in alcohol users and 12.3% in non-alcohol users. There was not a statistically significant impact of alcohol use on mortality rates compared to no alcohol use.

INJURIES & OUTCOMES

The most common kind of injury among all kinds of accidents was a TBI. Motorcyclists most commonly suffered definite moderate/severe traumatic brain injuries (39.1%). Within the category of head injuries, the most common injuries suffered by motorcyclists were subarachnoid hemorrhages (12.2%) and cerebral edema (10.3%). The most common musculoskeletal injuries amongst motorcyclists were tibial fractures (25.8%), femur fractures (19.6%), and fibula fractures (11.8%).

Amongst automobile occupants, the most common injuries were definite moderate/severe traumatic brain injuries (23.5%), femur fractures (20.6%), tibial fractures (17.6%), and fibula fractures (11.8%). Amongst pedestrians, the most common

injuries were tibia fractures (23.4%), fibula fractures (21.3%), and thoracoabdominal trauma (10.6%).

Moto (n=271)		Automobile (n=34)		Pedestrian (n=47)	
TBI	41.7%	TBI	26.5%	TBI	42.6%
Tibia Fracture	25.8%	Femur Fracture	20.6%	Tibia Fracture	40.4%
Femur Fracture	19.6%	Tibia Fracture	17.6%	Fibula Fracture	21.3%
Subarachnoid hemorrhage	12.2%	Fx fibula	11.8%	Cerebral contusion	12.8%
Fibula Fracture	11.8%	Vertbro-medullary trauma	11.8%	Thoracoabdominal trauma	12.8%

Figure 4: Most Common Injuries

The injuries that corresponded to higher risk of death were traumatic brain injuries, subarachnoid hemorrhages, cerebral edema, subdural hematomas, hemorrhagic contusions, intraparenchymal hematomas, cerebral contusions, and loss of consciousness for more than 24 hours. Patients who were unconscious for more than 24 hours were 41.5 times more likely to die than patients who were not (OR = 41.5, 95%CI: (16.16, 106.28)). Furthermore, patients who suffered a definite moderate/severe traumatic brain injury were 11.6 times more likely to die than those who did not (OR = 11.6, 95%CI: (4.73, 28.22)).

LIMITATIONS

Limitations in this study mainly involved the process of gathering data. The paper charts were written in Spanish, sometimes in illegible handwriting. Researchers did their best to interpret the information in the chart and accurately gather the data. Additionally, the charts often did not include information about alcohol use, helmet use, and seatbelt use, among other details about the accident. While this was partially remedied by the data gathered from the survey, a larger sample size would have provided more details. Automobile and pedestrian accidents were a small proportion of the accidents in this study. The sample sizes of these two demographics were also often too small to yield a statistically significant analysis.

The pivot to a survey was essential to gather details about the accident that the charts could not offer. A limitation of any survey is that it is self-reported data. Patients may have omitted certain details the accidents, especially ones that are illegal, ie: driving under the influence or without a helmet. This must be considered when interpreting the data.

CHAPTER FOUR
Discussion

Much of the data gathered in this study is consistent with results found in other studies about road traffic accidents. The most common vehicle involved is a motorcycle, there were more male patients than female patients, and injuries and fatalities were most common among patients between the ages of 15 and 30. A majority of motorcycle riders do not use helmets, and those who do not use helmets are more likely to suffer a TBI, which is associated with a higher risk of death. The ultimate takeaway is that this study reinforces that RTAs are a frequent cause of death and disability in the Dominican Republic, and many of these injuries are preventable. The WHO identifies five areas of focus to reduce RTAs and improve outcomes: institutional management, legislation and road user behavior, safe roads, safe vehicles, and post-crash care. (6)

The institutional management component involves sustainable funding, national strategies and goals, and effective leadership and coordination between agencies. The UN adopted a series of Sustainable Development Goals related to road safety, including an overall goal to reduce road traffic deaths and injuries by half. Among the twelve specific targets include new roads meeting safety standards, rehabilitation of roads that do not meet safety standards, increasing helmet usage, and decreasing driving under the influence (6). The Dominican Republic's lead agency is called INTRANT, and it receives national funding. Their current goal is a 30% in fatality reductions by 2020. This reflects progress from the Global Status Report on Road Safety published in 2015, where there was no lead agency or national road safety strategy (6). The crisis of road safety has become a priority for leaders of all levels in the Dominican Republic. For example, the

general director of HTNAL, Dr. Amaury Garcia Silverio, made a media appearance on local news program Enfoque Nacional to discuss the toll that traffic accidents take on the Dominican Republic. He believes that educating younger people and enforcing traffic laws are the key to reducing injuries, deaths, and costs due to traffic accidents. In addition to speaking out on the local news, he also began an educational program to teach mototaxi drivers about the importance of wearing a helmet and respecting traffic laws (11). Ongoing studies will be needed to evaluate the efficacy of these national and local efforts.

Changing road user behavior is one of the most effective ways to reduce traffic accidents and reduce the severity of road traffic injuries. A 1% decrease in speed decreases the risk of death by 4% and the risk of serious injury by 3%. Wearing a helmet decreases the risk of serious head injury by 69% and the risk of death by 42%. The Dominican Republic has laws regarding many aspects of road user behavior and meets the WHO's gold standard for many of them, including requiring all occupants of automobiles to wear seatbelts, all passengers and drivers of motorcycles to wear motorcycles, and strict drink-driving laws with random breath testing. However, the WHO measures helmet usage to be at 27% and seatbelt usage to be 18%. (5) Results were similarly underwhelming from our study, at 21.8% and 26.7% respectively.

Even when appropriate legislation exists, enforcement is necessary for these laws to be enforced. According to the Metropolitan Transit Authority (AMET), there were over 3,400 Dominicans with 50 or more unpaid traffic fines in 2013. Under 10% of the tens of thousands and tickets written each year for speeding infractions, lack of helmet, or running red lights are ultimately paid (4) . Improving road user accountability would

likely result in safer behavior on the roads and fewer hospitalized patients. The Dominican Republic can look to Vietnam, another LMIC, as an example on how to increase helmet usage. Vietnam passed a strict helmet law which increased helmet usage from 40% to 93% from 2007 to 2009. Its success is credited to the steep fine violators pay, combined with relentless advocacy programs. The law saved an estimated 1600 lives in its first year (19).

A majority of all road traffic fatalities and serious injuries are reported to occur on the same 10% of roads within most countries and cities. (6) This study was not able to collect geographical data precise enough to determine if there were particular streets where multiple patients were having accidents, but this evaluation is ongoing in the DR. According to the WHO, the DR has allocated investments to upgrade high-risk locations. Targeting the exact problem areas for road traffic accidents allows for efficient allocation of road rehabilitation resources, which is especially important in LMICs where funds may be limited.

Another aspect of safe roads involves expanding access to safe public transportation. Buses and trains decongest roads and provide an economic way to navigate a city. The first metro line was completed in 2008, and a second line was added in 2014. Construction is underway to further expand its reach. From January to June 2017, ONE reported over 37.6 million rides taken by metro users. Other initiatives include adding 200 new city buses and building a cable railway to connect marginal neighborhoods to the city (14). Not only would this cable line reduce the number of cars entering the city every day, but it would also provide people living outside of the city with easy access to job opportunities within the capital.

However, legislation that aims to improve the standard of quality of public transportation and vehicle standards are often protested by transport unions within the city. Outside of the government-subsidized city buses and the metro, there is a network of transportation from private companies and individuals which consists of guaguas (minibuses), carros públicos (unmarked shared taxis), and motoconchos (motorcycle taxis). These unofficial modes of public transportation often involve vehicles without seatbelts, taillights, and a higher than intended density of passengers. Safety is not a priority or an expectation. While these methods of transportation are unsafe, they are inexpensive, efficient, and far-reaching. When transport unions strike, they effectively shut down the city. Improving safety standards within unofficial public transportation is a unique challenge to the Dominican Republic.

Ensuring that drivers in the DR have vehicles that meet safety standards is another way to both prevent crashes and to decrease the severity of crashes when they occur. The DR has not adopted any of the suggested vehicle standards from UNECE WP.29, which is an international regulatory forum for vehicle safety. Most relevant to this study are motorcycle anti-lock braking systems (ABS) which prevent the brakes from locking during a hard brake and allows drivers to maintain more control and therefore decreases the risk of collision. Many countries with a high percentage of motorcycles are moving to ensure that all vehicles of a certain size have ABS, and this is something the DR should move toward as well (6). Enforcing vehicle standards of any type is difficult in LMICs because it increases the cost of vehicles.

Post-crash care includes pre-hospital care, initial stabilization and evaluation, and definitive care. Timely access to quality care was an aspect of this study we attempted to

measure. Many patients (43%) were transferred to HTNAL, traveling an average distance of 90.1 km to get there. Additionally, many patients (32.1%) did not have access to 911. Twice as many people die before reaching the hospital in MICs, due to delays in receiving care (17). As there are only three trauma hospitals in the Dominican Republic, many people who live in the country are not readily able to go to a trauma hospital in the event of an emergency. All municipalities have a hospital meeting level II criteria, which provides basic fracture settings and emergent operations. An investigation of these centers should be done to determine if they have the medical staffing, supplies, and skills to meet the burden of trauma-related injuries in the DR. Seeking care at quality level II centers is cost-effective and adequate for most patients who do not have critical injuries (17). We did not ascertain a statistical significant in the outcomes of patients who traveled a far distance to HTNAL or who were unable to use 911, and more research must be done to adequately answer this question. Once patients from RTAs reached HTNAL, the same trauma activation system that exists in the US does not occur. Studies show that an organized trauma system can result in a 15-20% decrease in mortalities. In medically preventable deaths this figure jumps to a 50% decrease (17). Quality improvement projects evaluating best practices at HTNAL would likely help to streamline a trauma system and improve outcomes for patients.

The positive aspect of examining the traffic accident epidemic in the Dominican Republic is that the solutions already exist. Cracking down on existing laws and passing stricter legislation influences road users to be safer and decreases the number of traffic accidents. Improving the quality of roads and the cars that drive on them mitigates human error. HICs that once suffered from much higher rates of traffic accidents currently have

decreasing rates of fatalities despite increasing population and number of vehicles. The negative aspect of knowing the solution to this problem is that it also brings the knowledge of the extreme effort that legislators, community leaders, and advocacy groups must exert. The purpose of this research study was to paint a general picture of the current state of road traffic accidents in the Dominican Republic. In order to most effectively inform policy and make an impact on the road traffic epidemic, much more research must be done to fill in the details.

CHAPTER FIVE
Conclusion

RTAs are a major source of death and disability worldwide and in the Dominican Republic. This study served to provide epidemiologic data on RTIs suffered by patients at HTNAL in Santo Domingo. Of the 362 patients included in this study, 85.4% were male and 14.6% were female. The mortality rate was 11.3% for males and 7.5% for females, for an overall rate of 10.8%. The highest percentage of mortalities occurred among motorcyclists, which was also the most common type of vehicle involved in an RTA in this study. 21.8% of motorcyclists were recorded wearing a helmet. The most common injury among motorcyclists was definite moderate/severe traumatic brain injuries (39.1%). Non-helmet users were 4.6 times more likely to suffer a TBI than those who did (95% CI: [1.4, 15.4]), and patients who suffered a definite moderate/severe traumatic brain injury were 11.6 times more likely to die than those who did not (OR = 11.6, 95%CI: (4.73, 28.22)).

The issue of road traffic accidents requires a multifactorial solution encompassing national and regional legislation and enforcement, safety standards for roads and vehicles, and improving access and quality of medical care. The most impactful effort in the context of the DR and this study would be to increase helmet usage. More research needs to be gathered to monitor this problem and continue to find solutions.

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Vitae

Maura Walsh grew up in Evanston, IL. She first became interested in working with underserved populations during high school after she went on a volunteer trip in New Orleans to help rebuild homes devastated by Hurricane Katrina. She attended the University of Illinois at Champaign-Urbana and majored in Molecular & Cellular Biology and minored in Spanish. During college, she engaged in volunteer opportunities in Guatemala and Peru and studied abroad in Spain. After graduation, she moved to Brownsville, TX and taught 8th grade science through Teach For America. She ultimately decided to pursue a career in medicine and matriculated at UT Southwestern, where she is currently a 4th year medical student. During her time at UTSW, Maura worked toward obtaining a Distinction in Global Health, through which she was able to conduct research projects in the Dominican Republic, Saipan, and complete a clinical rotation in India. She plans to go into general surgery and hopes to continue to work in global health during residency and in her career.