

2015

Prehospital Staffing and Road Traffic Accidents: Physician Versus Trained Nonphysician Responders

Timothy A. Grant
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Walden University

College of Health Sciences

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Timothy A. Grant

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Walden University

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Abstract

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Physician Versus Trained Nonphysician Responders

by

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MSW, University at Albany, 1994

BA, Russell Sage, 1992

Dissertation Submitted in Partial Fulfillment
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Doctor of Philosophy
Public Health

Walden University

February 2015

Abstract

Road traffic deaths, which affect people in their productive years, are projected to be the third leading cause of death by the year 2030. While most studies have focused on road infrastructure and vehicle safety, this study examined something new: the impact of prehospital response to road traffic accidents on the rate of death. Some countries send physicians to the scene of an accident; some send paramedics or registered nurses. The question this research sought to answer was whether the use of physician responders resulted in a lower rate of death compared to the use of nonphysician responders. The literature makes it clear that rate of road traffic death is related to country income and governance indicators, so first those variables needed to be equalized. My conceptual framework for this cross-sectional correlation study was the Haddon matrix, which organizes injuries by temporal (pre-event, event, and postevent) and epidemiological (host, agent, and environment) factors. Using World Health Organization data on road traffic injury and country income, World Bank data on governance indicators, and a literature search of 67 countries' prehospital response profiles, significant negative correlations ($p > 0.001$) were found for road traffic deaths and income, $r(65) = -0.68$, and governance indicators, $r(65) = -0.646$. No significant difference in the rate of road traffic death was found between physician and nonphysician prehospital staffing. Because increasing countries' income and improving governance are long-term, ambitious goals for developing countries, training nonphysician prehospital responders appears to be the most effective social change to decrease the burden of road traffic deaths.

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Dedication

Copyeditors do more than fix grammar, spelling, and punctuation. They solve problems every hour of every day and plant the flag for good English and clear writing—a worthy goal in the age of emoticons and Twitter shorthand. They save writers and the publications they work for from embarrassment.

A copyeditor asks questions and makes suggestions that, for whatever reason during the editing process, no matter how good the assigning editors are, never got asked or suggested: What do you mean? Who is this person ID'd by only a last name? That last sentence doesn't add much—it might be stronger to end with the previous one. This sounds choppy. Oh, and nice lede.

The best copyeditors are born, not made. You can be decent at the job with training and hard work, but it helps if you take pleasure in tasks many people would find mind-numbing. (O'Sullivan, 2013)

This dissertation is dedicated to the unsung heroes of publishing.

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Chapter 1: Introduction to the Study

In this study, I investigated differences in the rates of road traffic mortality between physician and nonphysician staffing. Emergency medical services are a vital component in the response to road traffic injuries (Coats & Davies, 2002; Krug, Sharma, & Lozano, 2000). Prehospital care has been demonstrated to reduce the number of deaths caused by road traffic trauma (Chakravarthy, Lotfipour, & Vaca, 2007; Lendrum & Lockey, 2012; Peden et al., 2004; Roudsari et al., 2007; Sanchez-Mangas, Garcia-Ferrer, de Juan, & Arroyo, 2010). Both the proficiency of prehospital response and the rate of road traffic death depend on a country's income (Kobnsingye et al., 2005; Roudsari et al., 2007) and governance (Ha, 2012; Law, 2009).

Many researchers have examined road and vehicle safety efforts (Anbarci, Escaleras, & Register, 2009; Chrisholm & Naci, 2009; Kopitis, 2004; Moeller, 2005; WHO, 2009), as well as the effect of country income and governance on road traffic injury (Ha, 2012; Kobnsingye et al., 2005; Law, 2009; Roudsari et al., 2007). However, the literature is limited on the difference that staffing of prehospital service—physician responder versus trained nonphysician (nurses, paramedics, or emergency medical technician responders)—has on the rate of road traffic deaths. Al-Shaqsi (2010), Arnold (1999), Dib, Naderi, Sheriddan, and Alagappan (2006), Dick (2003), and Roudsari et al. (2007) have attempted to compare the systems over the past 15 years, and each of these researchers has found conflicting results. There is no literature examining the relationship of prehospital service staffing and road traffic death when the interaction of the independent variables of country income level and governance indicators are included.

Because funding levels for prehospital care and the various safety and infrastructure improvements are difficult or impossible to obtain (O'Reilly, 2010), country income and governance levels were used as indicators for a country's ability to provide road infrastructure; rules, regulations, and enforcement; safety requirements for vehicles used on the roadways; and funding of hospital and prehospital care. This study is needed to assess the difference of prehospital staffing so that health care expenditures are not wasted (Al-Shaqsi, 2010). The outcome of this analysis will be most helpful to low- and middle-income countries, which experience the greatest burden from road traffic injury (Peden et al., 2004).

In this study, three levels of country income (low, middle, and high) and two categories of responder (physician and trained nonphysician) were compared with the rate of road traffic deaths per 100,000. Additionally, staffing and the road traffic death rate were compared to governance indicators, and the interaction of income, governance, and prehospital staffing rounded out the statistical analysis. In this chapter, I briefly address the background literature on prehospital services, road traffic death, and income and governance as it relates to road traffic death and prehospital staffing. Next I explain the research problem and purpose of the study, then the conceptual framework of the study. I then discuss the nature of the study, the definitions of the variables, and the scope and limitations. I end the chapter with a discussion of the significance of the study and a summary of the chapter.

Background

Prehospital Emergency Medical Care

The International Federation for Emergency Medicine “believes that a society has a right to expect immediate care in an emergency situation” (Bodiwala, 2010, p. xiii). Emergency response to injury is common in most countries, and the form and funding often determine the success of the service in reducing death and disability caused by road traffic injury (Sarlin & Alagappan, 2010). The World Health Organization ([WHO] 2009, p. 33) found that 78% of the 178 countries surveyed (138 countries; 178 countries are 82% of the 215 UN member states; 138 countries are 64% of the member states) had formal prehospital care systems, which vary in quality. Of these 178 countries, 123 (69% of the sample, 52% of UN member states) had national regulations governing the delivery of prehospital care (WHO, 2009, pp. 284–287).

Prehospital services are delivered by a governmental agency (centralized, state or provincial, district, or local), an international agency (e.g., International Red Cross or St. John Ambulance Association), private entities, or a volunteer service (O’Reilly & Fitzgerald, 2010). Funding for prehospital services follows a similar structure of government, international donation, private, and voluntary payments administered by a variety of organizations (O’Reilly, 2010). Determining cost-effectiveness for prehospital services is problematic due the complexity of the structures across countries, but funding for equipment, communications, supplies, staffing and education, administration, and other expenses can strain money allocated to a country’s health care (O’Reilly, 2010). An additional consideration is that assigning relative benefit to any particular procedure or

intervention in health care is very difficult without well-constructed random controlled experiments; this is a very problematic study form for health care because of the need for informed consent and the duty to treat (Coats & Davies, 2002; Schneiderman, Gilmer, & Teetzel, 2000).

A 2004 estimate claimed that for every death that occurred from a road traffic accident, 15 people were hospitalized for rehabilitation, and 70 suffered minor injuries (Peden et al., 2004, p. 5). This leads to a medical system strained from preventable road traffic injuries, representing "45%–60% of all admissions to surgical wards" (WHO, 2009, p. 3). Grimm and Treibich (2012) concluded that the quality and availability of health care and trauma services have an impact on road traffic injury risk and need to be considered in the analysis of road traffic injury. In "many low- and middle-income countries ... traffic-related injuries ... [are] between 30% and 86%"[of the total number of injuries sustained] (Peden et al., 2004, p. 5). In some European studies, 50% of deaths occurred within a few minutes of the incident; about 15% of the injured died at the hospital within 4 hours of the incident; and 35% died at the hospital beyond 4 hours (Peden et al., 2004, p. 94). The vast majority of deaths in low- and middle-income countries occurred during the prehospital stage (Peden et al., 2004, p. 93).

Mock, Kobusingye, Vu Anh, Afukaar, and Arreola-Risa (2005) placed prehospital care on a continuum between preventing road traffic events and postevent definitive hospital care and rehabilitation. They reviewed studies that demonstrated a "six-fold lower [mortality from trauma] in countries with high income than in countries with low income" due to the different trauma care systems employed (Mock et al., 2005, p. 295).

Improving prehospital care is an affordable intervention for countries with an established trauma care system, and, even though it requires a greater proportion of their health care budget, it is a good way to reduce the trauma burden in low-income countries (Mock et al., 2005, p. 295). Mock et al. (2005) explained that even for countries without a formal prehospital system, training lay people to deliver first aid and basic life support prior to transport to health facilities lowered a country's burden of trauma death. Anderson et al. (2012, p. 2) highlighted four fundamental emergency medicine factors that benefit populations:

1. Universal telephone access and education about how and when to use that access.
2. Effective training of lay first responders in the timely recognition of injury or disease and application of basic first aid.
3. Rapid-response providers, ranging from emergency medical technicians to paramedics and emergency care physicians, mobilized to assess, intervene, and transport in the out-of-hospital setting.
4. Emergency medicine clinics in hospitals.

Coats and Davies (2002), writing from personal experience and a literature review, explained that prehospital care is the first link in the chain of trauma care that starts 30 minutes or more before a patient arrives at the hospital. They advocated for advanced training for both physicians and nonphysicians alike, to form a system to continuously improve the response to road traffic crashes. Coats and Davies are

proponents of advanced trained physician staffing, known as the Franco-German philosophical form of prehospital services.

Two major philosophical styles of prehospital emergency medical services are discussed in the literature: the Franco-German style and the Anglo-American style (Sarlin & Alagappan, 2010). In the Franco-German style, emergency medical physicians are dispatched to severe trauma and medical conditions, treating the patient at the scene before transport and admission to hospital floors. In the Anglo-American style, emergency medical technicians (ambulance drivers, first responders, basic emergency medical technicians, advanced or paramedic emergency medical technicians, and nurses) treat life-threatening problems at the scene, then rapidly transport the patient to the emergency room for assessment and care (Sarlin & Alagappan, 2010).

The merits of these respective systems, however, are difficult to analyze, and authors are reluctant to conclude that one is superior to the other (Al-Shaqsi, 2010; Sarlin & Alagappan, 2011). Indeed, Sarlin and Alagappan (2010, p. 9) explained that there are four systems of emergency care in the world:

1. Unorganized, emergency response is a haphazard mixture of untrained and minimally trained lay people, attempting first aid and transporting sufferers to health clinics by any means available.
2. Basic life support is provided by personnel trained in basic first response with the ability to transport sufferers in modified transport vehicles.
3. Advanced life support is provided by personnel with greater knowledge in and permission to use more advanced life-support techniques.

4. Doctor-staffed advanced life support involves physicians and advanced life-support personnel able to treat life-threatening conditions on scene prior to transport to emergency care facilities.

O'Reilly and Fitzgerald (2010) elaborated further on the component structure of an emergency medical system (EMS) that makes the prehospital situation unique to a particular country. Each country

- Is at a different developmental stage—undeveloped, developing, or developed.
- Has a different sociopolitical framework, health system priorities, and geography.
- Has different administrative structure for
 - Authority for providing prehospital services—national, state or provincial, regional or district, community, or individual.
 - Agency responsible for EMS—government, volunteer, not-for-profit entities, private contractor, or none.
 - Funding prehospital services—government or publicly funded, voluntary, private, or none.
- Have different resources
 - For EMS transportation—vehicles, and road, air, or water routes.
 - For human resources (i.e., number of and levels of training of responders).
- Has different processes for

- Operations based on response philosophy—Franco-German or Anglo-American— and clinical leadership.
- Triage and dispatch—centralized, local, hospital, ad hoc, or none.

(Adapted from O'Reilly and Fitzgerald, 2010, pp. 39–40).

Road Traffic Death

Road traffic fatalities, most of which are preventable, are global problems with a wide range of causes. Road traffic death impacts individuals and families within all socioeconomic groups throughout the world (Ameratunga, Hajar, & Norton, 2006).

In 2000, Krug et al. detailed the burden caused by road traffic injury, using two 1998 WHO tables. They related the specific causes of death to income (high-income in one and low- and middle-income countries in the other), showing road traffic death was the leading cause of death for people from 5 to 44 years of age in high-income countries (Krug et al., 2000, p. 524). Road traffic death is the seventh leading cause of death for children to age 4 in high-income countries and the eighth leading cause of death for those 45 to 59. In 1998, road traffic crashes were the 10th overall cause of death in high-income countries (Krug et al., 2000, p. 254). In low- and middle-income countries, road traffic deaths were the third and second leading causes of death for those 5 to 14 and 15 to 44, respectively (Krug et al., 2000, p. 255). Road traffic deaths ranked 14th and 10th for those 0 to 4 years and 45 to 59 years, respectively (Krug et al., 2000, p. 255). Road traffic deaths ranked 10th as the overall cause of death in low- and middle-income countries in 1998 (Krug et al., 2000, p. 254). By 2011, road traffic deaths had moved to the ninth leading cause of death worldwide (WHO, 2013). Road traffic deaths are not

expected to decrease as populations increase and developing countries become wealthier; in fact, road traffic deaths are projected to be the overall third leading cause of death worldwide by 2030 (Mathers & Loncar, 2006).

The patterns of injuries vary by road user, vehicle, and country (Peden et al., 2004). Low-income countries have higher road traffic mortality and disability rates than high-income countries, and the more a country invests in its health care system, the lower its burden caused by road traffic fatalities (Ameratunga et al., 2006, p. 3). Some researchers have explored the relation of road infrastructure, vehicle safety, driving legislation and enforcement, and individual behavior to road traffic events; others have explored the effects of income and health care funding on traffic injury outcomes (e.g., Peden et al., 2004; WHO, 2009). Country income appears to be the biggest factor in road traffic injury, with an inverted U-shape curve of injury as income rises from low to middle and then decreases as income continues to rise from middle to high (Kopitis, 2004).

Globally in 2009, rates of road traffic fatalities per 100,000 population were 18.8 overall; 10.3 in high-income countries; 19.5 in middle-income countries; and 21.5 in low-income countries (WHO, 2009, p. 13). Five years earlier, Peden et al. (2004, pp. 172–173) reported similar numbers: 19.0 deaths per 100,000 people worldwide; 27.6 per 100,000 males and 10.4 per 100,000 females. Peden et al. further broke down the deaths per 100,000 into male/female by age: 0–4 years, 8.8/7.3; 5–14 years, 13.2/8.2; 15–29 years, 29.7/7.6; 30–44 years, 33.5/9.8; 45–59 years, 37.6/14.3; and greater than 60 years, 45.1/19.1.

Injury by Type of Road Use

In the United States, there were 9.53 million vehicles involved in the 2009 crash statistics: 5.2 million passenger cars, 4.25 million light trucks, 0.3 million large trucks, 0.06 million buses, and 0.019 million other/unknown vehicles (U.S. Census Bureau, 2012c). Additionally, 40,840 people died immediately from those incidences: 18,350 in passenger cars, 17,902 in light trucks, 3,215 in large trucks, 221 in buses, and 1,152 in other/unknown vehicles (U.S. Census Bureau, 2012c). A different report, also in 2009 but focusing on a different category, found that 4,462 motorcycle riders perished in traffic accidents as well as 4,092 pedestrians and 630 pedal cyclists (U.S. Census Bureau, 2012b).

Chisholm and Naci (2009) attempted to break down road user injury by type and world subregion, with the caveat that the data for all countries are incomplete or derived from varying and often incompatible methodological strategies. Occupants of four-wheel vehicles make up the bulk of the mortality and morbidity events in road traffic crashes in highly motorized subregions of the Americas (78%) and Europe (62%; p. 10). In Southeast Asia, motorcycle accidents caused between 43% and 50% of fatalities (p. 10). Pedestrian fatalities (55%) took a large toll in regions of Africa (p. 10). Chisholm and Naci provided a visual and numeric compilation of these findings: Pedestrian injuries are as low as 10% in the Americas and as high as 57% in East Africa; bicycle riders suffer 2% of the fatalities in some Southeast Asian countries and are as high as 13% in western Pacific island countries; motorcycle fatalities are 4% of road fatalities in European countries and up to 53% in Southeast Asia; passenger car fatalities were highest in the

Americas (up to 75%) and lowest in some East African countries (6%); bus and truck fatalities ranged from 3% in the Americas to 46% in some European and Southeast Asian countries (p. 11).

Globally, about 46% of road traffic deaths were of "pedestrians, cyclists, and riders of two-wheelers and their passengers" (WHO, 2009, p. 13). Rates of fatalities for each of these categories were quite variable. Peden et al. (2004, p. 41) reported a range from 41% to 75% for pedestrian deaths and 38% to 51% for vehicle passengers. In many low-income countries, both motorcycles and public transportation significantly contributed to road traffic death (p. 41) because fewer individuals owned cars in these countries. Buses, designed to transport many people, were not frequently involved in occupant road traffic fatalities, but they were a significant contributor to mass casualty events that involved 10 or more fatalities and injuries (Albertsson et al., 2003, p. 109). Rolison et al. (2012) assessed the safety associated with motorcycle riding in the United Kingdom. They found that there is a 76 times greater likelihood of casualty for drivers of motorcycles over all other types of vehicle, independent of the driver's age and experience (p. 568).

Governance and Income

Gaygisiz (2009b, pp. 536–537) compared economic indicators of gross domestic product (GDP) per capita, the unemployment rate, and the Gini index (a measure of income disparity among individuals or households; Organization of Economic Co-operation and Development, 2002) and found high values for each associated with high traffic safety. GDP per capita had a strong negative correlation with road traffic injury (r

= -0.60), as did the related Gini index, “implying that high road-traffic fatality rates are associated with more unequal distribution of resources” (Gaygisiz, 2009b, p. 537). The unemployment rate had a correlation of $r = 0.33$, not statistically significant but leaning in the positive direction of reduced road traffic fatality (pp. 536–537).

Pratte (1998, p. 58) stated that “almost every developing country suffers from a lack of financial resources, and therefore the capital available to spend on road safety improvements, road rehabilitation and maintenance, police enforcement and other governmental-level investments [is] severely limited.” It appears that the greater the wealth of people in a country, the better their health care system, including emergency care. Likewise, the greater the wealth of a country, the greater the emphasis on road infrastructure and traffic law enactment and enforcement, resulting in fewer road traffic injuries. Increased and targeted spending on preventative and emergency health care, traffic and driving policies, and road infrastructure in all countries will reduce road traffic injuries and the resulting personal, physical, and financial costs, leading to a healthier and more productive global population.

Framework for Studying Prehospital Response to Road Traffic Death

Accidents are not random events (Peden et al., 2004, p. 7). Many factors interact to make an accident or prevent one. In the field of public health, the examination of road fatalities generally uses an epidemiological approach, such as the one proposed by Haddon (1968, 1980) and widely expanded on by a number of researchers.

For this study, I used the Haddon matrix as the theoretical framework. The Haddon matrix (Haddon, 1968, 1980) was developed to study injury prevention and has

subsequently been enhanced by authors such as Runyan (1998, 2003), who added factors to consider in establishing policy and interventional approaches.

The 3-by-3 Haddon matrix organizes factors into rows for pre-events, events, and postevents and into columns for the epidemiological concepts of host (person at risk), agent/vehicle (person or organism/inanimate object involved in the incident), and physical and social environment to assist in the analysis of an event (Barnett et al. 2005; Haddon, 1980). Pre-event factors include vehicle type and safety features, road infrastructure (i.e., road design and lighting), road use regulations and police enforcement of regulations, the condition of the driver (e.g., any impairments), attitudes, beliefs, and behaviors (e.g., about driving and speeding), devices to prevent impaired drivers from starting the vehicle, sensors that warn of potential hazards, traffic signs with posted speed limits, and condition of roads (Wall, 2013). Event factors deal with the prevention of fatalities or injuries, for instance, whether the airbags inflated, if the seat belts were in use, and if crash-resistant rails along the roadways functioned properly (Albertsson et al., 2003). Postevent factors address the actions or events that sustained the lives of individuals who were injured and include such factors as the age of the host and existing health status of those injured, the first aid skills of the bystanders, the accessibility of trained prehospital personnel, access to the crash (i.e., congested roads and location of and condition of the vehicle; Thyer, Leditschke, & Briggs, 2009).

Runyan (1998, 2003) also provided an overview of the Haddon matrix and some adaptations that, she believed, improve the user's ability to make informed judgments and develop best practice policies. Runyan explained and expanded on the Haddon matrix by

discussing additional dimensions. She applied the factors of “effectiveness, equity, freedom, cost, stigmatization,” and other identified issues useful to “decision makers” in judging best approaches to each of the nine cells of the Haddon matrix (forming a cube of 45 cells; 2003, p. 61). The additional considerations increase the complexity of information and opinions available for decision making. Runyan (2003, pp. 62–63) also integrated Bronfenbrenner’s social ecological model so each of the cells can be further scrutinized by the additional concepts of cultural, institutional, interpersonal, and intrapersonal influences.

The Haddon matrix appears to be based on a pragmatic worldview, which allows researchers the “freedom” to pick and choose techniques and methodologies that help to explain behaviors relating to the object of interest (Creswell, 2009, pp. 10–11). It values “the what and how to research, based on intended consequences” and is best undertaken using mixed method techniques (Creswell, 2009, p. 11). For example, in their study of injury and injury prevention, Runyan (1998, 2003) and Runyan and Yonas (2008) blended the Haddon matrix with the social-ecologic model, and Gates et al. (2011) blended the Haddon with the action research model.

The extended Haddon matrix is described as a robust model that allows researchers to approach a study by qualitative, quantitative, or mixed methods (Runyan, 1998). The model is flexible and adaptable to brainstorming and other idea-generation techniques as well as guiding decision making (Runyan, 1998, p. 304). The matrix is set up for identifying a problem, options, and values, but care is needed in prioritizing values or interventions so that just, equitable, and effective policies are implemented (Runyan,

1998, pp. 305–306). To use the Haddon matrix, the problem needs to be identified, the factors identified as contributing to the problem need to be categorized by event time and epidemiological concept, and then analysis and intervention development need to be accomplished (Runyan, 1998, 2003).

For this study, the problem was to determine the difference between prehospital response staffing in relation to the reduction of the rate of road traffic deaths per 100,000. Many of the vehicle or agent factors involving specific infrastructure, vehicle design, and policy or rule development and enforcement extend across cells of the Haddon matrix; these are discussed briefly in the next section. Likewise the effect of income and governance on road traffic death influences many of the cells of the matrix and, along with prehospital services, constitute the pre-event, event, and postevent environmental factors with which this study is primarily concerned.

Road traffic deaths are major health-related burdens worldwide (Ameratunga et al., 2006; Mathers & Loncar, 2006; Peden et al., 2004). For countries with prehospital response services, two broad philosophical approaches exist regarding the staffing: the physician-staffed Franco-German style and the trained nonphysician-staffed Anglo-American style. In the Franco-German style, severely injured road traffic crash patients are treated extensively at the scene with advanced interventions before transport and admission to the hospital. In the Anglo-American style, severely injured patients are rapidly assessed and treated for urgent or life-threatening injury and rapidly transported to an emergency room for more in-depth assessment and intervention prior to transfer to the hospital floor.

There are costs and benefits to each style, and this study aimed at determining if the rate of road traffic deaths per 100,000 is lower in countries with physician-staffed prehospital response units than in countries with trained nonphysician-staffed units. Gross income, country wealth, and income-level groupings or per capita GNP were correlated with the number and rate of road traffic injury and appeared as a common variable used in studies (Anbarci et al., 2009; Grimm & Tribich, 2012; Kopitis, 2004). A country's income influences the ability of the government to develop policy and regulations, enforce laws, and provide for the health care of its people; this is known as governance (Gradstein, 2004; Ha, 2012; Khan, 2007; Lewis, 2006; Pillai, Diaz, Basham, & Ramirez-Johnson, 2011; Qadri, 2012). Because income and governance are shown to influence rates of road traffic death, the interaction of both of these independent variables needs to be accounted for to evaluate the staffing of prehospital systems in similar levels of the variables. To my knowledge, no studies have compared prehospital staffing systems within these income or governance groupings. That comparison will reduce the effect of varied health care, funding, and policy across countries.

Purpose of the Study

The purpose of this cross-sectional correlation study was to use the Haddon matrix postevent agent and environmental conditions to examine the difference James J. Menegazzi, PhD. in prehospital staffing choice on road traffic deaths per 100,000. The independent variable of staffing of prehospital response was defined as one of two conditions: the attendance of (a) a physician or (b) a trained nonphysician responder—a registered nurse, paramedic, or emergency medical technician—at the scene of a road

traffic accident. The independent variable of income was defined as the WHO (2013 Global Status) reported income level, based on the gross national income per capita, of sampled countries—low, US\$1,025 or less; middle, \$1,026 to \$12,225; and high \$12,226 or more. The independent variable of governance was defined as the sign of the standardized values for the World Governance Indicators (World Bank, 2013) in the selected countries.

The dependent variable of rate of road traffic death per 100,000 was determined by dividing the estimated deaths in a country provided by WHO (2013) by the quotient of the total population for 2010 provided by the WHO (2013) divided by 100,000.

Research Questions

The quantitative research questions for this study are as follows:

1. Is there a significant association between income level of a country and the rate of road traffic fatalities per 100,000?

H_a1 : There is a significant negative correlation between income level of countries and road traffic fatalities.

H_o1 : There is no association between income level of countries and road traffic fatalities.

2. Is there an association between the sign of standardized governance indicators of a country and road traffic fatalities per 100,000?

H_a2 : There is a significant negative correlation between the sign of standardized governance indicators of countries and road traffic fatalities.

H_{o2} : There is no association between the sign of standardized governance indicators of countries and road traffic fatalities.

3. Does the staffing of prehospital response services by physicians reduce the rate of road traffic fatalities per 100,000?

H_{a3} : There is a significant reduction in the rate of road traffic fatalities per 100,000 when prehospital services are staffed by physicians.

H_{o3} : There is no significant difference between physician-staffed and nonphysician-staffed prehospital services and the rate of road traffic fatalities per 100,000.

4. When grouped by income, do countries with physician-staffed response services have a lower rate of road traffic fatalities per 100,000?

H_{a4} : There is a significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

H_{o4} : There is no significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

5. When grouped by the sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_{a5} : When grouped by the sign of standardized governance indicators, there is a significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

H_o5: When grouped by the sign of standardized governance indicators, there is no significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

6. When grouped by income and sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_a6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

H_o6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services do not have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

H_o6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services do not have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

Definitions

Dependent variable: Rate of road traffic deaths per 100,000 determined by dividing the WHO (2013) estimated deaths for each country by the quotient of the WHO

(2013) reported population for each country divided by 100,000. Peden et al. (2004, p. 57) stated that the number of deaths is a good indicator for planning emergency medical needs and that fatalities per 100,000 population are a good indicator of the “impact of road traffic crashes on human populations.”

Independent variables: Prehospital staffing. Two levels of prehospital staffing were considered in this study: (a) physicians and (b) nonphysician prehospital trained nurses, paramedics, and emergency medical technicians.

Income category provided by the WHO (2013) in levels of low, US\$1,225 or less; middle, \$1,226 to \$12,225; and high, \$12,226 or greater.

Governance indicators: The standardized indicators provided by the World Bank (2013) for each selected country.

Nature of the Study

I used archival data in the public domain from the World Health Organization (2013 Global Status) and World Bank (2013) and country prehospital service profiles available over the Internet (see appendix C for a list of country profiles and sources currently identified). Archival data are appropriately included in correlational studies where strict randomization or nonrandom sampling techniques are used (Creswell, 2009). I employed bivariate correlational and univariate *t* test, ANOVA (analysis of variation), and MANOVA (multiple analysis of variation) computation. Correlation studies are often used by both positivists/postpositivists and pragmatists when designing quantitative and mixed methods studies (Creswell, 2009). Therefore, correlation studies are good choices for studies looking to find the relationships between or among factors (Creswell, 2009).

Either the t test or the Mann-Whitney U test, depending on the distribution of the data, and ANOVA/MANOVA are appropriate for the categorical and continuous data used in this study (Creswell, 2009, p.153).

Assumptions

First, I assumed that the prehospital service influence on road traffic deaths can be measured by the rate of road traffic deaths per 100,000. This assumption was made in the belief that income and governance influences are equivalent within groupings, will cancel out the effects of trauma care once the victim arrives at the hospital, and will make other factors equal.

Second, I assumed that credentials for the prehospital providers are equivalent within each category of provider—physician, nurse, paramedic, or emergency medical technician (EMT)—in each of the conditions of income level and governance value.

Third, I assumed that nonmedical road traffic death factors—road use rules and enforcement, vehicle safety requirements, road infrastructure, and the like—are equivalent within income and governance values divisions.

Scope and Delimitations

Profile data were not available for all countries, and not all country profile data were available for the same years.

Data for this study were cross-sectional, with data taken at one point in time (Creswell, 2009). This study used a single-stage sampling strategy, collecting data from all countries with usable data. Unfortunately, the constraints of the profile data made this a convenient sample of countries that have prehospital system profiles available in

English and that supplied data to the World Bank (2013) Governance Indicators data set and the WHO (2013) *Global Status Report on Road Safety 2013: Supporting a Decade of Action*.

Generalizability and Internal and External Validity

Atkinson and Brandolini (2001) described the difficulty of using cross-country income data aggregated from multiple sources. They demonstrated how various assumptions and data collection techniques alter the within- and across-country values for income per capita and for income disparity. World Bank (2013) Development Indicators, however, are considered reliable and measured consistently across the time series. Bhalla, Harrison, Shahraz, and Fingerhut (2010) described the difficulty of tracking road traffic deaths across countries for similar reasons. However, the WHO (2013) databases are considered reliable and are used as a standard in research.

The conclusions of this study are generalizable to the countries studied and could be considered generalizable to all countries because all countries were subject to inclusion in the study (“Measured Progress,” n.d.). The error that would interfere with the generalizability of the study was spread equally across the countries studied (“Measured Progress,” n.d.).

Because of the imperfect randomization of the sample and the vagaries of the secondary data definitions and collections, in general, the data may not be truly valid and may cause internal and external validity problems (Creswell, 2009). The data used, however, were from sources that made the best data available and were used across studies, making results comparable (WHO, 2013; World Bank, 2013).

Limitations

This was a correlational study that demonstrated relationships among factors but was not able to attribute the cause. The nature of the data sets was also a limitation, as data were collected using a variety of methods and definitions (Koziol & Arthur, n.d.). The latter issue, however, is the same for other researchers using the data; therefore, the results are comparable to results in other studies (World Bank, 2013).

The mentioned disadvantages of using secondary data (Atkinson & Brandolini, 2001; Bhalla, 2010) certainly posed limitations on the resulting analysis because uncertainty was injected into the data collection. However, this uncertainty was spread across all countries that have data, and other researchers have used the data, giving some continuity to cross-study analysis.

There was a bias built into the study caused by lower-income countries not reporting data to the databank managers as frequently as higher income countries report. There were fewer results for income, governance, road traffic fatalities, and prehospital staffing to be found from lower-income countries. This shifted the burden of evidence toward middle- and high-income countries. Little could be done to overcome this difficulty, there were enough compelling results to allow further exploration.

Significance

Road traffic fatalities burden countries by killing income earners in their most productive years (McKenzie, Pinger, & Kotecki, 2008). Road traffic fatalities are estimated to be the third leading cause of death for 15- to 35-year-olds worldwide by 2030 (Mathers & Loncar, 2006).

This research was intended to give governments and policymakers information to evaluate the system of and control over prehospital systems with respect to traffic death. This knowledge will be beneficial to governments in developing policies and training that will provide cost-effective and beneficial results for their people. People injured in road traffic accidents will benefit from a prehospital response that meets their immediate needs and reduces the burden placed on families from the loss of loved ones, family structure, and income.

Summary

Road traffic death is a major problem worldwide, and road traffic crash events are the focus of much research. Overall, income is the best determinant of road traffic death. Income and governance interact to affect the health and wealth of a country.

Prehospital services have two main styles: the Anglo-American and the Franco-German. The former uses nurses, paramedics, and emergency medical technicians, who rapidly transport victims to an emergency facility for care; the latter uses emergency physicians treating victims more extensively at the scene before transport to medical facilities. There are arguments supporting and opposing both systems, but the Anglo-American style offers lower initial expense per patient for prehospital services. In this study, I investigated the benefits of each system with respect to death from road traffic crashes.

In Chapter 2, I take a closer look at the studies on prehospital staffing and response to road traffic crashes, including exploring the literature on income and governance on prehospital response. I conclude with a discussion of data sets and

analysis techniques necessary to understand the difference among country road traffic fatality rates.

Chapter 2: Literature Review

Introduction

Prehospital services respond to calls for road traffic crashes as a major function of their mandate. Road traffic injuries, an important public health concern, are the "leading cause of death to those in the first [3] decades of life" and are important enough for the "United Nations and World Health Organization to declare [2010–2020 the] decade of action for road safety" (Centers for Disease Control and Prevention, 2012). Income per capita governs the ability of people to buy and use road vehicles (Anbarci et al., 2009; Kopitis, 2004), and the safety of vehicles has been shown to increase as the per capita income increases (Anbarci et al., 2009). The number of pedestrians and the number of two-wheeled vehicles both decreased as higher income levels were reached, reducing road traffic fatality rates (Anbarci et al., 2009; Grimm & Treibich, 2012). Additionally, income influences governance, which in turn influences road traffic death rates through rules of law, enforcement, regulation, and finance of health care (Ha, 2012; Law, 2009). Income and governance are important factors in the postcrash response and prehospital care of crash victims and have been demonstrated to save lives (Ha, 2012; Law, 2009).

The Haddon matrix was used as a framework for the study of the effects of prehospital staffing on road traffic death. The relationship among income, governance, road traffic death, and prehospital services was explored, as well as the effects of prehospital services on the overall health care of a country and the effect of staffing prehospital services with physicians or trained nonphysician responders.

Literature Review

The literature search was conducted using the multiple database search engine Thoreau from the Walden University Library, the Cochrane Library, Google, and Google Scholar. Search terms used include combinations of *road traffic injury*, *income*, *governance*, *indicators*, *prehospital* and *emergency medical services*.

Peer-reviewed articles, in English, primarily from 2000 to the present, with a preference for 2008 onward, were sought. Randomly controlled studies would have been desirable, but such studies are difficult to perform and few are available. Meta-analyses of descriptive studies predominate in the literature. The WHO was a key sponsor of seminal reports on road traffic injury. However, there is a complete lack of literature on the effects of country income and governance on prehospital service staffing and road traffic death.

Theoretical Foundations

The WHO (2009) framework for the determination of road traffic mortality includes grouping independent variables into exposure factors (vehicle and road density); risk factors, defined as preventative or moderating measures (policies and interventions for and enforcement of alcohol and speed regulations and investment in public transportation); mitigating factors (health care system and prehospital emergency care); and income in relation to the outcome of mortality. A similar approach is the Haddon matrix of categorizing and analyzing factors that influence injury.

Haddon (1968, 1980) believed that descriptive approaches to injury lacked scientific rigor and proposed that multiple factors influenced a vehicle crash event. The

basic epidemiologic structure of this matrix is that a crash and the impact of the crash are a combination of pre-event, event, and postevent occurrences influenced by human/host, vehicle/agent, and social, political, and environmental conditions (Haddon, 1980).

Haddon (1968) posited that occurrences in the social, psychological, and behavioral environments are as important as vehicle safety and road infrastructure. The Haddon matrix is a flexible tool for "investigating the series of events leading toward a final outcome," both in analysis and to suggest countermeasures (Albertsson et al., 2003, p. 110). Barnett et al. (2005), in their discussion of preparedness for mass casualty events, explained that the Haddon matrix can be used as a tool to identify and develop primary (e.g., before a crash), secondary (e.g., at the time of the crash), and tertiary (e.g., after the crash) prevention interventions.

The one-time director of the National Highway Safety Bureau, Dr. William Haddon (1968, p. 1431), wrote, "The phenomena of trauma to be dealt with scientifically must be based not on descriptive categorizations, but on etiologic ones." As knowledge about a phenomenon develops, it is subdivided into smaller, distinct phenomena; Haddon used the example of the one-time diagnostic categories of wasting and fever being subsequently redefined as syphilis, protein deficiency, amebiasis, and tuberculosis, all sharing some symptoms but with different etiologies. Haddon believed it followed that accidents are not random or chance occurrences but phenomena with causation which can be understood when the etiology is investigated and new definitions are applied to these events. To identify the etiologic causes of and countermeasures to crash events Haddon devised a "two-dimensional matrix" that labels rows as precrash (pre-event), crash

(event), and postcrash (postevent) and columns as the identified factors needing consideration; for example, Haddon's (1968, pp. 1435–1436) factors were driver, passenger, pedestrian, bicyclist, motorcyclist, vehicles, highway, and police.

By the 1980s, Haddon had developed his matrix to focus on epidemiological considerations and replaced the vaguer identified factor columns with host or human, agent or vehicle, and environment. He had operationally defined the columnar categories and simplified them into the prescribed three used today. Haddon (1980) also recounted the 10 strategies he developed, along with his safety and hazards research (i.e., the Haddon matrix):

1. Prevent the creation of the hazard in the first place.
2. Reduce the amount of hazard created.
3. Contain or prevent the release of the preexisting hazard.
4. Modify the rate or spatial distribution of the released hazard from its source.
5. Separate the hazard from the potential host or target by time or space.
6. Erect barriers between the hazard and the host/target.
7. Modify the relevant basic qualities of the hazard.
8. Strengthen the defenses of the host.
9. Begin to counter the damage already done by the hazard.
10. Stabilize, repair, and rehabilitate the host/target once the damage has been

done. (Adapted from Haddon, 1980, p. 418)

In the current research, I was interested in the postevent host and environment cells of the Haddon matrix, as well as the last two strategies Haddon developed: (9) begin

to counter the damage done and (10) stabilize, repair, and rehabilitate the host once the damage has been done.

The Haddon matrix is useful for a variety of purposes and blends well with other frameworks. Four frameworks related to prehospital care and injury prevention were proposed by Runyan (1998), Gates et al. (2011), Meisel, Hargarten, and Vernick (2008), and Gofin (2005). Runyan's (1998) adaptation of the Haddon matrix separates the environment column into a column for the physical environment and a column for social environment. She wished to highlight the influence of the environment as an important element in the complete picture developed when using the Haddon matrix. Runyan (1998) was eager to point out that the matrix rows of pre-event, event, and postevent constitute a temporal relationship in which the time periods blend into the antecedent and the future, as do the issues affecting the host, the agent, and the physical and social environments.

Runyan (1998, p. 303) used a house fire as an example, but in keeping with the topic of this paper, I used road traffic crashes. The lack of social or political will against drunk driving leads to the lack of regulations against drunk driving (social or political environment for pre-event and event). Some drunk drivers are able to start and drive vehicles because anti-drunk-driving ignition disablers are not required (depending on the focus, pre-event or event agent, and host behavior). Some of those drunk drivers are involved in road traffic crashes, often at a high speed because the driver's behavior is disinhibited, the driver's judgment is impaired, and there is little or no law enforcement available to deter or stop the drunk driver (event host behavior, pre-event social or

political environment). The road traffic crash event may involve only the drunk driver or it may involve other road users (event agent). If the people involved are fortunate, there will be a rescue and prehospital system available to treat and transport them to emergency care; otherwise, they will need to rely on themselves or the kindness of bystanders for rescue and transport to a health care facility (pre-event social/political environment, postevent agent and environment). If they are fortunate, they will have advanced medical care available in their country, supported by the political and social will of their fellow citizens, and will recover physical and social functions. If no advanced health care or social and political will exists, the crash victim's prospects are bleaker.

In each phase of the drunk driving scenario, the factors of host, agent, and physical or social environment are present and interact to influence the outcome; these are each available points for interventions aimed at the prevention of the event or the reduction of the severity of its aftermath. Runyan (1998) stressed that Haddon warned that care needs to be taken not to place a factor or intervention in the wrong cell or fail to realize that the factor or intervention may be in more than one cell. Haddon (1980) used the example of seat belts, an intervention that is primarily in the agent-event cell, where it is intended to prevent injury to the wearer from impact with the internal surfaces of the vehicle. The seat belt is also in the political environment pre-event and event and the host pre-event and event behavioral factor cells of the Haddon matrix. Sleet et al. (2011, p. 79), writing about the history of injury prevention, saluted the Haddon matrix (and Haddon himself) as an important tool in saving "328,551 lives" from 1960 to 2002.

Runyan (1998) adapted the Haddon matrix to include costs and benefits of interventions, effectiveness of interventions, social and political values interpretations, and feasibility of interventions, allowing for additional categories as needed, so the matrix becomes a useful tool in decision making and policy development. Runyan (2003) compared and blended the Haddon matrix with the social-ecologic framework of Bronfenbrenner. The social-ecologic framework, as explained by Runyan (2003), states that factors of, for example, human developmental state are influential in the interactions people have with each other. These interactions, in turn, influence the institutional or political interactions so that the larger society is influenced by and influences the individual. Runyan (2003) used the image of Chinese boxes (also appropriate are Russian Matryoshka dolls), each nestled within the next size larger, to describe these influences. For a road traffic use analogy, consider the adolescent male who, in his inexperience, defiance, and fearless nature, drives too fast for conditions, egged on by friends in the car. The accidents that result from these conditions cause insurance rates to increase for all adolescent males and drive policymakers to impose regulations on driving age, the amount of training needed to obtain a driver's license, the number of passengers that can be in the car with the adolescent, and the time of day the adolescent is allowed to drive. (After I devised this analogy, I discovered that Runyan and Yonas [2008] used a similar analogy.)

Another example of how the Haddon matrix encourages blending with other theoretical constructs is presented by Gates et al. (2011). They used the Haddon matrix to identify issues and subsequently suggest interventions to reduce violence against

prehospital and emergency room workers. Using the action research model, Gates et al. (2011) developed questions or focus points for structured group interviews of emergency care workers. Action research is a qualitative framework that engages the subjects of the research in the research developmental process. Sagor's (2000, n.p.) succinct definition is this: "[Action research] is a disciplined process of inquiry conducted *by* and *for* those taking the action. The primary reason for engaging in action research is to assist the 'actor' in improving and/or refining his or her actions." Gates et al. (2011) developed focus group content for host, vector, physician, and social environment in each of the time periods (pre-event, event, and postevent) that seem remarkably similar to Runyan's (1998) social-ecological model, emphasizing education, policy, awareness of others' emotional and behavioral state, building relationships with coworkers and patients, and other features. Participants in Gates et al.'s (2011) study talked through their thoughts and opinions regarding each of the topics, and a set of recommendations were developed for the participating hospital. The similarity with the social-ecological model (Runyan, 1998) is that the third dimension of value and benefits was used to generate the research questions, and the relationships among the participants and with the perpetrators of violent actions were analyzed.

Meisel et al. (2008) used the Haddon matrix as the organizing model for a study using the injury prevention and control approach. This approach seeks for root causes of an event, in this case prehospital safety lapses, and looks for the "readily modifiable factors" that can be modified by automatic interventions (Meisel et al., 2008, p. 413). The injury prevention model seeks to change the pre-event host behavior, the vector or agent

of injury, and the physical and social environment that leads to the event. This approach is beneficial for prehospital providers because those using it hope to deemphasize blame and fault finding, while changing the way procedures are accomplished and materials are packaged (Meisel et al., 2008). The connection to the Haddon matrix should be obvious; the matrix was used in this study as the organizing tool for identifying medial and procedural errors prior to the development of corrective interventions.

Despite a USA-centric bias, the epidemiological triangle model (Gofin, 2005) is useful for explaining the need and rationale for preparedness and response to terrorism, a major concern to prehospital care providers. The epidemiological triangle is the interaction of the behavior of the host and the influence of the agent or vector and the environment (Gofin, 2005). The similarity with the Haddon matrix is apparent if a temporal element of pre-event, event, and postevent is introduced. The interaction among the factors is also similar to the social-ecologic framework of Runyan (1998). Indeed, Gofin acknowledged Runyan for influencing his decision to write his article.

Albertsson et al.'s (2003, p. 110) investigation of mass transit crashes found the Haddon matrix to be a flexible tool for "investigating the series of events leading toward a final outcome," both in analysis and to suggest countermeasures. Other authors using the Haddon matrix included Chrisholm and Nanci (2009), describing road traffic safety interventions; Peden et al. (2004), when reporting on worldwide road traffic injury for the WHO; Khankeh, Khorasani-Zavareh, and Masoumi (2012), to help explain the road traffic fatality rate in Iran; and Pratte (1998), in a discussion of road traffic deaths in Africa. Additionally, Stav, Arbesman, and Lieberman (2008) incorporated the Haddon

matrix in their literature review of older drivers' safety; Yancey, Martinez, and Kellermann (2002) referenced the Haddon matrix in the development of their "Accidents Aren't" pre-event intervention program to be delivered by EMS personnel; and Grimm and Treibich (2012), while investigating the subsequent rise in road traffic deaths as people's ability to purchase vehicles increases with prosperity, used the Haddon matrix to categorize influential topics.

In a talk before the Australasian Road Safety Research, Policing, and Education Conference, Wall (2013) explained the importance of the Haddon matrix in all aspects of vehicle crash science and the response in the postcrash phase. Meisel et al. (2008) also described the power of the Haddon matrix in the prehospital and emergency room settings. Moreover, Thyer et al. (2009) described their use of the Haddon matrix in the evaluation of the postcrash, prehospital use of cervical collars to immobilize the victim's neck until potential injury can be ruled out. Many other combinations and adaptations of the Haddon matrix can be found in the literature.

Rationale for Theory Choice

Road traffic accidents have a variety of causes and outcomes that can be categorized by the Haddon matrix. Along with the addition of Runyan's (1998) social-ecologic model, it served as a good backdrop for evaluation of the overarching influence of income and governance on prehospital systems factors on road traffic deaths. The pre-event and postevent sociopolitical environment, as well as the pre-event and postevent agents—physicians, nurses, paramedics, EMTs—were the focus in this study. The

Haddon matrix is quite common in the literature, and several more studies will be addressed.

The Haddon matrix was used in a report conducted by Peden et al. (2004) for the WHO on road traffic injury prevention and on studies on attributable risks of road traffic accidents and injuries by Chrisholm and Nanci (2009), income and road traffic deaths by Grimm and Treibich (2012), and road traffic death in developing countries by Pratte (1998). Albertsson et al. (2003) used the Haddon matrix in their investigation of crashes involving buses and motor coaches. Chakravarthy et al. (2007) described the factors of pedestrian road traffic fatalities using the Haddon matrix.

Peden et al. (2004, p. 93) place prehospital systems in the category of risk factors for postevent outcome, or what Runyan (1998) might call the effectiveness value of the pre-event and postevent social or political environment:

Weak public health infrastructure in many low-income and middle-income countries is a major risk factor. In high-income countries, the pre-hospital risk factors are not so pronounced, but where they exist, are associated with the need to improve the existing elements of post-impact care. (Peden et al., 2004, p. 94).

The use of advanced life support and rapid transport for road traffic victims can likewise be categorized as a postevent risk factor and intervention that can be placed in the agent and environment cells and evaluated for effectiveness (Peden et al., 2005). The training of first responders is an important factor in reducing death from road traffic crashes, as police and firefighters often arrive before prehospital care providers and can significantly influence the victim's outcome in a crash (Peden et al., 2005). Educating

both physicians and paramedics in advanced life-support procedures has been shown to improve the outcome for road crash victims (Peden et al., 2005). Peden et al. (2004) concluded that prehospital services are an important factor in the reduction of road traffic deaths. In their study, Chrisholm and Naci (2009, p. 6) populated their Haddon matrix postcrash human, vehicle, and environment cells with first aid skills and access to hospital, ease of access, fire risk, rescue facilities, and congestion as factors to explain their identification of risk and interventions.

Approaches to the Study of Prehospital Services and Road Traffic Fatalities

Two main approaches have been used by researchers when studying emergency medical systems and interventions. Retrospective studies use archival data, and prospective studies collect data from participants as they occur. Prospective studies watch for outcomes during the study period, but the outcome needs to be common or the study very large for statistically significant results to be found (StatsDirect, n.d.). Although biases, such as loss of participants during the study period, need to be avoided, prospective studies have fewer sources of bias and confounding than retrospective studies because the researcher controls the definitions and data collection (StatsDirect, n.d.). Retrospective studies examine the risks that precede the current outcome (StatsDirect, n.d.). Because the researcher is using data collected under someone else's definitions and purpose, more bias and confounding plague these studies (StatsDirect, n.d.). Prospective studies take longer to perform because data are collected from the start of the collection period through the end of the period and data analysis cannot occur until the end of the

data collection (LaMorte, 2013). Data analysis in retrospective studies can happen quickly because the data already exist in databases (LaMorte, 2013).

Randomized controlled trials (RCT), one of the prospective study styles, are difficult to design for medical-related topics because of the ethical considerations of withholding treatment to injured patients. RCTs control all variables except the variable of interest and form groups with and without the variable present (Himmelfarb Health Sciences Library [HHSL], 2011). RCTs reduce population bias, are easier to blind participants and researchers, and are amenable to known statistical tools (HHSL, 2011). The disadvantages are that RCTs are more expensive and time-consuming, willing participants may not be representative of the whole population, they do not reveal causation, and participants may not follow up after receiving the intervention (HHSL, 2011).

A number of retrospective studies on the topic of road traffic safety have been conducted. Baker, O'Neill, Haddon, and Long (1974) used archival medical records and chart reviews of injured road users in eight Baltimore hospitals during 1968 and 1969 to test a predictive grading scale for posthospital outcomes. Canto et al. (2002) surveyed 772,586 hospitalized patients suffering myocardial infarction between 1994 and 1998, finding that more than half of the patients used EMS and received definitive care more rapidly than did non-EMS users. Albertsson et al. (2003) used a case study to investigate a bus crash and recommended, among other things, that more people be trained and available to respond to road traffic crashes. Wall (2013) used a literature review to discuss the benefit of prehospital response to road traffic crashes.

Gaygisiz (2010) accessed archival data to investigate culture, governance, and road traffic fatalities, finding a reduction in road traffic deaths in higher-income countries. Based on their study of archived deidentified patient-level data (i.e., chart reviews) from nine countries' trauma systems, Roudsari et al. (2007) recommended increased prehospital care services and training of laypeople in basic first-response medical care in developing African countries.

Kirves, Handolin, Niemela, Pitkaniemi, and Randell (2010) used retrospective chart reviews to evaluate physician versus nonphysician injury assessments, finding that physicians were better than paramedics at identifying the extent of injury. Zwerling et al. (2005) used archival data from governmental data sets in reviewing road traffic deaths in rural versus urban settings. Ramanujam and Aschkenasy (2007) used published and unpublished survey data in their study of the need for prehospital and emergency care. Nathens, Jurkovich, Rivara, and Maier (2000) used archival data from registries and governmental sources as well as survey results from emergency medical service directors in their study of the effectiveness of information from state trauma registries in reducing injury-related mortality.

There are few prospective studies, especially random controlled trial studies, on the topic of road traffic safety. In one prospective study, Bobrow et al. (2008) compared the results of 886 out-of-hospital cardiac arrests between 2005 and 2007 and found that minimally interrupted chest compression performed by EMS personnel increased survival rates by 5.3%. Silivestri et al. (2004) conducted a prospective, observational analysis of 153 out-of-hospital intubated patients, finding a 9% rate for misplacement, but no

misplacement when end tidal carbon dioxide monitoring was used. Fischer et al. (2011) used data collected between January 2001 and December 2004 in their prospective study of physician versus nonphysician prehospital response to cardiac problems. Roudisari et al. (2007) used observational techniques to follow advanced life-support providers—nurses and paramedics trained in advanced technique—and physician providers in a comparison study of prehospital staffing on fatality.

Factors Influencing Road Traffic Injury

In the literature on road traffic injury, the commonly referenced factors are vehicle safety, seat belt use, speeding, and alcohol and drug use (Anbarci et al., 2009; Chrisholm & Naci, 2009; Kopitis, 2004; Moeller, 2005; WHO, 2009). In one way or another, these factors influence across the cells of the Haddon matrix and may be either advantages or disadvantages to those involved in a road traffic crash.

Vehicle Safety

The vehicle itself—its size, body style, and safety equipment—is an area where intervention before a crash can reduce injury (Moeller, 2005). Anbarci et al. (2009, p. 245) report on studies demonstrating that a 1% increase in weight of one involved vehicle resulted in a 5% increase in fatality rate for the driver of the lighter vehicle, and that a 2.5% increase in fatality resulted for the operator of the lighter vehicle for every 100 pounds of weight difference. Additionally, because the weight of a vehicle usually increases as its price increases, “the average injury rate for vehicle occupants can be expected to fall by about 0.57% for each 1% increase in vehicle price” (Moeller, 2005, p. 254). But, although higher price and weight of the vehicle increased safety for the

occupants of that vehicle, they also increased the chance that occupants of other involved vehicles (and other vulnerable road users) will be injured (Moeller, 2005, p. 252).

Vehicle safety is a factor in all three rows and columns of the Haddon matrix.

Seat Belt Use and Child Restraints

Seat belts and child restraints were effective interventions in the severity of road traffic injury (Chrisholm & Naci, 2009; Kopitis, 2004). Chrisholm and Naci (2009, p. 7) found a 2% to 12% reduction in death when restraints were in use.

Seat belt use reduced crash fatalities by 40% to 50% for passengers and drivers in the front seat and up to 75% for passengers in the rear seats (WHO, 2009, p. 24). Eighty-eight percent of countries reported having seat belt use laws, but only 57% required all passengers to use seat belts (76% of high-income, 54% of middle-income, and 38% of low-income countries; WHO, 2009, p. 24). Use of child restraint systems can reduce infant and child deaths in crashes by 80%, but only about 50% of countries reported having child restraint laws: 90% of high-income and only 20% of low-income countries (WHO, 2009, p. 26). Few countries reported significant enforcement of child restraint laws (p. 26). Seat belts fit into pre-event and event factors for the host, the agent of injury, and environment.

Helmet Laws for Motorcycle and Bicycle Riding

Wearing a motorcycle helmet can reduce risk of death by almost 40% and risk of severe injury by 70% (WHO, 2009, pp. 22–23). Ninety percent of countries have motorcycle helmet laws (WHO, 2009). Kopitis (2004, pp. 15–28) found that not wearing a helmet increased the injury and death rate in motorcycle accidents by 1% to 12%.

Chrisholm and Naci (2009, p. 17) reported in their study that not wearing a helmet increased injury and death in bicycle accidents by up to 5%, depending on the country and income level. Helmets are event host cell factors.

Speed as a Factor

Driving too fast for conditions increased the chance of a crash by 10%; in fact, there was a 20% increase in fatal injury for every 5% increase in speed (WHO, 2009, p. 18). Pedestrians have a 90% survival rate when hit by a vehicle traveling at 30 km/h (22 mph), but less than a 50% chance of survival at 45 km/h (28 mph; p. 18). Yet, despite the fact that a difference of only 6 mph doubles the chance of death, "only 29% of countries have speed limits of 50 km/h [30 mph] or below on [urban roads] and allow authorities to reduce them further" (p. 19). Speed was the greatest risk factor for up to 28% of the incidents in Chrisholm and Naci's (2009) study.

Driving too fast for road conditions also increases the severity of injury when a crash occurs, making speed limits and enforcement two of the best interventions to reduce road traffic accidents (Chrisholm & Naci, 2009; WHO, 2009, p. 18; Moeller, 2005, pp. 275–280). Reporting on risk factors in fatalities across the World Health Organization's 14 subregions, Chrisholm and Naci (2009, p. 17) found that speeding caused 21% to 28% of injuries and fatalities and that speed limits were an effective intervention. Speeding is a pre-event and event factor in the host, agent, and environment cells of the Haddon matrix.

Alcohol, Drugs, and Distracted Driving

Alcohol use is by far the most important factor in driving too fast for conditions, followed by drug use and distracted driving (Chrisholm & Naci, 2009; Moeller, 2005, pp. 275–280; WHO 2009, p. 21). Drinking and driving contributed to 1% to 21% of crash injuries and fatalities, depending on region (Chrisholm & Naci 2009, p. 17). Use of mobile phones and other distractions were also contributing factors to pre-event and event road traffic injury (Peden et al., 2004).

The risk of a crash "increased significantly with a blood alcohol content (BAC) of 0.04 g/dl (grams of alcohol per deciliter of blood) and laws that establish a BAC between 0 and 0.02 g/dl led to a 4% to 24% reduction in young driver crashes" (WHO, 2009, p. 21). Sobriety enforcement is cost-effective and reduces alcohol-related crashes by 20% (p. 21). Seventy-nine percent of countries reported using either sobriety checkpoints or random breath tests: 21% of high-income, 11% of middle-income, and 9% of low-income countries (p. 22). Ninety-six percent of countries had "drinking-driving" laws, but only 49% used a BAC of 0.05 g/dl or less as a threshold (p. 21). Alcohol, drugs, and distracted driving fit into the pre-event and postevent cells for host, agent, and environment in the Haddon matrix.

Age as a Factor

Driver age has been of interest in road traffic injury. Both youths' inexperience and seniors' slow reaction contributed to road traffic injury (Chrisholm & Naci, 2009; Moeller, 2005; WHO 2009, p. 21). Atubi (2012) noted a 16-year cycle and a 32-year

cycle in road traffic injury, which he attributed to the addition of new drivers on the road and a reduction of veteran drivers.

The WHO (2007 Youth and road safety) points to inexperience and bravado as the major causes for youthful road traffic crashes, specifically inexperience with road environments and bravado from developmental factors, such as risk taking and social influences, and gender. Subzwari et al. (2009) note that older drivers have a higher crash rate than younger drivers, excluding adolescent males, due to physical and mental slowing as well as reduction in vision. Age is a factor of the Haddon matrix cell for pre-event, event, and postevent host, agent, and environment.

Other Factors

Economic and social deprivation, demographics, the mixture of high speed and vulnerable road users (i.e., pedestrians and pedal-powered and motor-driven two-wheeled vehicles), driver fatigue, gender, and time of day were additional risk factors for road traffic injury and fatality (Peden et al, 2004). Pre-event interventions that have been shown to reduce road traffic injury include engineering speed and traffic flow, road design for weather-related and topographic conditions and population density, vehicle safety inspections, public safety campaigns on speed and alcohol and drug use, and campaigns against distracted driving (Chrisholm & Naci, 2009; Kopitis, 2004). Chrisholm and Naci (2009) add to their list the need for increased visibility of pedestrians and barriers to protect pedestrians and bicycle riders from motorized traffic. Some factors increasing postcrash severity are delay in detection, fire, hazardous material leakage,

inability to extricate people from vehicles, and the lack of prehospital and emergency medical care (Peden et al., 2004).

Atubi's (2012) findings from his study of road traffic injury and population density in Lagos, Nigeria, suggested, counterintuitively, that the better the conditions of the road in a country, the greater the chance for fatalities. He tempers the fatality rate in his study with the influence of crowding in urban areas, which forces vehicles to travel more slowly and encourages a greater presence of law enforcement officers. Over the years of his study, frequency of accidents and severity of injury increased as the road infrastructure improved. He also notes the increased frequency of accidents at places where road improvement ends and more rustic roadways begin. This seeming contradiction to other studies may be explained by the increasing wealth of the Nigerian people and the subsequent increase in motorized two- and three-wheeled vehicles on the road that provide less safe transport at higher speed. When speeding vehicles reached an abrupt change in road development, drivers were unable to maintain control of their vehicles.

Chrisholm and Naci (2009) reviewed the risks of different road user types in different world regions. They found that broad interventions were less effective and less cost-effective compared to tailored and targeted interventions when considered at the population level; that is, messages about safe driving should be targeted to specific populations. Chrisholm and Naci (2009, p. 5) concluded that law enforcement is the most effective deterrent to speeding and that drinking and driving laws and enforcement combined with seat belt laws and enforcement showed the most effectiveness in reducing

road traffic injury. Motorcycle and bicycle helmet use were most effective in less motorized countries but were less significant in heavily motorized countries (Chrisholm & Naci, 2009, p. 5).

Appendix A summarizes Chrisholm and Naci's (2009, pp. 30–33) findings across the four subregions they studied for the most effective interventions to reduce road traffic injury: Africa (AfrE), America (AmrA), Southeast Asia (SearD), and western Pacific (WprB). They reported on five interventions and three combinations of interventions measured in disability adjusted life years (DALY) saved in total and per 1 million population and measured in "annualized costs per year" in millions of dollars, with a 3% reduction correcting sample error, or cost per capita. One DALY is the accounting for "one lost year of healthy life" across the population by summing the years lost to premature death and the years lost to disability, tempered by a calculation of the length of time a disability is present prior to death (WHO, Health Statistics and Health Information Systems, 2013).

The single most cost-effective strategy varied by subregion, but generally speaking, a combined intervention strategy that simultaneously enforced multiple road safety laws produced the most health gain for a given amount of investment. For example, using the standardized international dollar (I\$) value, the combined enforcement of speed limits, drinking and driving laws, and motorcycle helmet use appeared on the cost-effectiveness "frontier" in three out of four subregions, with each DALY averted costing I\$1,181 (SearD), I\$4,550 (WprB), and I\$14,139 (AmrA), respectively. In AfrE, the single most cost-effective strategy was enforcement of bicycle

helmets (I\$1,233), which, at least in part, reflected the very different road traffic patterns in this subregion (fewer cars and motorcycles). In AmrA, by contrast, legislation and enforcement of bicycle helmet use was by far the least cost-effective option, with each healthy life year gained costing nearly I\$300,000 (Chrisholm and Naci, 2009, p. 34).

Other variables affecting road safety included country population (WHO, 2009, p. 234), road use policy, road density and infrastructure (Kopitis, 2004, pp. 15–28), vehicle density and road density (WHO, 2009, p. 234), walking and cycling patterns, and public transportation (WHO, 2009; Kopitis, 2004).

An interesting investigation found relationships between road accident mortality rates and economic conditions, cultural characteristics, personality dimensions, and intelligence scores in some high-income Organization of Economic Cooperation and Development (OECD) member states (Gaygisiz, 2009b). Countries with higher fatality rates had greater power disparity in the society (power distance), more emotionally mediated reactions to change (uncertainty avoidance, which encourages slow, safe changes in society and proliferation of laws and rules), and greater focus on the relationships among people (embeddedness), highlighted by a strong social hierarchy. “Countries with lower road-traffic accident fatality rates were more individualistic, egalitarian, and emphasized autonomy of individuals. Conscientiousness and IQ correlated negatively with road-traffic accident fatalities” (Gaygisiz, 2009b, p. 531). The correlation between traffic accident fatalities and individualism was as high as $r = -0.52$. “Embeddedness ($r = 0.61$) and hierarchy ($r = 0.49$) had positive correlations, and affective autonomy ($r = -0.55$), intellectual autonomy ($r = -0.56$), and egalitarianism ($r =$

–0.47) negative correlations with road-traffic accident fatalities” (Gaygisiz, 2009b , p. 540). Finally, conscientiousness ($r = -0.53$) correlated negatively with traffic injury and accident (Gaygisiz, 2009b , p. 542).

Hofstede’s “power distance” dimension and Schwartz’s value dimensions (“embeddedness,” “hierarchy,” and “mastery”) were positively related to traffic fatalities, and “intellectual autonomy” and “egalitarianism” were negatively related (Gaygisiz, 2009b, p. 540). Gaygisiz’s (2009) findings fit nicely into Runyan’s (1998, 2003) expanded model considering how culture and other human factors influence the greater Haddon matrix.

The Social and Economic Costs of Road Traffic Injury

Working-age members of society (ages 15–34) incurred the greatest burden in terms of the cost of human suffering and the economic cost to society for the number of productive years lost by disability or death (McKenzie et al., 2008). Road traffic accidents cost the world economy an estimated US\$518 billion per year (WHO, 2009, p. 2). Peden et al. (2004, p. 5) reported that "road crash injury costs an estimated 1% of gross national product in low-income countries, 1.5% in middle-income countries, and 2% in high-income countries." According to Grimm and Triebich (2012, p. 3), however, in India, for example, the social cost of road traffic injury was estimated to be as high as 3.2% of GNP. "About three-quarters of road traffic deaths are among men and ... the highest impact is in the economically active age range" (WHO, 2009, p. 11). Besides suffering medical and funeral costs, many families were unable to recover from the loss of their breadwinner (WHO, 2009, p. 3). "Given that these fatalities are concentrated in

the economically active population, reducing the number of road traffic injuries and fatalities could confer large welfare gains to households" (Grimm & Treibich, 2012, p. 2).

Key Variables and Concepts

Income and Road Traffic Injury

Country income is a very important factor in road traffic, cutting across the cells of the Haddon matrix. Income is the environmental factor that influences the other cells.

Country income forms an inverted curvilinear relationship with road traffic injury and death (the inverted U or Kuznets curve; Anbarci et al., 2009; Grimm & Treibich, 2012; Kopitis, 2004). As income trickles through the society and people become wealthier, they are able to progress from walking to human-powered and motorized two-wheeled vehicles to safer four-wheeled vehicles (Anbarci et al., 2009; Grimm & Treibich, 2012; Kopitis, 2004). At the government level, with greater economic development comes greater safety interventions, more investment in road and health infrastructure, and more police and law enforcement, all of which help reduce the number of road traffic fatalities (Anbarci et al., 2009; Grimm & Treibich, 2012; Kopitis, 2004). Grimm and Treibich (2012, p. 8) reported that in India, when the per capita income rose to Rs 9,971 (rupees), the number of road traffic injuries leveled off and then began to decline at Rs 12,500 as more four-wheeled vehicles were on the roads.

Anbarci et al. (2009) believed that the decrease in fatalities may happen in aggregate as income increases, but within-country and between-country income disparity led to within- and between-country road traffic fatality disparity. This effect, or externality, appeared in all countries independent of the country's mean income (Anbarci

et al., 2009, p. 244). Anbarci et al. (2009) explained that vehicles are a luxury item that increase in safety as the price increases; higher-income people can afford more crash-worthy vehicles, while lower-income people need cheaper, less safe vehicles (if they can afford a vehicle at all) to match their budget. The interaction between the transportation types results in more fatalities for the cheaper, less safe transportation mode (Anbarci et al., 2009, p. 244). Additionally, although overall income in a society results in the ability of countries to develop and enforce safety standards in vehicles, road infrastructure, and policy and enforcement of speed, alcohol use, and the like, income disparity still results in higher fatality rates for vulnerable road users (Anbarci et al., 2009, p. 248).

As income and economic development increase for a country, especially beyond the middle-income range, fewer people die in the road traffic crashes that do occur (Ameratunga et al., 2006). However, the resulting minor to very serious injuries still leave people with the need for rehabilitation (Ameratunga et al., 2006).

The WHO (2009, p. 234) found that the rate of road traffic injury was influenced by country income level: the higher the income, the lower the rate of injury. In their review of the literature on population health and governance, Klomp and de Haan (2008, pp. 604–605) found that income has a positive effect on access to health resources: "With increasing income comes increasing life-expectancy, lower levels of poverty, and greater access to nutrition and health care." Chrisholm and Naci (2009) also pointed to economic development as an independent variable that influenced the burden of road traffic injury placed on road user groups; lower-income countries experienced greater pedestrian and

bicycle road traffic injuries, while higher-income countries saw more four-wheeled occupant injury.

Grimm and Treibich (2012) compared 25 areas in India and presented evidence they believe points to income, the ability to afford increasingly more complex vehicles, and urbanization as the factors contributing the most to the burden placed on the Indian people from motor vehicle accidents. Grimm and Treibich (2012) discussed the same curious increase in road traffic fatalities as a country (or region) transitions from low- to middle- to high-income that others have found (e.g., Anbarci et al., 2009; Kopitis, 2004). Grimm and Treibich (2012) speculated that as people can afford more four-wheeled vehicles and abandon walking on busy roads or driving less safe two-wheeled bicycles or motorcycles, the rate of injuries increased and then decreased at a point of saturation for four-wheeled vehicles. Grimm and Treibich (2010) suggested that during the transition, injuries increased because a significant number of people still walk or ride bicycles or motorcycles and suffer collisions with the four-wheeled vehicles the newly wealthier people can afford. Grimm and Treibich (2010) reported that increased motorization, urbanization, and pedestrian and two-wheeled traffic are the major factors leading to an increase in road traffic injury rates in India. Indian women were a particularly high-risk group of vulnerable road users. Grimm and Treibich (2010, p. 1) recommend that Indian officials focus on road infrastructure, separation from traffic of pedestrians and other vulnerable road users, and traffic regulation and enforcement, and should be particularly mindful of women road users as India develops. Specifically, Grimm and Treibich (2010) looked at how much money was allocated to enforcement of traffic laws, which they

measured as expenditure per police officer, and found that "higher expenditure per policeman is associated with lower fatality rates"; an increase of 1% led to a decline in fatality rate by about 0.15% (Grimm & Treibich, 2010, p. 13).

Mohan (2002; cited in Grimm and Treibich, 2012, p. 3) believed the issues surrounding road crash injuries were more complicated in low- and middle-income countries due to the following:

- A high proportion of [low-income] road users.
- A high proportion of vulnerable road users sharing the road with motorized vehicles.
- A high population density in urban areas.
- A low enforcement level of road traffic rules and regulations.
- Severe limitations on public resources available for road and other infrastructure.

Bishai, Quresh, James, and Ghaffar (2006, p. 65) found that

a 10% increase in GDP in a lower income country (GDP per capita < \$1,600) . . .

[raises] the number of crashes by 7.9%, the number of traffic injuries by 4.7%,

and the number of deaths by 3.1% through a mechanism that is independent of

population size, vehicle count, oil use, and roadway availability. Increases in GDP

in richer countries appear to reduce the number of traffic deaths, but do not reduce

the number of crashes or injuries.

In contrast, Anbarci et al. (2009, p. 251) discussed a controversy in the literature regarding the use of aggregate data to determine the death rate from road traffic fatalities.

The use of aggregate data is a prime ingredient in the ecological fallacy, whereby the behavior of individuals is concluded from observation and analysis of data on the group the individual belongs to (Anbarci et al. 2009, p. 251). The assertion that as income increases in a country the road traffic injury rate decreases is an ecological fallacy, especially the assertion that income inequity is an exception to the reduction. The issue is the ability of relatively wealthier individuals in a society to afford heavier, safer vehicles while the less wealthy can afford only the lighter, less safe vehicles (Anbarci et al. 2009, p. 251). In their defense, Anbarci et al. (2009) argued that their assertion—that income inequality, independent of the overall wealth of a country, results in higher injury rates from traffic accidents—is supported by disaggregate data about specific subpopulations in a country, not the aggregated death rate for the whole population.

Governance

Control of resources (material, intellectual, emotional and behavioral, and political) is the source of a person's or group's power to "influence others' thoughts and self interests ... or the satisfaction of human needs and aspirations" (Neal & Neal, 2011, pp. 159–160). Individuals or groups with higher power are able to reward or punish, set agendas, and/or influence shared consciousness to exercise their status (Neal & Neal, 2011, p. 159). Power relationships are available only when there is an asymmetrical distribution of resources (Neal & Neal, 2011, pp. 161–162).

There are forces within countries to include and exclude the participation of citizens (Babajanian & Hagen-Zanker, 2012). Citing the International Labour Organization, UNICEF, and the World Bank, Babajanian and Hagen-Zanker (2012)

develop the argument that greater inclusion in the society reduces poverty, improves participation in and strengthening of economic growth, reduces the cost of health care, improves satisfaction with government, and promotes general well-being. Conflict is often present during social change to redistribute power but does not necessarily accompany all power relationships. “Conflict-free power might be observed in at least three forms: acquiescence [to the power differential], authority [of the individuals welding power], and unawareness [that a power difference exists]” (Neal & Neal, 2011, p. 162).

Application of power and governance lies on a continuum from anarchy to totalitarian systems, with democracy and republican representation in between. The difference among these types of governance is the amount of control over the people ruled. When there is no controlling government, anarchy exists and people are forced to protect themselves, their family and property, while gathering the resources necessary to live. When all control over the people is held by one person, a monarchy or dictatorship exists, and the people are subjected to the whim of the ruler (adams4nchouse, 2012). Between these extremes are oligarchy, rule by a group; democracy, rule by the majority (subject to the current whims of the majority); and republic (rule by established law), which is the least volatile and a constraint to mob rule (adams4nchouse, 2012). In effect there are only oligarchies and republics, as one person cannot control all of a society and anarchy rapidly forces people to band together and find protectors to stabilize the society. Democracy is too susceptible to the mood of the day; people in the minority are at risk from the whims of the majority. A democratic form of government rapidly moves toward

an oligarchy or a republic (adams4nchouse, 2012). Republics rely on formal rules agreed on and used to protect people from vigilantism. It follows that in most republics (commonly referred to as democratic systems), democracy happens at nodes: the public elects, by a majority vote, the executive, legislative, and (some of) the judicial representatives, which in turn vote on, approve, or constrain the majority actions at hand (adams4nchouse, 2012).

Governance principles apply in societies economically structured around capitalism, socialism, or a mixture of the two. “Governance involves [the] means for achieving direction, control, and coordination of individuals and organizations on behalf of [the] interests they have in common” (Forbes, Hill, & Lynn, 2007, p. 455). Kooiman (1999 ; cited in Forbes et al., 2007, p. 453) identifies common elements in these definitions as “the emphasis on rules and qualities of systems, co-operation to enhance legitimacy and effectiveness and the attention for new processes and public-private arrangements.”

Government is the interplay of legislative lawmaking, judicial decisions, and executive action in place to administrate social order and social welfare; “multiple layers of governing institutions,” in cooperation with public and private stakeholders, protect and provide support to a people (Forbes et al., 2007, p. 453). Governance describes the decision making and implementation of agencies or government bodies (McQueen, Wismar, Lin, & Jones 2012, p. 4).

Governance takes place across all sectors of society, with government (central, regional and local) taking responsibility for many aspects of society ranging from

the mundane (sewers, transportation, housing, energy, commerce) to the humane (education, the arts, sports). . . . The tools of action . . . [are] persuasion, regulation, law and legislation. (McQueen et al., 2012, p. 6)

To be effective governments need to focus on “political will, partnerships and constituents’ interests, leadership, the political importance of the issue, the immediacy of the problem, context for effectiveness, resources and implementation practicalities” (Lin, Jones, Synnot, & Wismar, 2012, p. 40).

Indicators of all kinds are developed to simplify and rank-order complex phenomena and are invested with a power that “shapes how the world is understood,” but they may obscure important nuances (Davis, Kingsbury, & Merry, 2012, p. 76).

Important decisions can be made based on the oversimplifications present in indicators (Davis et al., 2012). Yet this simplification provides a consistent representation, with discernible biases, across countries (Davis et al., 2012).

Governance and political style are also important factors and are related to country income (Ha, 2012; Gradstein, 2004; Khan, 2007; Lewis, 2006; Pillai et al., 2011; Qadri, 2012). Kirigia and Kirigia (2011, p. 3) demonstrate the links between a nation’s economic situation, poverty reduction, national health, and political stability, pointing to a transmatrix influence of the factors of governance.

Governance is the interplay of laws and rules, judicial decisions, and executive actions in place to administer social order and social welfare through cooperation with public and private stakeholders. A country’s cultural heritage, ethnic diversity, religious affiliations, and geography all have a place in the makeup of the governance of a people

(Al-Marhubi, 2005, p. 459). In “ethno-linguistically fractionalized” and “ethnically diverse” countries, for instance, there is likely to be more restriction on political freedoms, more intervention to regulate social mobility, and greater governmental inefficiency and corruption (Al-Marhubi, 2005, p. 459). La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1999) found that governance is also directly related to the way a society redistributes its wealth and protects the rights and well-being of its citizens.

In a pure form, "governance involves [the] means for achieving direction, control, and coordination of individuals and organizations on behalf of [the] interests they have in common" (Forbes et al., 2007, p. 455). Olafsdotir, Reidpath, Pokhrel, and Allotey (2011, p. 2 of 8) defined governance as "the process whereby societies or organizations make their important decisions, determine whom they involve in the process, and how they render accountability." Governance can be defined as the process of decision making by the government and the process by which decisions are implemented (or not implemented; Klomp & de Haan, 2008, p. 599). "Governance, broadly defined as the framework of rules, institutions and practices by which authority is exercised, is a key element for a well-functioning market economy and indispensable for sustained growth and equitable development" (Al-Marhubi, 2005, p. 453).

Governance refers broadly to the manner in which authority is exercised. Defined in this way, governance transcends government to include relationships between the state, civil society organizations and the private sector. It includes the norms defining political action, the institutional framework in which the policy-making process takes place, and the mechanisms and processes by which public policies

are designed, implemented and sustained. Common governance issues include the limits of authority and leadership accountability, transparency of decision-making procedures, interest representation and conflict resolution mechanisms. (Al-Marhubi, 2005, p. 454)

McQueen et al. (2012, pp. 4– 6) asserted:

Governance is a verb; it describes decision making and implementation of actions of agencies or government bodies. . . . Governance takes place across all sectors of society, with government (central, regional, and local) taking responsibility for many aspects of society ranging from the mundane (sewers, transportation, housing, energy, commerce) to the humane (education, arts, sports). . . . The tools of action . . . [are] persuasion, regulation, law and legislation.

Forbes et al. (2007, p. 453) list the common elements of governance:

- Emphasis on rules and qualities of the system.
- Cooperation to enhance legitimacy and effectiveness.
- Development and implementation of new processes and public-private arrangements.

There seems to be broad consensus that good governance implies that a government is accountable, transparent, responsive, effective, and efficient and follows the rule of law, thereby assuring that corruption is minimized (Klomp & de Haan, 2008, p. 600). Weale (2011, p. 63) discussed governance as a range of hierarchical procedures and players who "through bargaining and negotiating form a policy making body." Governance is accomplished by "multiple layers of governing institutions" working to

develop, implement, and evaluate rules and regulations for the governed (Forbes et al., 2007, p. 453).

An army of civil servants fills the ranks of cabinets, agencies, bureaus, and departments that form the bureaucracy that gets the work of government done (McQueen et al., 2012, p. 16). To be effective governments need to focus on “political will, partnerships and constituents’ interests, leadership, the political importance of the issue, the immediacy of the problem, context for effectiveness, resources and implementation practicalities” (McQueen et al., 2012, p. 40).

Kirigia and Kirigia (2011) reviewed the literature on indicators used to measure governance in health development to form an index of governance. They offered a broad definition for health governance that incorporates a number of facets of citizens’ well-being:

Sectors that assure human rights to education, employment, food, housing, political participation, and security combined have greater impact on health development than the health system. For example, the significant negative impact of political and macroeconomic instability on health development has been starkly demonstrated in the diminished health indicators of the African countries that have undergone various forms of political and macroeconomic turmoil. (Kirigia & Kirigia, 2011, p. 2)

Klomp and de Haan (2008) studied governance as a factor driving mortality. They found that governance indirectly influences the mortality rate through the financial support of a country's health care sector to provide quality care. Klomp and de Haan

(2008) looked at the governance indicators of legislative effectiveness, control of corruption, bureaucratic quality, law and order, regulation, and legal system and property rights. They correlated governance with the measures of life expectancy, mortality rates, years lost to disease, number of health care professionals, number of hospital beds, and the level of basic health care preventative services provided. Then they segmented their data by country income level and concluded that especially in low- and middle-income countries, income is the primary determinant of health. This finding is similar to the observation that income affects rates of traffic deaths.

"It is widely believed that poor governance causes well-intentioned spending to have no impact due to bribes, corrupt officials, and mis-procurement. Indeed the scant available evidence suggests that poor governance has a negative impact on health" (Klomp & de Haan, 2008, p. 599). Klomp and de Haan (2008, p. 605) found that good governance has a positive effect, particularly on health and the health care sector, but does not directly improve the health and income of individuals. A 1% increase in good governance leads to an increase of 0.55% in the quality of the health care sector and an increase in the health of individuals of about 3.54% (Klomp & de Haan, 2008, p. 607).

Kickbusch and Gleicher (2012, p. 15) suggested that in European Union countries health governance was the direct outcome of the "knowledge revolution." They argued that education is the best intervention and that a 10% increase in education funding would significantly improve health (Kickbusch and Gleicher, 2012, pp. 4–7).

Indicators simplify and rank-order complex phenomena and are invested with a power that "shapes how the world is understood," but they may not allow for important

nuances (Davis et al., 2012, p. 76). Important decisions can be made based on the oversimplifications present in indicators, yet the simplification inherent in these indicators provides a consistent representation from all parties across countries (Davis et al., 2012). Andrews et al. (2010, p. 391) argued that indicators may do little more than reflect a country's development and should have "a . . . focus on specific fields of engagement, and the size of outcome, and control for key contextual differences in comparing countries."

With this caveat in mind, World Governance Indicators (WGI) can be used as a comparison or evaluation tool among countries for a given time period, but the aggregate measures may be too vague to use to measure a specific topic or program in an individual country (World Bank, 2013). "More detailed and country-specific diagnostic data that can identify the relevant constraints on governance in particular country circumstances" are needed (World Bank, 2013). Disaggregated data used to compile the individual indicators are available from the World Bank if a view of a particular area is desired (World Bank, 2013).

A key feature of the WGI is that all country scores are accompanied by standard errors. These standard errors reflect the number of sources available for a country and the extent to which these sources agree with each other (with more sources and more agreement leading to smaller standard errors). These standard errors reflect the reality that governance is difficult to measure using any kind of data. In most measures of governance or the investment climate they are however left implicit or ignored altogether. (World Bank, 2013)

The six WGI used by the World Bank (2013) are (a) voice and accountability, (b) political instability and violence, (c) government effectiveness, (d) regulatory quality or burden, (e) rule of law, and (f) control of corruption. Governance indicators are a summation of the observations and opinions of key stakeholders in a country, as well as those of experts in the fields of world government and finance (World Bank 2013).

Voice and accountability: “Voice and accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media” (World Bank, 2013).

Weale (2011, p. 64) defined the components of accountability as "explanation and sanctions." In a democracy with free elections, accountability is inherent in the electoral process, but it "induces blame shifting and blame avoidance behaviors by officeholders, so that it may be impossible for even well-informed members of the electorate to know how well or badly a particular group of actors has performed" (Weale, 2011, p. 66). As the governance policies become more vague, accountability decreases and policies are enacted less often (Weale, 2011).

Grimmelikhuijsen (2011) described the importance of media access to governmental information to assure accountability. This author focused on three aspects of transparency: in decision-making processes (steps taken and rationale), in policy content, and in policy outcome or effects (Grimmelikhuijsen, 2011, p. 38). The key considerations were the completeness of information, the usability of the information, and the understandability of the information. However, government information can be

manipulated to serve the political agenda and to "divert attention, counter transparency information, provide favorable or positive interpretations of specific information (including the use of statistics), present positive effects while ignoring negative information or present lies" (Grimmelikhuijsen, 2011, p. 36).

Political instability and violence: This indicator "measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism" (World Bank, 2013). Ha (2012), for instance, discusses the role the free market and social welfare play in the development of a country. An unstable political environment is counterproductive to attempts to attract economic improvement due to potential investors' fear of loss. A government that is unstable is also unlikely to promote infrastructure or social welfare programs.

Government effectiveness: One way governments can be efficient is when the population is concentrated in geographical areas. Klomp and de Haan (2008), for instance, suggested that the denser the population, the easier it is for the government to provide efficient health care, but overall population and rapid population growth can overwhelm the health care sector, diminishing its effectiveness. The level or density of the rural population has a negative effect on health, and population growth has a significant negative impact on the health care sector (Klomp and de Haan, 2008, p. 605).

Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political

pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. (World Bank, 2013)

Regulatory quality: Regulatory quality “captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development” (World Bank, 2013).

The ability of the state to provide effective regulatory institutions can be expected to be a determinant of how well markets and the economy perform. The impact of regulatory institutions on economic growth will depend on both the efficiency of the regulatory policies and instruments that are used and the quality of the governance processes that are practised by the regulatory authorities. (Jalilian, Kirkpatrick, & Parker, 2007, p. 28)

Rule of law: Atubi (2012), studying the relation of population density to road fatality in Nigeria, found a reduced fatality rate in densely populated areas. This he attributed to the funding levels for enforcement. Atubi calls for consistent funding and political attention to the development of policies to protect Nigerian citizens and for public health interventions and campaigns aimed at promoting safety as well as greater funding for law enforcement efforts.

Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. (World Bank, 2013)

La Porta et al. (1999) measured rule of law according to whether a country has British Common Law as the origin of its legal system, believing that this should have a positive effect on governance. British Common Law represents greater protection of property rights against the state and “can be taken as a proxy for the intent to limit rather than strengthen the state” (La Porta et al., 1999, p. 232).

Control of corruption: “Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as ‘capture’ of the state by elites and private interests” (World Bank, 2013).

Nwabuzor (2005) reported that bribery, over \$1 trillion per year worldwide, accounted for up to 12% of the GDP in some nations. Corruption sustains high or increasing property rents, reduces product quality, and reduces economic development and incomes, resulting in the reduced overall well-being of citizens.

At moderate levels, corruption is self-sustaining and accepted by a society. Rosenblatt (2012, p. 237) defined corruption as the "misuse of power or position for personal or organizational gain ... [and] suggests that organizational corruption is driven by the individual and institutional tendency to structure society as group-based social hierarchies." Additionally, "it seems that certain individuals associate power, status, and authority with a get out of jail free card" (Rosenblatt, 2012, p. 237). Rosenblatt (2012) referenced social dominance theory to discuss the adjustments people make to and their mundane acceptance of the organizations they are a part of.

Corruption is reduced in more open economies because competition forces prices down, giving less leverage to those who would extract additional fees to provide services (Al-Marhubi, 2005, pp. 455–456). The more corruption and the poorer the governance technique, the less international trade will be attracted to a country (Al-Marhubi, 2005). A large economy in a good geographic location encourages more openness to trade than does the enactment of financial policy, further discouraging corrupt practices (Al-Marhubi, 2005).

One of the factors Law (2009) looked at in her study was the effects of corruption on motor vehicle deaths. Two findings emerged from her work: in low-income countries, corruption was correlated with a decrease in road traffic accidents and with reduced economic development. Both of these correlations are the effect of decentralized corruption increasing the cost to the population, which decreased the GDP per capita. Lower income results in fewer vehicles on the road and fewer road traffic fatalities. Higher income countries, Law (2009) explained, had more centralized corruption, which reduced the number of corruption events individuals needed to contend with, reducing the waiting cost and increasing the economic status of the country. An improved economy, or the aggregate increase in GDP per capita, is correlated with an increase and then a decrease in road traffic fatality.

Nwabuzor (2005, abstract) cites reports finding that bribery worldwide costs “over \$1 trillion per year, accounting for up to 12% of the GDP” of some nations. Corruption results in sustaining or increasing poverty and reducing product quality, economic development, and the overall well-being of a country’s people (Nwabuzor,

2005, abstract). Rosenblatt (2012, p. 237) writes, “Organizational corruption is driven by the individual and institutional tendency to structure societies as group-based social hierarchies.”

Openness: The openness of a country to internal and world inclusion and investment is not currently considered a governance indicator, but it is an important factor in economic development.

Al-Marhubi (2005, p. 468) believes that the quality of governance and openness to trade are significantly related:

The significance of trade suggests that globalization, which is a major dynamic of our time, can enhance countries’ incentives to build good governance. By reducing the costs of transportation and communication through technological advancement, globalization can potentially increase the extent to which countries are integrated with the rest of the world. As a result, and contrary to popular perceptions, openness to the world economy could be an important force for positive social change with important spillover effects on governance.

Al-Marhubi (2005, pp. 455–458) found six explanations in the literature that are proposed to account for the effect of the openness of an economy to trade on governance: (a) corruption, (b) membership in international institutions, (c) a constrained and stable policymaking philosophy, (d) independent central banks and autonomous tax agencies, (e) gradual social and cultural changes, and (f) resilience in governing.

Membership in international institutions demonstrates a thoughtful approach to policy development and forces a government to adopt policy that “harmonizes” relations

among countries (Al-Marhubi, 2005, p. 457). A constrained and stable policymaking philosophy gives investors the sense of safety in the investments they make in a country (Al-Marhubi, 2005, p. 457). Countries with division of powers (the separation of powers among the legislative, executive, and judicial branches) tend to constrain economic policy and provide investors with a stable environment in which to invest (Al-Marhubi, 2005, p. 457).

Independent central banks and autonomous tax agencies reduce the low investment return when countries undergo surprise growth without inflation but high depreciation of investments (as recently happened prior to the downturn in 2008; Al-Marhubi, 2005, p. 457). Additionally, gradual social and cultural changes might encourage integration into the global economy, which encourages knowledge acquisition and the pursuit of representative forms of government. Representative forms of government tend toward openness and global integration (Al-Marhubi, 2005, p. 457). Finally, quality governance guarantees that investors will not suffer losses due to political or economic instability and provides rule of law and accepted procedures for economic stability (Al-Marhubi, 2005, p. 458). “More open economies have better governance structures. . . . The quality of governance is related significantly to openness in international trade” (Al-Marhubi, 2005, p. 468).

The WGI were correlated at 0.94 across countries, yet Al-Marhubi (2005, p. 455) adjusted the index to address the criticism that the indicators may not be measuring the same thing in each country; it may be that if a country governs in a particular way in one

area, it will govern with the same quality in others (i.e., good governance leads to good governance and bad to bad).

In his study, Al-Marhubi (2005) reduced the indicators to three:

1. Voice and accountability and political instability are averaged into a single indicator to represent how governments are selected, monitored, and replaced.
2. Government effectiveness and regulatory burden are averaged into a single indicator to represent the capacity of the state to implement sound policies.
3. Rule of law and graft are averaged to produce an indicator that summarizes the respect of the citizens and the state for the rule of law. (Adapted from Al-Marhubi 2005, pp. 455–456)

Governance and Income

Forms of government, rule of law, and corruption affect the wealth and welfare of citizens across countries (Pillai, 2011; Gradstein, 2004; Lewis, 2006). Democracy increases trade and is shown to improve income (Pillai, 2011, p. 69). A “political climate” that wills the legislature to enact and implement social or wealth-distributive programs is an important additional factor in income equality and country wealth (Pillai, 2011, p. 69). Gradstein (2004) explored the relation between property rights and growth and found that protection of property without undue constraint on trade improves country wealth. Lewis (2006, p. 7) described corruption not only as direct payments in cash but payment for absenteeism or for services not provided and other “uses of public office for private gains.” Corruption is demonstrated to inhibit both the GDP and the effectiveness of social improvement programs (Lewis, 2006).

Much of the recent literature on governance and income has focused on openness to trade in countries, using the WGI (e.g., openness, corruption, rule of law) and governmental style. Income inequality tends to be greater the freer the market economy becomes (Ha, 2012). There are governments that lean toward free markets and less regulation, allowing income to be redistributed from entrepreneurs to employees; other governments, generally leftist or socially oriented, are more controlling of markets and trade, and the redistribution of wealth across the population is accomplished through taxation and social programs (Ha, 2012).

Historically, freer markets have increased the wealth of a country and improved wages for unskilled workers, but, as Ha (2012) points out, only citizens who work benefit from wage increases because the government may not devote money to social improvements like health care, education, and public works. Ha (2012) further explains that, just like the rebuilding after World War II, a blending of liberal market policies with social protective programs is the recipe for economic gain and citizens' welfare. Governments that do not attend to social programs risk social unrest, which hampers or completely disrupts the economic gains from free markets (Ha, 2012).

Both Khan (2007) and Qadri (2012) concurred that the openness of markets needs to be tempered by adequate funding of social programs to ensure minimal social unrest and impediments to the growth potential of the free market. In other words, concern for both individual profit and the good of the people is needed for responsible and sustainable economic growth. Qadri compared low-, middle-, and high-income countries for the effects of spending on human capital or social improvement programs. He found

that different benefits could be reported for each of the income levels: low-income countries received the greatest economic growth benefit from improved services and programs for the population, and high-income countries benefited least because the resources in those countries were already in place and already improving the lives of the population. Qadri concluded that only new spending improves the well-being and happiness of the citizens. This point, that happiness is diminished as income increases, is also the focus of a paper by Easterlin (2005), which followed the happiness of people in low- through high-income states. Easterlin (2005) found that as income rises, each additional monetary unit becomes a smaller portion of the total income. At some point basic needs are met and discretionary income is available, which allows people to consume nonessential and often competitively priced items, the “keeping up with the Joneses” spending that is often characterized as hollow (Easterlin, 2005). Happiness increases faster when basic needs are being met and slows as more luxury items become available.

Gradstein (2004) explored the protection of property rights, equivalent to the rule of law and protection against corruption, and found that low levels of property rights protection exist in low-income countries, where the cost of enforcing property rights is either financially or politically too costly, resulting in slow economic development, if any, occurring in these countries. At moderate to high levels of property rights protection, law enforcement is less of a burden on the budget, spurring people to invest in more economic-stimulating activities and hastening the growth of the economy.

Governance, Income, and Road Traffic Fatalities

Gaygisiz (2010) compared road traffic fatalities with the six World Bank World Governance Indicators from 46 countries and determined that for each of the six indicators safety improved as governance improved. Gaygisiz (2010) found a high positive correlation among the WGI and combined the six indicators into one value, which was correlated with road traffic accidents. The six WGI had a negative correlation with road traffic fatalities, such that the higher the quality of government, the lower the number of road traffic deaths (Gaygisiz, 2010, p. 1894). However, Law (2009) looked at governance, policymaking, and road traffic fatalities and concluded that fatalities follow the Kuznets curve. This, Law (2009) explained, is the relationship between increasing prosperity and the ability of governments to afford institutions and policy interventions aimed at improving the driving experience and driving safety.

Law (2009) compared governance with road traffic deaths to find the inverted U of the Kuznets curve in the increase in road traffic deaths as governance indicators improved to a threshold and then a decrease in road traffic deaths as the indicators continued to improve. She attributed this to the same explanation as the relation of income to road traffic deaths: that the improved well-being and wealth of a citizenry allow for greater, but less safe, road use until regulation, enforcement, and safety standards improve to reduce road traffic fatalities.

Law (2009) identified corruption as a factor that can affect the rate of road traffic deaths. Corruption reduces the enforcement of road traffic regulations and impacts the rate of economic development in low- and middle-income countries, both factors in road

traffic death rates. When comparing corruption, political freedom, per capita income, and motor vehicle crash deaths, Law (2009) found the inverted U shape of death rate as income increased. But for corruption she found that lower-income countries had greater levels of corruption and higher-income countries had less corruption with a negative correlation ($r = -0.17, p. < 0.05$). Law calculated the death rate per gross domestic product, which increased “from -1.398 to 1.754 for highly developed countries and increased from -0.599 to 1.885 for less developed countries” (Law, 2009, p. 129). Although Law’s (2009) report is on corruption, other authors (e.g., Al-Marhubi, 2005) demonstrate strong correlations among governance indicators ($r = 0.94$ in Al-Marhubi’s study), suggesting that one indicator can approximate the effect of any of the other indicators.

Governance, Income, and Prehospital Services

Governmental involvement is vital for a prehospital system to meet the needs of a country’s people (Jakubazko, Hori, Khruerkarnchana, & Kanchanasut, 2010). Governments need to improve “health care, health insurance, economic growth, and provide leadership” to make prehospital services efficient and effective (Jakubazko et al., 2010, p. 51). Aguilera, Cabañas, and Machado (2010) assert that prehospital delivery systems are dependent on governmental regulations to justify their existence, regulate personnel and scope of practice, and determine which agency and fiscal arrangements (i.e., public, private, voluntary) will provide services. Yet there is a lack of common knowledge, language, and priorities between governments and prehospital providers, which hampers development of consistent improvements in quality (Jakubazko et al.,

2010). Advocacy from key stakeholders and media in conjunction with education of professionals and laypeople on the benefits of and skills needed in providing prehospital care are very important tools in influencing policymakers in strengthening prehospital legislation (Jakubazko et al., 2010, p. 52).

Roberts et al. (2014) found that the improving economy of Canada brought with it an increase in recreational injuries (including from off-road vehicles), but not an increase in road traffic deaths. Roberts et al. (2014) believed their data reveal that the number of crashes has increased due to a greater number of vehicles on the road, but advances in trauma care have improved the crash victims' outcome.

Prehospital Services

Although prehospital services can be placed in several cells of the Haddon matrix, it is the postevent agent and environment cells that are of interest in this study. A pre-event cell position for prehospital services, however, is for training and preparedness. Anderson et al. (2011, p. 2) pointed out that countries require different strategies for implementing improvements in their emergency medical systems. "Optimizing the use of existing resources can be an effective strategy for strengthening [a prehospital] system"; such structural refinement has been shown to reduce mortality from 50% to 8% when using a definition of reduction based on either all injuries or only those "individuals who reach the hospital alive" (Anderson et al., 2011, p. 2).

Advocacy for strong prehospital services can be surmised from the literature. Jakubaszko et al. (2010), for instance, advocate for high levels of civil engagement in health care and emergency services. They believed that citizens can stimulate and

encourage interactions among health care professionals, EMS, politicians, and mass media to promote legislation that ensures public health and stimulates economic growth. Kazzi and Jabr (2010) used Lebanon as a case study to demonstrate how EMS and public services interplay for the benefit of citizens and national interests; they also argued that commitment and persistence among advocates are needed to build and maintain relationships with the government for the betterment of the system. Kazzi and Jabr (2010) recognized that a stable political system is a requirement for the development of an emergency medical system. Finally, Brice, Brown, and Snooks (2010) supported the development of a strong emergency medical system and called for funding, information systems, and rigorous evidence-based research models, as well as for future multicenter and multinational research for quicker and higher quality response to EMS needs.

Prehospital Responder Training

In the United States people responding to emergencies fall into a number of job classifications. Holliman (2010, pp. 3–6) defined advanced life support as the level of care provided by paramedics trained in emergency care for between 450 and 1,500 hours, or more extensively trained nurses trained in prehospital services for two to six years, or physicians trained for six to 13 years. Emergency medical technicians are trained at a lower level than paramedics, at 10 to 500 hours, to provide basic medical assistance, stabilization, and rapid transport to a care facility; they provide basic life support (Holliman, 2010, p. 4). First responders arrive at a scene first and are trained in rudimentary medical management until more advanced help arrives (Holliman, 2010, p. 5); these include police and firefighters. Bystanders and passersby are not trained or

authorized to perform medical care but are in the vicinity and may offer assistance (Holliman, 2010, p. 4).

Aguilera et al. (2010, p. 126) described providers of basic life support, the lowest level of training, as people trained to provide “airway support . . . , cardiopulmonary resuscitation, bleeding control, spine immobilization, and splinting techniques.” This describes the emergency medical technician—basic (EMT-B), who is trained to perform “scene triage, patient assessment, and patient monitoring during transport” and may be approved to administer certain drugs based on local protocol (e.g., epinephrine for allergic reactions or bronchodilator metered dose inhaler for wheezing airways; Aguilera et al., 2010, p. 126). Advanced life-support providers, often called paramedics or EMT-P, receive additional training in basic and more advanced invasive (e.g., endotracheal intubation) and drug administration techniques (i.e., intramuscular, intravenous, and intraosseous [bone marrow] routes, as well as electrographic monitoring and electrical intervention of heart arrhythmias; Aguilera et al., 2010, pp. 126–127). Registered nurses, with similar or more advanced training, are more often based in the hospital but may staff prehospital response vehicles or provide critical care in interfacility transport, via ground or air (Aguilera et al., 2010, p. 127). Physicians are involved in most prehospital services, some as medical directors and others as direct care providers able to intervene with the most invasive techniques (Aguilera et al., 2010, pp. 128–131). Physicians are the most highly trained response personnel; in many countries, they provide more extensive care and intervention at the scene of a road traffic crash (Aguilera et al., 2010, p. 127). The

tasks and responsibilities of physicians in prehospital services vary widely among countries (Aguilera et al., 2010, pp. 128–131).

Rainer, Graham, and Cattemole (2010) expanded the standard set of skills and training programs across country systems. As can be expected, they described great variation among countries regarding priorities for and effectiveness in training prehospital response personnel. Each country has a unique set of needs that must be accounted for (e.g., a remote community may need training in specific diseases and injuries common in the area that other providers do not need; Rainer et al., 2010, p. 143). The standard set of elements recommended for competency in knowledge and skill needs to be tailored to the situation but should provide for basic life support (e.g., airway management and hemorrhage control) through advanced life-saving techniques (e.g., intubation, cardiac monitoring, and drug administration; Rainer et al., 2010, pp. 144–152). The ability to train prehospital response staff is governed by the financial ability and policy necessities of each country (Rainer et al., 2010).

Prehospital Service and Health

Anderson et al. (2011, p. 1) discussed the importance of the World Health Assembly Resolution 60.22, Health Systems: Emergency Care Systems “as a policy tool for improving emergency care access and availability globally.” Emergency care providers have been shown to be an effective primary agent in the prevention and reduction of disease and injury, and policies strengthening emergency medical systems can serve all countries as they attempt to improve the health and welfare of their people (Anderson et al., 2011, p. 1).

One major problem that low- and middle-income countries have in their emergency response to road traffic injury is the lack of medical providers available within the first few minutes or hours after the incident. Training health care providers in the community may be an answer to this problem. Jennings (2010) discussed the role that the emergency medical system (generally called prehospital providers in this paper) can play in public health and public education. Prehospital providers operate at the entrance to the health care system and provide disease surveillance, primary treatment, and health education. Jennings (2010) advocated for an expanded role for prehospital personnel in the field. Incorporation or enhancement of prehospital providers can benefit the population in low- and medium-income countries by dealing with injuries and other health-related difficulties (Kobusingye et al., 2005; Razzak & Kellermann, 2002). Kobusingye et al. (2010) encourage community and country leaders to see the benefit of emergency care to cost-effective public health, population health, and health care systems in general in low- and medium-income countries and to support prehospital care in their country. Likewise, Brown and Devine (2008) suggest that resources can be stretched, costs reduced, and the public educated more effectively with the collaboration of prehospital and other health care-providing agencies.

Stirling, O'Meara, Pedler, Tourle, and Walker (2007) supported the expanding scope of practice of emergency medical technicians and paramedics as a cost-effective way to provide health care services to rural and other hard-to-reach populations. To that end, Shah, Rajasekaran, Sheahan, Wimbush, and Karuza (2008) developed a geriatric training for EMTs that is aimed at increased access to health care in the rural United

States. Likewise, Reeve, Pashen, Mumme, and Cheffins (2008) described the rural paramedic certification program in Australia and the satisfaction of the participants in the program, who take pride in having a greater role in the health of rural Australians. Closer to home, Liebowitz and Taigman (2008) reported on the expansion of EMT and paramedic personnel into the arena of community health for chronic disease treatment, prevention, and health promotion in Pittsburgh, Pennsylvania. These efforts are reported to have benefited the residents of the catchment area involved. The success of the Pittsburgh trials has spurred an expanded investigation into the use of prehospital personnel in community health and illness prevention (K. Walk, director of Allegheny County Emergency Medical Services, personal communication, September 1, 2013).

Holliman et al. (2011, p. 1) performed a literature review of the efficacy and value of emergency medicine and identified 282 articles demonstrating the efficacy of emergency critical care and procedures, cost-benefit value of emergency care for "public health and preventative medicine," "trauma and airway," "ultrasound and radiology," and "medical residencies in emergency care." Holliman et al. (2011) concluded that emergency medical care is a vital component of the health care system and, especially in low-income countries, should be allotted funds to provide much of the general medical care of the citizens.

Likewise, Sarlin and Alagappan (2010) recommended that emergency medical services be a coordinated component of the overall health care system in all countries. O'Reilly and Fitzgerald (2010, p. 40) encouraged countries to incorporate responsible authority, agents, and human resources when developing and improving their emergency

medical services system and to provide access to care. Levels of training and responsibility should be systematized, starting with primary care (at the scene) and proceeding through subsequent levels of care to the doctors at the emergency hospital. Al-Shaqsi (2010, p. 319) specified four components of a successful health care system in the case of traffic accidents: (a) access to emergency care, (b) care in the community, (c) care en route to the emergency facility, and (d) care upon arrival at the facility.

Anderson et al. (2012) proposed six steps (compressed into five here) necessary to strengthen emergency care, based on the World Health Assembly Resolution 60.22:

Assess Worldwide and Individual Country Systems:

1. Encourage governments to plan and provide for a basic level of emergency services.
2. Develop data and tracking to provide objective outcomes for emergency care services.
3. Develop or encourage standardized protocols and procedures for prehospital and hospital treatment.
4. Support World Health Organization member states "with assessing and improving their emergency care system."
5. Encourage member states to establish evidence-based intervention. (Adapted from Anderson et al., 2012, p. 6)

Prehospital Response and Road Traffic Fatalities

Coats and Davis (2002), writing from personal experience and a literature review, detailed the experience of responding to road traffic crashes with casualties. Trauma care

for victims (in developed countries) starts with the crash event notification, then the dispatch and the arrival of rescue and prehospital medical units on scene. Depending on the complexity of the crash and subsequent extrication of victims there is a “30–45 minute interval [or longer] between the time of the crash and arrival at hospital” (Coats & Davis, 2002, p. 1135). The scene is “a disorienting environment ... [with] sights (flashing lights and wreckage), sounds (noise of generators and engines), and smells (fuel and exhaust).... Lighting may be poor at night, weather conditions may be adverse ... ambulance equipment may be unfamiliar [to physicians stopping to give aid at the scene]” (Coats & Davis, 2002, pp. 1135–1136). The victims need rapid assessment of basic life threats (e.g., airway blockage, hemorrhage, and cervical spine fracture), but further treatment needs to be delayed until the victim is extricated (Coats & Davis, 2002, p. 1137). Extrication may include removing window glass, doors, roof support posts, or entire roofs. There is a potential for undeployed airbags to spontaneously activate with explosive force, and sharp metal edges are a safety concern, as is the potential for fire. Before being sent to an appropriate hospital for definitive care, the victim is packaged for transport in a cervical collar strapped to a straight, hard backboard, possibly with bleeding-control bandages and direct pressure needed to stop or slow hemorrhage, and possibly with cardiopulmonary resuscitation in progress (Coats & Davies, 2002).

The idea that emergency medical services are beneficial to increase survival from road traffic accidents is well accepted. Sanchez-Mangas et al. (2010), for instance, demonstrated outcomes of emergency medical systems and road traffic fatality. Noland and Quddus (2004) measured lengths of stay in the emergency room and subsequently in

the hospital to evaluate the effectiveness of prehospital and early hospital care in a cross-sectional time series, showing that as medical technology in emergency care increased in sophistication, fatality rates from road traffic accidents decreased. Henry and Reingold (2012, abstract) performed a Cochran Library systematic review and meta-analysis of trauma systems in the developing world. After analyzing 14 studies, they found a 25% reduction in loss of life from trauma when prehospital services were available (*relative risk [RR] of death 0.75: 95% confidence interval [CI], 0.66–0.85*). The reduction in loss of life in rural areas was notable (*RR 0.71: 95% CI, 0.59–0.86*).

Grimm and Treibich (2012, p. 5) asserted that health care supply and the quality of trauma and medical care matter for the chances of accident victim survival. Moreover, the quality and accessibility of health facilities may also have an indirect impact on the risk attitude of road users. Bishai et al. (2006) found that governance has the ability to reduce the number of road traffic crashes and, by extension, the death rate from crashes through improved safety, reducing the need to fund competing priorities (i.e., effectively meeting other needs of the society), and influencing economic growth (including people's ability to purchase safer vehicles); death rate alone was a factor in improving emergency medical care in both the prehospital and hospital arenas. Van Beeck, Borsboom, and Mackenbach (2000) credited the improvement of health care in the reduction of road traffic fatalities they saw in a longitudinal study of economic development and road traffic death from the 1960s to the 1990s.

Physician Versus Nonphysician Prehospital Providers

Both Al-Shaqsi (2010) and O'Reilly and Fitzgerald (2010) described the prevalent models for emergency care worldwide. There are two main methods: the Franco-German model of extensively treating the patient in the field, transporting to the hospital, and directly admitting to the floors, and the Anglo-American style of rapidly assessing and treating life-threatening injuries or conditions in the field and rapidly transporting the patient to the hospital to receive definitive treatment from emergency medicine staff and physicians there. Emergency rooms are more important in the Anglo-American system, as are the emergency medical technician and paramedic. The Franco-German style favors emergency physicians in the field, although this increases the cost of care. Some countries with the Franco-German style are Germany, France, Greece, Malta, and Austria; some countries with the Anglo-American system are the United States, Canada, the Sultanate of Oman, and Australia (Al-Shaqsi, 2010, p. 320).

Botker, Bakke, and Christensen (2009) found an increase in survival rate for myocardial infarction and respiratory disease patients under the Franco-German model, but they did not find any difference in outcome in a larger group of patients with less severe maladies who received invasive airway-protecting endotracheal intubation done either by physicians or paramedics.

Al-Shaqsi (2010) was reluctant to make head-to-head comparisons between the two systems, thinking that they are too dissimilar for meaningful comparisons. Al-Shaqsi (2010) does describe a third, hybrid system taking hold in Great Britain. That country is experimenting with a community triage model, in which advanced practice health care

providers visit patients in their home or in their community to determine the necessity of emergency health care (Al-Shaqsi, 2010). According to Al-Shaqsi (2010), in the U.K. health care system, roughly 50% of the calls for services are released from the emergency room without significant treatment or referral. Because the National Health Service is socialized, system cost containment is paramount and referral to appropriate services must take place. In the United Kingdom and elsewhere, emergency medical services often act as the gatekeeper to other levels of care (Al-Shaqsi, 2010).

Hass and Nathens (2008) reviewed the current literature comparing the two major theoretical approaches to prehospital emergency care, which they called the "scoop-and-run" (Anglo-American style) and the "stay-and-play" (Franco-German style). In the scoop-and-run system the patient is rapidly assessed and "packaged" for transportation after urgent and life-threatening conditions are attended to. In the stay-and-play system intensive medical intervention is performed at the scene in hopes of stabilizing the patient prior to transport to the hospital. Hass and Nathens (2008) reported that approximately half of severe trauma patients die at the scene and a quarter die within 24 hours of admission to the hospital. These authors asserted that, based on their literature review and analysis, more patients benefit from diagnostic radiology and surgery in the hospital than from physician stabilization at the scene. Hass and Nathens (2008) made a similar argument for cardiac arrest and respiratory failure. They concluded that the benefit of a physician's extended time at the scene needed to stabilize a patient does not outweigh the benefits of definitive care at the hospital, independent of the skill level of the prehospital care provider. One notable study Hass and Nathens (2008) discussed is Roudsari et al.

(2007, p. 998), who reported that even among physician-staffed systems there was a "fourfold difference" in patient outcome for the same initial condition but that having a physician on the scene produced a "lower early trauma fatality rate." On the other hand, Kirves et al. (2010) performed a post hoc analysis of the ability of physicians and paramedics in the field to predict or estimate the degree of trauma a patient had suffered and found inconclusive results across their study populations. Kirves et al. (2010) summed up the literature as lacking the substance to be a valuable source for determining the relative benefits of physician or lesser trained responders in emergency medical care in the field.

Timmermann, Russo, and Hollman (2008) reviewed the literature on paramedic versus emergency physician on scene at prehospital incidents. Their findings were inconclusive in large part, yet they were willing to state that there is evidence suggesting "that some critically ill patients benefit from the care provided by an emergency physician-based emergency medical service, but further studies are needed to identify the characteristics and early recognition of these patients" (Timmermann et al., 2008, p. 222). Looking at worldwide trends, O'Reilly and Fitzgerald (2010) reported that a centralized system of emergency medical care, like the Anglo-American system, is becoming the preferred system.

Fischer et al. (2011) compared four common systems of providing prehospital emergency care: (a) care by bystanders and minimally trained first responders, (b) basic life support provided by more extensively trained emergency medical technicians, (c) advanced life support provided by even better trained paramedic and prehospital nurses,

and (d) advanced life support provided by physicians. Fischer et al. (2011) compared these systems in four cities: Bonn, Germany; Coventry, England; Richmond, Virginia; and Cantabria, Spain. Fischer et al. (2011, p. 285) stated, "The hypothesis ... was [that patients get] better pre-hospital medical care by physicians compared to paramedics." These authors compared the four emergency care systems on the outcomes of cardiac pain relief, reduced respiratory rate, and patient response to out-of-hospital cardiac arrest resuscitation and concluded that, compared to other sites, prehospital emergency physicians in Bonn provided an increased survival rate for patients suffering out-of-hospital cardiac arrest and improved status for cardiac chest pain and respiratory failure. However, Fischer et al. (2011) limited their investigation to the most severe patients and made no mention of the percentage of responses these patients represent compared to the overall response for all sites.

Lee, Garner, Fearnside, and Harrison (2003) took a different approach, comparing responders qualified in basic life support (BLS; e.g., EMTs) or advanced life support (ALS; e.g., paramedics) and emergency care physicians when responding to patients with or without severe blunt head trauma. Lee et al. (2003) found an interesting phenomenon: among patients who were not subsequently admitted to an intensive care unit (ICU) at a hospital, more died (i.e., in the field or emergency department) when the responders were physicians (*odds ratio [OR] 4.27: 95% CI, 1.46–12.45*) than those treated by ALS providers (*OR 2.18: 95% CI, 1.05–4.55*) or BLS providers (*OR 1.0, no CI reported; p. 817*). For those surviving to be admitted to the ICU, the *OR/CI* were 0.63 (0.28–1.39), 0.79 (0.53–1.18), and 1 (no *CI* reported), respectively, reported as an insignificant

difference (Lee et al., 2003, p. 817). The odds ratios for dying at the scene or within 24 hours were greatest when the responder was a physician and lowest if the responder was only a BLS provider. An opposing result comes from Roudsari et al. (2007), who also measured death rate in the first 24 hours comparing ALS-staffed (paramedics) and physician-staffed services. Roudsari et al. (2007) compared trauma registry data and concluded that physician-staffed services have a lower death rate for trauma-related injury than ALS services did. Roudsari et al. did not report individual *OR* for the physician groups or ALS groups, making comparison with Lee et al. (2003) impossible.

Governance, Income, Prehospital Staffing, and Road Traffic Death

To my knowledge no studies have been conducted that relate the effects of prehospital staffing on road traffic deaths when income or governance is held constant. Income influences road traffic death rates, and governance influences the funding of health care and so ultimately road traffic death rates. To look at the effect that differing approaches to prehospital care have on road traffic death rates, countries need to be categorized by income level and governance factors so these effects are canceled out.

Rationale for Selection of the Variables or Concepts

The income of a country is associated with the rate of road traffic deaths in that country (Anbarci et al., 2009; Grimm & Treibich, 2012; Kopitis, 2004; Pratte, 1998). As income rises, more people use motorized vehicles, traveling at greater speed on unimproved roads, putting themselves, their passengers, and other road users at risk of road traffic crashes and death. As income continues to rise, vehicles become safer, road use rules and enforcement become more stringent, and road infrastructure improves.

Fewer pedestrians and pedaled or motorized two-wheeled vehicles share the road with larger (and safer) four-wheeled vehicles. The pattern of road traffic death thus changes with income (Chisholm and Naci, 2009).

Income and governance are directly related (Gradstein, 2004; Ha, 2012; Law, 2009; Lewis, 2006; Pillai, 2011). Governance is related to health (Andrews et al, 2010; Chisholm & Naci, 2009; Dao, 2012; Grimm & Treibich, 2012; Klomp & de Haan, 2008; Kopitis, 2004; Yu et al., 2009, Olafsdottir et al., 2011) and likewise related to road traffic deaths (Gaygisiz, 2010a, 2000b; Law, 2009).

Governance and income have a direct effect on prehospital services through regulation, direction, and funding (Aguilera et al. 2010; Jakubazko et al., 2010; Roberts et al., 2014). Prehospital services are an important factor in the health of a people and their survival from road traffic crashes (Anderson et al., 2011; Brown & Devine, 2008; Henry & Reingold, 2012; Holliman et al., 2011; Jennings, 2010; Kobusingye et al., 2005; Razzak & Kellermann, 2002; Sarlin & Alagappan, 2010; Sanchez-Mangas et al., 2010; Stirling, 2007). But the best type of staffing for the response to road traffic crashes is controversial (Al-Shaqsi, 2010; O'Reilly & Fitzgerald, 2010). Some authors find greater benefits from the physician-staffed response system (Botker et al., 2009; Fischer et al., 2011; Roudsari et al., 2007), some from the trained nonphysician systems (Hass & Nathens, 2008), and some are reluctant to point to either as better (Al-Shaqsi, 2010; Kirves et al., 2010; Timmermann et al., 2008). O'Reilly and Fitzgerald (2010) did report that the trained nonphysician staffing services appear to be the preference of new and developing prehospital services. Lee et al. (2003) looked at the related factor of advanced

versus basic prehospital skills and techniques (but still separated advanced practitioners into groups of physician or paramedics) and could find no significant difference between the two groups of advanced providers.

In this study, I assumed that within comparable income and governance groupings, the prehospital services for both physician and trained nonphysician staffing sequelae are equivalent within each group. Therefore, it should be possible to see significant differences between the groups, if one exists, when the income and governance factors are constant.

Summary and Conclusions

Much is known about safety for road travelers, but that knowledge is not equally distributed across or among countries. Infrastructure, laws and enforcement, and vehicle components have all received scrutiny. The effects of prosperity and governance have been shown to influence the rate at which people die from road traffic accidents. Prehospital response is demonstrated to reduce mortality from road traffic crashes. What is not known is what form of prehospital staff response is best suited for the greatest decrease in road traffic fatality. Assuming physician-staffed services are equivalent and trained nonphysician-staffed services are equivalent within income and governance groupings, a significant difference may be found to demonstrate a reduction in fatality from road traffic crashes due to the staffing preference.

In chapter 3, “Research Design and Rationale,” methodology and threats to validity are discussed in detail. Design choice, populations, sampling techniques, data sets, operational definitions of variables, and data analysis software and techniques are

also detailed, as are threats to validity from internal and external sources, the ethical treatment of subjects, and approval of the internal review board.

Chapter 3: Research Method

Introduction

The purpose of this cross-sectional correlation study was to test for differences between the independent variable, prehospital staffing choices on road traffic deaths per 100,000, using the Haddon matrix postevent agent and environment conditions when the social political considerations of the independent variable of country income are grouped into low, middle, and high and when governance indicator assessments are grouped into either positive or negative standardized groupings. In this chapter, I detail the research design and rationale of the methods used, the methodology to be used, and the instrumentation of the data collection, operationalization of variables, threats to validity, and ethical considerations. The population, sampling considerations, and data collection and analysis are defined. Finally, the summary of methodological considerations is presented.

Research Design

The plan of this cross-sectional correlation study was to determine whether an association exists between road traffic death and staffing of the prehospital responders dispatched to the crash scene, income level, and governance indicators. The independent variable of staffing of prehospital response is defined as one of two conditions: the attendance of (a) a physician or (b) a registered nurse, paramedic, or emergency medical technician. The variable of income is divided into the categories provided by the WHO (2013): low, US\$1,225 or less; middle, \$1,226 to \$12,225; and high, \$12,226 or greater.

The variable of governance indicators was provided by the World Bank (2013) for each selected country.

The simplest analysis of this question comes from discovering if there is a relationship between emergency medical style and road traffic injury, using a correlational study, with the caveat that it is not possible to assign cause and effect with a correlational study. Research may only suggest cause and effect based on the temporal relation of the variables (Babbie, 2010; Sayer, 1992). Additionally, the exploration of the difference can be undertaken using t tests and possibly ANOVA to explore the means among groups (Babbie, 2010). No time constraints were anticipated as archival data were used. The only resources required were the Internet, computer software, and processing time.

Methodology

Target Population

The target population was a set of 183 countries that have numeric values for road traffic fatalities and income (approximately 85% of the 215 member states in the United Nations; WHO, 2013), reduced to the number of countries, yet unknown, with available prehospital systems profiles published in English.

Sampling

The WHO (2013) Global Status Report on Road Safety surveyed 183 countries; 77 countries with available profiles in English were identified (36% of UN member states, 42% of WHO states).

Databases

I used the Global Status Report on Road Safety (WHO, 2013) collected from 183 (98.6% of total) UN member countries through survey and consensus of key stakeholders in each country. Income in the WHO (2013, p. 45) was taken from the World Bank income levels for each country and are defined as gross national income (GNI) per capita with the following income levels: low, US\$1,225 or less; middle, \$1,226 to \$12,225; and high, \$12,226 or greater. Road traffic deaths were counted from those actually reported, and estimates were based on a formula developed to equalize reporting among countries and capture underreporting due to collection technique and definitions. The WHO (2013) listed both reported and estimated road traffic deaths in their database. Reported road traffic deaths are those reported to the WHO (2013, p. 45) from “police, transportation, health, or vital statistic records.” Estimated road deaths (correlated with reported deaths at $r = 0.9$, $p < 0.0000$, Figure 1) were calculated by computing the regression of reported deaths, adjusted numbers, and values from comparable countries over the period 1950–2010 (for a fuller explanation, see WHO, 2013, p. 48). To make meaningful comparisons across countries with a variety of incomes, populations, and reported and estimated death rates, the rate per 100,000 was calculated from the WHO estimated road traffic deaths divided by the quotient of the WHO reported population for the country divided by 100,000. Data were formatted into a comma-separated spreadsheet file suitable for the statistical software computation.

Worldwide Governance Indicators (World Bank, 2013) were collected from a consensus of survey responses from key stakeholders from 215 countries. Six dimensions

of governance were reported: Control of Corruption, Political Stability, Regulatory Quality and Absence of Violence, Rule of Law, Voice, and Accountability. Governance indicators “[were] reported . . . in their standard normal units, ranging from approximately -2.5 to 2.5 . . . with higher values corresponding to better outcomes” (World Bank, 2013, n.p.).

A matrix of country prehospital staffing data was constructed from a literature search for prehospital system profiles, written in English (Appendix B). Prehospital staffing was recorded from these articles, coded as (1) physician and (2) trained nonphysician—nurse, paramedic, or EMT. Countries without a formalized prehospital response or a description of the staffing credentials were eliminated from the study.

Power Analysis

A sample size sufficient to provide a 0.80 power analysis is considered adequate for rejecting the null hypothesis (Burkholder, 2010, slide 9). This was a correlational study, however, and correlations of 0.06 to 0.14, based on the correlation coefficient squared, were reasonable to find a medium effect (Burkholder, 2010, slide 22). For an α of 0.05 and power of 0.8, the sample size of 0.06 significance may be problematic.

Statistical Significance of Correlations (n.d.) provides guidance and a table of significance for one- and two-tailed hypothesis tests, presumably at the 0.8 power level. To meet the criterion of correlation coefficient squared (r^2) of 0.06 to 0.14 or a correlation coefficient (r) of 0.24 to 0.37 between 28 and 60, subjects need to be in the condition (Statistical Significance of Correlations, n.d.). If, however, a correlation coefficient of 0.75 ($r^2 = 0.54$) is found, only 16 subjects are needed to assert significance

(Statistical Significance of Correlations, n.d). StatsToDo (n.d.) estimated a sample between 44 and 314 for the same criterion of 0.06 to 0.14. (This calculation required an identified power, and 0.8 was used.) To assure that a sufficient number of participants met the requirements for power considerations, the 49 countries identified or more were needed. However, assuming the unlikely condition that all 77 countries currently identified are the number of observations, *R* statistical software predicts a single-tailed *r* of 0.28 is needed to reach a significant $p < \text{or} = 0.05$ with a power of 0.8 (arctangh transformation) for correlation calculations.

Ethics of the Study

No informed consent was needed for this study, which used archival data from countries. No participants were engaged in the study, and no exit strategy was needed. No follow-up procedures were needed. The intended data were freely available from the World Bank and World Health Organization. Journal articles describing country emergency medical systems were generally part of the holdings of Walden University or available through document delivery systems. Therefore, permission to use data was unnecessary.

Instrumentation and Operational Definitions

No published instruments were used in this study. A simple matrix (Appendix C) was used to collect data from literature on country prehospital system profiles: country, style (dummy coded with the nominal 1 for physician-based and 2 for paramedic-based), and author identification.

No reliability issues regarding instrumentation were anticipated. Recording of prehospital staffing components is a straightforward process of transcription from literature sources. Many country-specific articles were available on the specifics of individual prehospital systems, providing straightforward access for data collection.

Operational Definitions

Prehospital Care System

Two types of responses were assessed: a service using a response vehicle staffed by a physician (dummy code 1) and a service using a response vehicle staffed by a trained nonphysician (nurse, paramedic, EMT, or equivalent; dummy code 2).

Road Traffic Fatality

The WHO (2013) estimated road traffic fatalities by “classif[ying] the countries into four groups as follows”:

1. Countries with death registration data completeness of at least 80%.

For this category, I used one of the following: death registration, projection of the most recent death registration, reported death, or projected reported death.

2. Countries with other sources of information on cause of death.

This group includes India, Iran, Thailand, and Vietnam. For these countries, a regression method was used to project forward the most recent year for which an estimate of total road traffic deaths was available.

3. Countries with population less than 150,000 and [that] did not have eligible death registration data.

For these countries, the deaths reported in the survey were used directly, without adjustment.

4. Countries without eligible death registration data.

For these countries, a negative binomial regression model was used. For more information about this process, see *Global Status Report on Road Safety 2013* (WHO, 2013, pp. 48–51).

Income: The WHO (2013, p. 45) uses the World Bank designation for Gross National Income per capita: “low US\$1,025 or less, middle \$1,026 to \$12,225, and high \$12,226 or more.”

Road traffic deaths: Road traffic deaths are deaths reported by “police, transport agencies, health or vital statistics registration records or combined sources” (WHO, 2013, Global, p. 45).

World Governance Indicators: Indicators for voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption came from Kaufmann, Kraay, and Mastruzzi (2013) and were individually derived from various sources, including business surveys, political surveys, and key citizen reviews.

Data Manipulation

R statistical software (R Core Team, 2013, Vienna, Austria: R Foundation for Statistical Computing) was used to analyze correlations, *t* tests, ANOVA, or multiple regressions as appropriate. Data needed to be selected and formatted using Microsoft

Excel (Redman, Washington; data from the WHO and World Bank are presented in Excel tables) prior to use in *R* software.

Research Questions

The purpose of this cross-sectional correlation study was to test the Haddon matrix postevent agent and environment conditions for a difference in road traffic deaths per 100,000 in relation to the independent variables of country income level, governance indicator, and prehospital staffing. The independent variable of staffing of prehospital response was defined as one of two conditions: the attendance of (a) a physician or (b) a trained nonphysician responder—a registered nurse, paramedic, or emergency medical technician—at the scene of a road traffic accident. The independent variable of income was defined as the WHO (2013) reported income level, based on the gross national income per capita, of sampled countries: low, US\$1,025 or less; middle, \$1,026 to \$12,225; and high, \$12,226 or more. The independent variable of governance was defined as the sign of the standardized values for the World Governance Indicators (World Bank, 2013) in the selected countries.

1. Is there a significant association between income level of a country and the rate of road traffic fatalities per 100,000?

H_a1 : There is a significant negative correlation between income level of countries and road traffic fatalities.

H_o1 : There is no association between income level of countries and road traffic fatalities.

2. Is there an association between the sign of standardized governance indicators of countries and road traffic fatalities per 100,000?

H_{a2} : There is a significant negative correlation between the sign of standardized governance indicators of countries and road traffic fatalities.

H_{o2} : There is no association between the sign of standardized governance indicators of countries and road traffic fatalities.

3. Does the staffing of prehospital response services by physicians reduce the rate of road traffic fatalities per 100,000?

H_{a3} : There is a significant reduction in the rate of road traffic fatalities per 100,000 when prehospital services are staffed by physicians.

H_{o3} : There is no significant difference between physician-staffed and nonphysician-staffed prehospital services and the rate of road traffic fatalities per 100,000.

4. When grouped by income, do countries with physician-staffed response services have a lower rate of road traffic fatalities per 100,000?

H_{a4} : There is a significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

H_{o4} : There is no significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

5. When grouped by the sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_a5: When grouped by the sign of standardized governance indicators, there is a significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

H_o5: When grouped by the sign of standardized governance indicators, there is no significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

6. When grouped by income and sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_a6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

H_o6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services do not have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

Correlation coefficient, *t* tests, and ANOVA/multiple regressions were applied to the data as appropriate. Correlations were used to detect relationships among the variables; *t* tests were used for comparing the means of road traffic fatalities by emergency medical system style within income and government groupings;

ANOVA/multiple regressions tested the variation in road traffic fatalities among the groupings.

Threats to Validity

Threats to validity were the inability to gather a random sample and fewer data available for lower income countries. Another validity issue arose from the use of surveys of key stakeholders when gathering data on road traffic deaths, governance indicators, and the like used to develop the databases. The databases used for this study, however were from reputable sources and were considered reliable data for comparison of countries.

Ethical Procedures

No access agreement was needed for data to be used in the study; only documentation of the database was required. No human subjects participated in this study. No recruitment materials were needed for this study. All data used were collected from country sources and are publicly available. No confidential data were stored for this study. No other ethical issues were anticipated.

Summary

I proposed to determine whether there is a difference in the number of road traffic fatalities due to the prehospital system staffing. Countries were grouped by income level and governance indicators to control for those influences. Data came from the World Health Organization and the World Bank, as well as a literature search for country prehospital profiles.

Unfortunately the sample was a convenience sample due to the nature of the available data; some countries reported the data needed for analysis, but others did not. All of the available country data were needed to raise the power of the study as high as possible, while abandoning the random sample assumption for correlations, *t*-tests, and ANOVA/multiple regression.

Because the data came from archival sources there were no ethical considerations for the safety of human subjects. And because published instruments were not used and the data were in the public domain no permission from participants was needed.

The results of the data analysis are described in Chapter 4.

Chapter 4: Results

Introduction

Purpose, Research Questions, and Hypotheses

Road traffic injuries and deaths are major health-related burdens worldwide (Ameratunga et al., 2006; Mathers & Loncar, 2006; Peden et al., 2004). In this study, I considered whether the rate of death per 100,000 is lower in systems employing physicians at the scene of a road traffic event compared to systems employing trained nonphysician responders. I explored the relationship to road traffic death rates between that staffing preference and a country's income level or per capita GNP and governance indicators. The research questions and hypothesis for this study are as follows:

1. Is there a significant association between income level of a country and the rate of road traffic fatalities per 100,000?

H_{a1} : There is a significant negative correlation between income level of countries and road traffic fatalities.

H_{o1} : There is no association between income level of countries and road traffic fatalities.

2. Is there an association between the sign of standardized governance indicators of countries and road traffic fatalities per 100,000?

H_{a2} : There is a significant negative correlation between the sign of standardized governance indicators of countries and road traffic fatalities.

H_{o2} : There is no association between the sign of standardized governance indicators of countries and road traffic fatalities.

3. Does the staffing of prehospital response services by physicians reduce the rate of road traffic fatalities per 100,000?

H_{a3}: There is a significant reduction in the rate of road traffic fatalities per 100,000 when prehospital services are staffed by physicians.

H_{o3}: There is no significant difference between physician-staffed and nonphysician-staffed prehospital services and the rate of road traffic fatalities per 100,000.

4. When grouped by income, do countries with physician-staffed response services have a lower rate of road traffic fatalities per 100,000?

H_{a4}: There is a significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

H_{o4}: There is no significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

5. When grouped by the sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_{a5}: When grouped by the sign of standardized governance indicators, there is a significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

H_{o5}: When grouped by the sign of standardized governance indicators, there is no significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

6. When grouped by income and sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_a6 : When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

H_o6 : When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services do not have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

In this chapter, I describe the data collection procedures, discrepancies in data collection from the proposed data collection scheme, and descriptive and hypothesis-testing statistics.

Data Collection

Data were collected in a literature search of Google Scholar, Walden University's library multidatabase search engine Thoreau, and the National Institutes of Health. Search terms included the following: *emergency medical system* by country, *prehospital care* by country, and *emergency medicine* by country, and in combination with *international emergency, medical care, and prehospital care*. Traffic death and income information came from the World Health Organization (2013) *Global Status Report on*

Road Safety 2013: Supporting a Decade of Action, which provided information on 181 of the 215 (84.1%) UN member states. Governance indicators came from the World Bank (2013) *Worldwide Governance Indicators*.

During the literature search and review of prehospital and emergency services demographics, new assumptions were made to respond to unanticipated results. First, the literature pointed to a great variation across both types of services, describing differences in the authority directing service, the agencies providing service, training of personnel, protocols allowed, type and technical capacity of transport vehicles, type and quality of triage, response in rural areas, and use of standard phone numbers to summon service. This revelation confirmed the warning by Al-Shaqsi (2010) and O'Reilly and Fitzgerald (2010) that an analysis of style of prehospital services is problematic for these and other reasons. To explore this variation, a more in-depth qualitative or mixed-methods study, which is beyond the resources available, is needed; this is addressed in Chapter 5. However, the results did allow for a separation of trained nonphysician prehospital responders into advanced life-support responders (ALS: registered nurse, paramedic, or equivalent, Code 2), basic life-support responders (BLS: emergency medical technician, first responder, or equivalent, Code 3), and minimally or not trained responders (NT, Code 4; physician (PHY) responders remain coded 1).

The number of observations made the power to exclude a type II error only 50%. For a sample of 67 observations an $r = 0.336$ is required to obtain a $p = 0.05$ with a 0.8 power to prevent type II errors. This result is different from the weak $r = 0.16$ to $r = 0.24$

suggested by Burkholder (2010). Analysis considering both suggested r will be reported as appropriate in the analysis.

Results from the Study

Descriptive and Demographic Characteristics of the Sample

Descriptions, in English, for 70 of 215 (32.5%) United Nation member countries (37% of the WHO, 2013) were identified in the literature (Appendix B). Of those countries, 67 (31.2% of UN members, 35.8% of WHO, 2013) had usable data for all variables (Appendix C).

Death Rate for Road Traffic Events per 100,000

The WHO (2013) included both reported road traffic deaths and estimated road traffic deaths in its database. Reported road traffic deaths are those reported to the WHO from “police, transportation, health, or vital statistic records” (p. 45). Estimated road deaths (correlated with reported deaths at $r = 0.9$, $p < 0.0000$) were calculated by computing the regression of reported and adjusted rates and values from comparable countries over the period 1950 to 2010. (For a fuller explanation, see WHO, 2013, p. 48.) To make meaningful comparisons across countries with a variety of incomes and reported and estimated death rates, the rate per 100,000 was calculated from the WHO (2013) estimated road traffic deaths divided by the quotient of the WHO (2013) reported population for the country divided by 100,000. Death rate per 100,000 population was used as the consistent marker across countries; it correlated with the study sample of reported deaths $r = 0.26$ ($p = 0.0356$, power = 0.5002) and estimated deaths $r = 0.22$ ($p = 0.0805$, power = 0.5168). A better maker would be the percentage of road traffic deaths

resulting from the number of road traffic accidents, but those data were even harder to obtain and were not available for this study.

Income and Road Traffic Death

In Question 1. Is there a significant association between income level of a country and the rate of road traffic fatalities per 100,000?

H_a1 : There is a significant negative correlation between income level of countries and road traffic fatalities.

H_01 : There is no association between income level of countries and road traffic fatalities.

Road traffic deaths per 100,000 were correlated with all 182 countries included in the WHO (2013) and with the 67 countries identified as having usable data for this study. Income, death rate from road traffic events (for this and subsequent questions), governance, and staffing preference (for subsequent questions) were compiled, in alphabetical order, in Appendix B for the sample of 67 countries.

Low-income countries: Four low-income countries were examined in this study (1.9% of member states, 17.1% of low-income from WHO, 2013, 6% of sample). Their mean GNI per capita was \$640, with a death rate from road traffic events of 19.3 per 100,000. The averages for governance indicators were control of corruption, -0.63 ; effectiveness of governments, -0.96 ; political stability, -0.75 ; regulatory quality, -0.93 ; rule of law, -1.04 ; and voice and accountability, -0.87 . The lone low-income country with trained prehospital services, Zimbabwe, had an ALS service, GNI of \$480, 14.6 road traffic deaths per 100,000, and an average governance value s for control of corruption, $-$

1.31; effectiveness of government, -1.50; political stability, -1.12; regulatory quality, -2.053; rule of law, -1.81; and voice and accountability, -1.48. The three low-income countries with no trained prehospital services, Comoros Islands, Kenya, and Rwanda, had an average GNI of \$693.33, 20.87 per 100,000 road traffic deaths, and the following average governance values: control of corruption, -0.40; effectiveness of government, -0.78; political stability, -0.62; regulatory quality, -0.56; rule of law, -0.78; and voice and accountability, -0.67.

Middle-income countries: This study examined 32 middle-income countries (14.4% of member states, 53.4% of middle-income from WHO, 2013, 46.3% of sample); 14 systems had physician-staffed prehospital response, six had advanced life support, two had basic life support, and 10 had minimally or not trained responders. This group had a mean GNI per capita of \$5,415.31; mean reported and WHO estimated 2010 road traffic deaths of 13,515.19 and 25,754.69, respectively; and mean deaths per 100,000 population of 19.14. The means of governance indicators for the 32 countries were as follows: control of corruption, -0.29; effectiveness of government, -0.11; political stability, -0.47; quality of government, -0.13; rule of law, -0.30; and voice and accountability, -0.21. The 14 middle-income countries with physician-staffed prehospital services are Iran, Russia, China, Kazakhstan, Colombia, Vietnam, Armenia, Turkey, Panama, Brazil, Lithuania, Mauritius, Belarus, and Malaysia. Their average GNI is \$6,829.29; they average 18.9 road traffic deaths per 100,000; and their mean scores for governance indicators are the following: control of corruption, -0.08; effectiveness of government, -

0.17; political stability, -0.19; quality of government, -0.14; rule of law -0.02; and voice and accountability, -0.19.

The six middle-income countries with advanced life-support services are Indonesia, Sri Lanka, Argentina, India, Peru, and South Africa. Their average GNI is \$4,271.67; they average 18.48 road traffic deaths per 100,000; and their mean scores for governance indicators are the following: control of corruption, -0.37; effectiveness of government, -0.11; political stability, -0.66; quality of government, -0.19; rule of law, -0.31; and voice and accountability, -0.06.

Two middle-income countries, Pakistan and Mexico, had basic life-support prehospital services. Their average GNI is \$4,990.00; they average 16.05 road traffic deaths per 100,000; and their mean scores for governance indicators are the following: control of corruption, -0.72; effectiveness of government, -0.31; political stability, -1.71; quality of government, -0.16; rule of law, -0.66; and voice and accountability, -0.35.

Ten middle-income countries have minimally or not trained service: Angola, Bosnia and Herzegovina, Botswana, Cuba, Ecuador, Ghana, Lebanon, Nicaragua, Philippines, and Thailand. Their average GNI is \$4,207, with an average of 20.48 road traffic deaths per 100,000 and the following mean scores for governance indicators: control of corruption, -0.44; effectiveness of government, -0.47; political stability, -0.49; quality of government, -0.47; rule of law, -0.59; and voice and accountability, -0.39.

High-income countries: Thirty high-income countries (13.9% of member states, 26.2% of middle-income from WHO, 2013, 44.8% of sample) were examined. They have a mean GNI of \$35,900.65; mean reported and WHO estimated road traffic deaths of

2,683.77 and 2,906, respectively; and mean 2010 deaths per 100,000 population of 8.39. Their mean scores for governance indicators are the following: control of corruption, 1.07; effectiveness of government, 1.12; political stability, 0.62; quality of government, 1.06; rule of law, 1.10; and voice and accountability, 0.78.

Fifteen member states (53.4% of middle-income from WHO, 2013, 46.3% of sample countries) have physician-staffed prehospital response: Spain, Greece, Italy, Israel, Hungary, Poland, Czech Republic, Portugal, France, Germany, Iceland, Austria, Norway, Sweden, and Finland. They have an average 2010 GNI of \$35,812.00 and an average of 6.85 road traffic deaths per 100,000. Their mean scores for governance indicators are the following: control of corruption, 1.02; effectiveness of government, 1.18; political stability, 0.62; regulatory quality, 1.11; rule of law, 1.15; and voice and accountability, 1.08.

Eleven high-income countries have advanced life-support prehospital services: Saudi Arabia, Switzerland, Oman, United States, South Korea, Malta, United Kingdom, Australia, Canada, Netherlands, and Denmark. They have an average GNI of \$39,006 and an average 2010 rate of 10.36 road traffic deaths per 100,000. Their mean scores for governance indicators are the following: control of corruption, 1.12; effectiveness of government, 1.11; political stability, 0.58; regulatory quality, 1.11; rule of law, 1.16; and voice and accountability, 0.61.

Three high-income countries have basic life-support prehospital service: Bahamas, Croatia, and Japan. They have an average GNI of \$25,970, and their average 2010 rate of road traffic deaths per 100,000 is 9.77. Their mean scores for governance

indicators are the following: control of corruption, 0.27; effectiveness of government, 0.34; political stability, 0.43; regulatory quality, 0.14; rule of law, 0.15; and voice and accountability, -0.02.

Two high-income countries with minimally or not trained responders are Singapore and New Zealand. They have an average GNI of \$34,380 and an average of 7.1 road traffic deaths per 100,000. Their mean scores for governance indicators are the following: control of corruption, 2.30; effectiveness of government, 2.03; political stability, 1.18; regulatory quality, 1.78; and voice and accountability, 0.67.

Low-income countries are underrepresented. The other two income categories represent 14.4% of the world's middle-income and 13.9% of the world's high-income countries.

Table 1 lists the demographics of study countries by income level, GNI per capita, reported road traffic deaths, estimated road traffic deaths, rate of estimated road traffic deaths per 100,000 population, and governance indicators and by staffing preference.

Table 1

Income, Reported and Estimated Deaths, Death Rate and Governance Indicators

Income ¹	<i>n</i>	GNI ¹	Reported Deaths ²	Estimated Deaths ²	Death Rate ³	Corr ⁴	Eff ⁴	Stab ⁴	Qual ⁴	Law ₄	Voi ⁴
Low	4	640	1,298	3,149	19.3	-0.63	-0.96	-0.75	-0.93	-1.04	-0.87
PHY ⁵	0	-	-	-	-	-	-	-	-	-	-
ALS ⁵	1	480	1,777	1,832	14.6	-1.31	-1.50	-1.12	-2.05	-1.81	-1.48
BLS ⁵	0	-	-	-	-	-	-	-	-	-	-
NT ⁵	3	693	1,139	3,587	20.9	-0.40	-0.78	-0.62	-0.56	-0.78	-0.67
Middle	32	5,415	13,515	25,755	19.14	-0.29	-0.11	-0.47	-0.13	-0.30	-0.21
PHY	14	6,829	13,690	30,203	18.91	-0.08	0.17	-0.19	0.14	-0.02	-0.19
ALS	6	4,272	31,028	50,338	18.43	-0.37	-0.11	-0.66	-0.19	-0.31	-0.06
BLS	2	4,990	11,247	23,423	16.05	-0.72	-0.31	-1.71	-0.16	-0.66	-0.35
NT	10	4,207	32,16	5,244	20.48	-0.44	-0.47	-0.49	-0.47	-0.59	-0.39
High	31	35,901	26,84	2,906	8.39	1.07	1.12	0.62	1.06	1.10	0.78
PHY	15	35,812	1,590	1,680	6.85	1.02	1.18	0.62	1.11	1.15	1.08
ALS	11	39,006	4,776	5,191	10.36	1.12	1.11	0.58	1.11	1.16	0.61
BLS	3	25,970	2,080	2,376	9.77	0.27	0.34	0.43	0.14	0.15	-0.02
NT	2	34,380	284	329	7.1	2.30	2.03	1.18	1.80	1.78	0.67

Note. ¹ GNI = gross national income per capita. The WHO (2013) sets low GNI at less than or equal to \$1,225; middle GNI at \$1,226 to \$12,225; high GNI at \$12,226 or greater.

² Number of road traffic deaths reported by individual countries and estimated number of road traffic deaths, both provided by WHO (2013).

³ Death rate from road traffic events per 100,000 population, calculated from country population provided by WHO (2013) and estimated death rate per 100,000.

⁴ Corr = control of corruption, Eff = government effectiveness, Stab = political stability, Qual = regulatory quality, Law = rule of law, Voi = voice and accountability. World Bank (2013) governance indicators.

⁵ PHY = physician-staffed prehospital response; ALS = prehospital response staffed by advanced life-support responders (registered nurse, paramedic, or equivalent); BLS = prehospital response staffed by basic life-support responders (emergency medical technician, first responder, or equivalent); NT = prehospital response staffed by minimally or not trained responders.

The WHO (2013) estimated and reported death rates per 100,000 were correlated with the gross national income per capita. Table 2 shows the results of that correlation.

Table 2

Correlation of Road Traffic Deaths or Death Rate and Country GNI per Capita

	<i>n</i>	<i>df</i>	<i>r</i>	<i>p</i>	β
WHO estimated ¹	182	180	-0.09	0.2325	0.684
WHO per 100,000 ¹	182	180	-0.02	0.0088	0.017
Study estimated ²	67	65	-0.2	0.1065	0.645
Study per 100,000 ²	67	65	-0.68	>0.001	0.99

Note. Correlation of deaths from road traffic events between the WHO (2013) estimated country deaths or the calculated death rate per 100,000 or between the estimated deaths of the sampled countries or with the calculated death rate per 100,000 for the sample.

¹WHO (2013) estimated road traffic deaths and death rate from road traffic events per 100,000 calculated from WHO (2013) estimated road traffic deaths and country

²Estimated deaths and death rate from road traffic events from the WHO (2013) for the countries identified as having prehospital staffing information in their country profiles.

Using all 182 observations from the WHO (2013) correlations between both the estimated deaths from road traffic events and calculated death rate per 100,000 with the GNI per capita resulted in an insignificant correlation between the estimated road traffic deaths and the GNI per capita, $r(180) = -0.09$, $p = 0.23$, and a significant correlation between the GNI per capita and the calculated road traffic deaths per 10,000, $r(180) = -0.02$, $p = 0.009$. The power (β) for the latter correlation was only 0.017, resulting in a very weak relationship and a good possibility of making a type II error or accepting the null hypothesis when it is false. The correlation between the death rate from road traffic events and the GNI per capita for the 67 countries of the sample $r(65) = -0.68$, $p > 0.001$, with a β of 0.99 was very significant and powerful.

For the data compiled for this study, the correlation of the GNI per capita and estimated road traffic deaths approached greater significance than that of the full database from the WHO (2013), $r(65) = -0.02$, $p = 0.11$, $\beta = 0.65$, making the relationship stronger but not meeting the $\beta = 0.8$ sought in this study. The relationship between the study data GNI per capita and the study data death rate per 100,000, however, did result in a strong correlation, $r(65)$, $p > 0.001$, $\beta = 0.99$ (see Table 3 and Figures 1 and 2). Figure 1 shows the scatter plot of GNI per capita and the death rate from road traffic events taken from the sample; Figure 2 shows a potential curvilinear regression line that might echo Kopitus's (2004) conclusion that at low- and high-income levels there are fewer road traffic deaths, but there were not enough low-income countries in the study to demonstrate that finding.

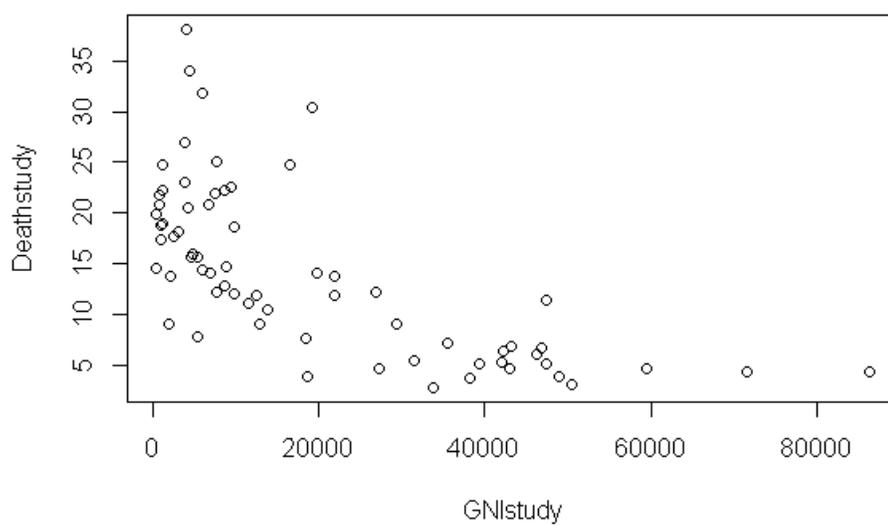
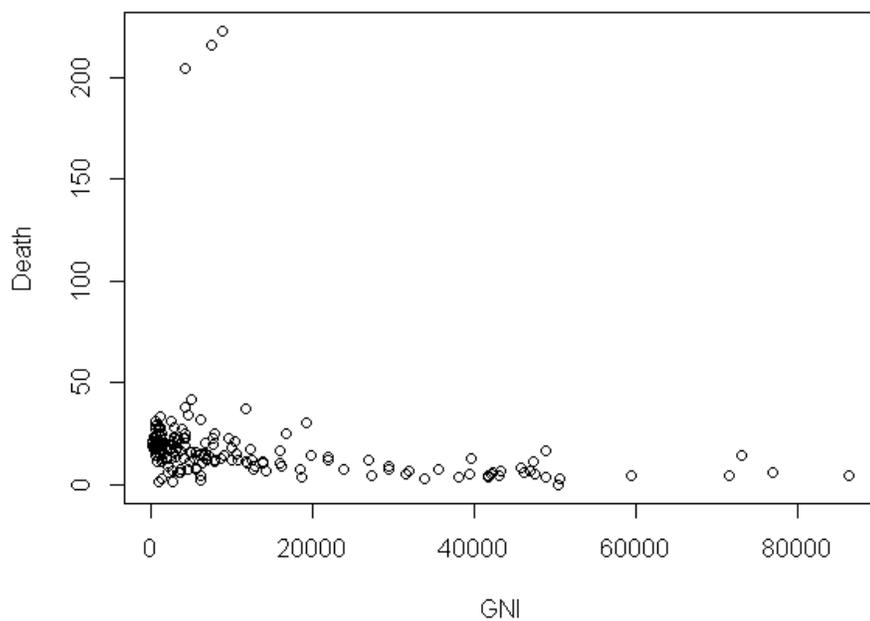


Figure 1. GNI per capita for the study for 67 countries (GNIstudy) and 182 countries in WHO (2013; GNI) in US\$.

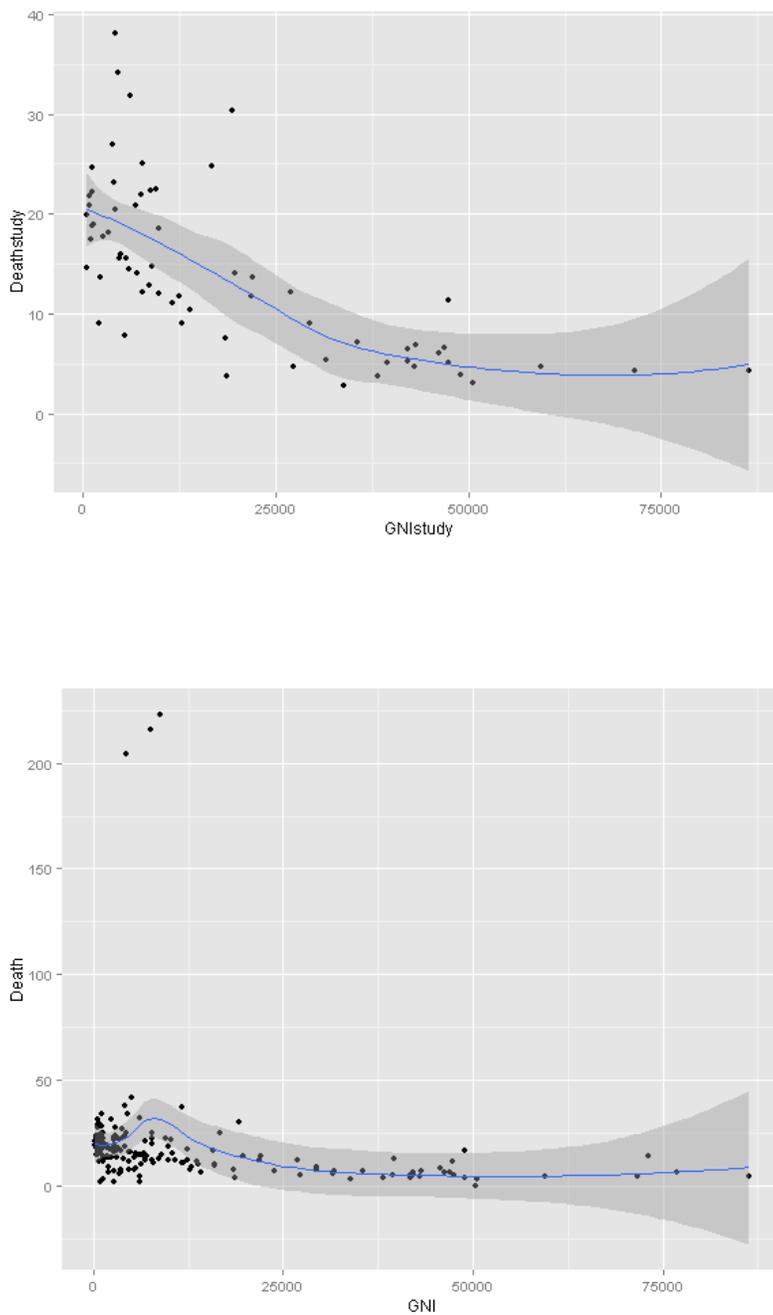


Figure 2. Curvilinear GNI per capita for the study 67 countries (GNIstudy) and WHO (2013; GNI) 182 countries in US\$ and data death rate from road traffic events per 100,000 of the study (Deathstudy) and WHO (2013; Death).

Based on the results of this study of GNI per capita and study death rate from road traffic events per 100,000, I must reject the null hypothesis and accept the alternative hypothesis that there is a significant negative correlation between country road traffic fatalities and country income.

Correlation of Governance and Road Traffic Death

For Question 2. Is there an association between the sign of standardized governance indicators of countries and road traffic fatalities per 100,000?

H_a2 : There is a significant negative correlation between the sign of standardized governance indicators of countries and road traffic fatalities.

H_02 : There is no association between the sign of standardized governance indicators of countries and road traffic fatalities.

All six governance indicators and the calculated average of all indicators had a negative correlation with road traffic deaths.

Correlation of the governance indicators with the calculated average confirmed that the average governance indicator is a reasonable marker for grouping countries. WGI were strongly related to each other, with coefficients of $r = 0.64$ ($p < 0.0000$) to $r = 0.98$ ($p < 0.0000$). The individual indicators and averaged indicator have coefficients of $r = .83$ ($p < 0.0000$) to 0.98 ($p < 0.0000$). The average governance indicators was used to classify the rate of road traffic deaths, income, and staffing preference as having positive or negative governance indicators (see correlation matrix Table 3; see Figure 3 for scatter plot).

Table 3

Correlations Among Governance Indicators Individually and With the Average of All Indicators

	Corr	Eff	Stab	Qual	Law	Voi	Avg ¹
Corr	1.000	0.932	0.789	0.848	0.947	0.754	0.952
Eff	0.932	1.000	0.729	0.929	0.969	0.803	0.968
Stab	0.789	0.729	1.000	0.689	0.779	0.639	0.830
Qual	0.848	0.929	0.689	1.000	0.932	0.824	0.942
Law	0.947	0.969	0.779	0.932	1.000	0.822	0.983
Voi	0.754	0.803	0.640	0.824	0.822	1.000	0.872
Average	0.952	0.968	0.830	0.942	0.983	0.872	1.000

Note. All correlations $p > 0.001$.

Corr = control of corruption, Eff = government effectiveness, Stab = political stability, Quality = regulatory quality, Law = rule of law, Voi = voice and accountability.

¹Calculated from World Bank (2013) values.

This is in keeping with Al-Marhubi's (2005) combining governance indicators (current names used here): voice and political stability, government effectiveness and regulatory quality, and rule of law and control of corruption. All of these indicators correlate at $r = 0.82$ ($p = 0$) or greater and correlate with the average of all indicators at $r = 0.92$ ($p = 0$) or greater, so the average of all the governance indicators was believed to be sufficient to represent country governance.

Countries by Sign of the Average Governance Indicator

Of the 67 countries in this study, 30 had a negative and 37 a positive sign for their average governance indicator. For the sample, the income level was 2.4 (leaning toward high income), with a GNI per capita of \$19,235. There was a staffing value of 2.09, slightly leaning toward BLS and NT. The death rate from road traffic events was 14.18

per 100,000. The scores for governance indicators were as follows: control of corruption, 0.32; effectiveness of government, 0.41; political stability, 0.02; regulatory quality, 0.37; rule of law, 0.31; voice and accountability, 0.20; and average governance value, 0.27. All skewed slightly positive.

There were 30 countries with a negative average sign for their governance indicators: Angola (−1.01), Argentina (−0.29), Armenia (−0.30), Belarus (−0.96), Bosnia and Herzegovina (−0.39), China (−0.56), Colombia (−0.37), Comoros Islands (−0.99), Cuba (−0.59), Ecuador (−0.80), India (−0.29), Indonesia (−0.48), Iran (−1.22), Kazakhstan (−0.50), Kenya (−0.66), Lebanon (−0.62), Mauritius (−0.89), Mexico (−0.19), Nicaragua (−0.64), Pakistan (−1.11), Peru (−0.25), Philippines (−0.55), Russia (−0.76), Rwanda (−0.26), Saudi Arabia (−0.24), Sri Lanka (−0.38), Thailand (−0.34), Turkey (−0.05), Vietnam (−0.57), and Zimbabwe (−1.54). The scores for governance indicators were as follows: control of corruption, −0.60; effectiveness of government, −0.47; political stability, −0.76; regulatory quality, −0.49; rule of law, −0.64; and voice and accountability, −0.65. The average governance value is −0.60.

For the 37 countries with a positive average sign for their governance indicators, the average income level was 2.76 (1 = low, 2 = middle, 3 = high income) with an average GNI per capita of \$29,910, skewed toward high income. The staffing value of 2.53 was skewed toward BLS and NT. The death rate from road traffic events per 100,000 was 18.5. The scores for governance indicators were as follows: control of corruption, 1.06; effectiveness of government, 1.12; political stability, 0.66; regulatory quality, 1.08; rule of law, 1.08; and voice and accountability, 0.90. The average

governance value was 0.98; all scores skewed positive. The 37 countries and their average governance values were Australia (1.60), Austria (1.55), Bahamas (0.93), Botswana (0.67), Brazil (0.11), Canada (1.61), Croatia (0.39), Czech Republic (0.89), Denmark (1.82), Finland (1.87), France (1.26), Germany (1.43), Ghana (0.10), Greece (0.40), Hungary (0.71), Iceland (1.43), Israel (0.57), Italy (0.52), Japan (1.22), Lithuania (0.72), Malaysia (0.34), Malta (1.21), Netherlands (1.64), New Zealand (1.78), Norway (1.72), Oman (0.23), Panama (0.08), Poland (0.78), Portugal (0.94), Singapore (1.48), South Africa (0.25), South Korea (0.76), Spain (0.86), Sweden (1.77), Switzerland (1.71), United Kingdom (1.39), and the United States (1.24).

Table 4 displays the 67 countries in relation to their negative and positive standardized governance signs. Figure 3 shows the scatter plots of GNI per capita, road traffic deaths per 100,000, the six individual governance indicators, and the average of all indicators. Please note the negative relationship between GNI per capita and death rate per 100,000, the negative relationship between death rate per 100,000 and each of the governance indicators, the positive relationship between GNI per capita and governance indicators (an unintended, serendipitous graphic finding generated by the statistical program), and the positive relationship among the governance indicators individually and with the calculated average.

Table 4

Sign of Average Governance Indicators, Income, Prehospital Staffing, GNI per Capita, and Death Rate per 100,000 from Road Traffic Events

Sign ¹	<i>n</i>	Inc ²	Staff ³	GNI ²	Death ⁴	Corr ⁵	Eff ⁵	Stab ⁵	Qual ⁵	Law ⁵	Voi ⁵	Avg ⁵
Spl ⁶	67	2.40	2.09	19,235	14.18	0.32	0.41	0.02	0.37	0.31	0.2	0.27
Neg	30	1.97	2.53	6,070	18.5	-0.60	-0.47	-0.76	-0.49	-0.64	-0.65	-0.60
Pos	37	2.76	1.73	29,910	10.56	1.06	1.12	0.66	1.08	1.08	0.90	0.98

Note. ¹ Countries assigned to governance group bases on average governance value. World Bank (2013) governance indicators standardized from -2.5 to +2.5.

² Income; dummy coded as 1 = low, 2 = middle, and 3 = high. For this sample the total sample (Spl) and the positive (Pos) group are between 2 and 3 or middle to high income. The negative (Neg) group is between low and middle income.

³ Indicates that the sample (Spl) and positive (Pos) groups are made up of more nonphysician responders than physician responders. The negative (Neg) group has more physicians included. Staffing is coded as physicians, 1; advanced life-support responders (ALS: registered nurse, paramedic, or equivalent), 2; basic life-support responders (BLS: emergency medical technician, first responder, or equivalent), 3; minimally or not trained responders (NT), 4.

⁴ Death rate from road traffic events per 100,000 population calculated from country population provided by WHO (2013) and estimated death rate per 100,000.

⁵ Corr = control of corruption, Eff = government effectiveness, Stab = political stability, Qual = regulatory quality, Law = rule of law, Voi = voice and accountability. World Bank (2013) governance indicators average (Avg) is calculated from the average of the indicators.

⁶ Spl = sample as a whole.

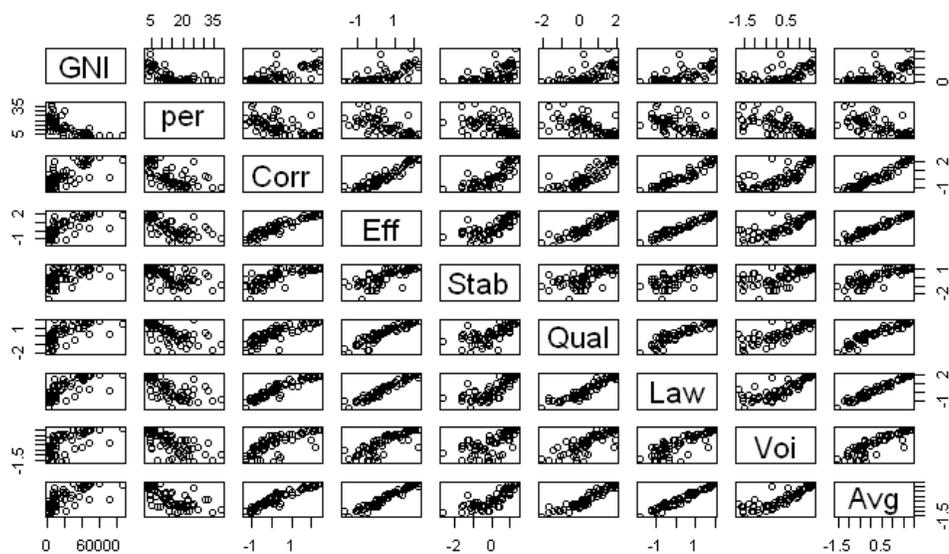


Figure 3. GNI per capita, death rate from road traffic events per 100,000, and individual and average governance indicators for sample countries, 2010.

GNI = gross national income per capita, from WHO (2013); per = death rate from road traffic events per 100,000, calculated from WHO (2013); Corr = control of corruption; Eff = government effectiveness; Stab = political stability; Qual = regulatory quality; Law = rule of law; Voi = voice and accountability; Avg = calculated average of governance indicators (indicators from World Bank, 2013).

Table 5

Correlation Among Death Rate From Road Traffic Events per 100,000 and Governance Indicators

	Death	Corr	Eff	Stab	Qual	Law	Voi	Avg
Death	1.00	-0.61	-0.63	-0.48	-0.59	-0.63	-0.64	-0.65
p	-	>0.01	>0.01	>0.01	>0.01	>0.01	>0.01	>0.01
95%	-	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
conf	-	-0.5	-0.4	-0.3	-0.5	-0.5	-0.5	-0.5
β	-	0.97	0.99	0.66	0.95	0.99	0.99	0.99

Note. Death rate from road traffic events per 100,000 population calculated from country populations provided by WHO (2013) and estimated death rate per 100,000. Corr = control of corruption, Eff = government effectiveness, Stab = political stability, Qual = regulatory quality, Law = rule of law, Voi = voice and accountability. World Bank (2013) governance indicators average (Avg) is calculated from the average of the indicators. The 95% conf= the value at which the middle 95% of the population ends it denotes the tails of the distribution. The lower value is the value below which the middle ends at the left side of the distribution and the upper value the value above which on the right tail of the distribution the middle 95% ends. β = the power calculated describing the assurance that the finding is not a type II error, that a true finding is on correct.

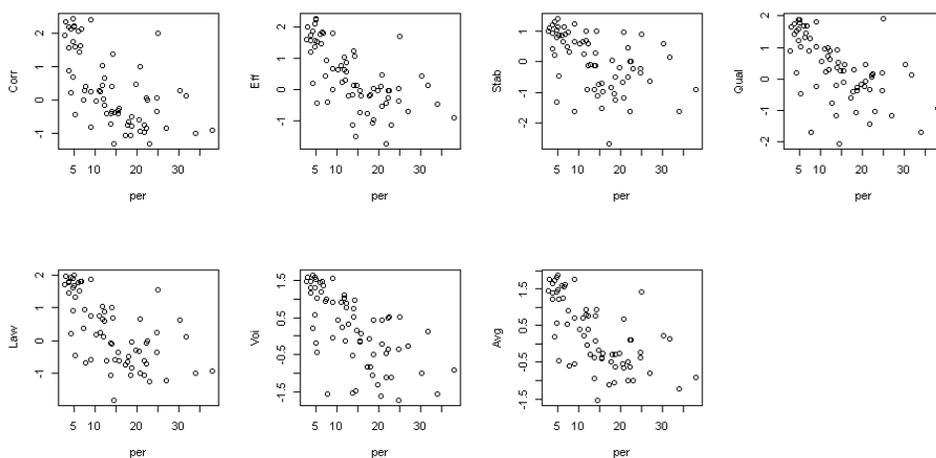


Figure 4. Death rate from road traffic events per 100,000 with governance indicators. Per = death rate from road traffic events per 100,000 (calculated from WHO, 2013); Corr = control of corruption; Eff = government effectiveness; Stab = political stability; Qual = regulatory quality; Law = rule of law; Voi = voice and accountability (World Bank, 2013).

Table 6 displays the correlations of each of the governance indicators with the road traffic deaths per 100,000; all are negative and significant at the $p > 0.001$. Figure 4 is the detail of the scatter plot of the death rate per 100,000 and each governance indicator, enlarged for better viewing.

Pearson correlations between death rates from road traffic events per 100,000 and governance indicators (World Bank, 2013) resulted in the following significant negative correlations: death rate and control of corruption, $r(65) = -0.607$, $p > 0.001$, 95% $CI [-1.0, -0.46]$, $\beta = 0.972$; death rate and effectiveness of government, $r(65) = -0.634$, $p > 0.001$, 95% $CI [-1.0, -0.49]$, $\beta = 0.985$; death rate and political stability, $r(65) = -0.478$, $p > 0.001$, 95% $CI [-1.0, -0.31]$, $\beta = 0.661$; death rate and regulatory quality, $r(65) = -0.594$, $p > 0.001$, 95% $CI [-1.0, -0.45]$, $\beta = 0.951$; death rate and rule of law, $r(65) = -0.627$, $p > 0.001$, 95% $CI [-1.0, -0.49]$, $\beta = 0.985$; death rate and voice and accountability, $r(65) = -0.643$, $p > 0.001$, 95% $CI [-1.0, -0.51]$, $\beta = 0.989$; and death rate and average of governance indicators, $r(65) = -0.646$, $p > 0.001$, 95% $CI [-1.0, -0.51]$, $\beta = 0.993$. Based on the results from this sample of countries there was a significant negative correlation between all governance indicators, including the calculated average, and the death rate from road traffic events per 100,000. Based on these results I rejected the null hypothesis and accepted the alternative, that there is a significant negative correlation between governance indicators and road traffic death.

Prehospital Staffing and Road Traffic Death

For Question 3. Does the staffing of prehospital response services by physicians reduce the rate of road traffic fatalities per 100,000?

H_{a3} : There is a significant reduction in the rate of road traffic fatalities per 100,000 when prehospital services are staffed by physicians.

H_{o3} : There is no significant difference between physician-staffed and nonphysician-staffed prehospital services and the rate of road traffic fatalities per 100,000.

No significant difference was found between systems staffed by physicians and those staffed by advanced life-support trained responders. Likewise, no significant difference was found among systems staffed by physicians, advanced life-support providers, or basic life-support providers.

In the sample of 67 countries, 29 (43%) were staffed by physician responders; these countries had a GNI per capita of \$21,820, income level leaning toward high income (2.40 on the 3-point scale), and a death rate from road traffic events of 12.67 per 100,000. The scores for governance indicators of physician-staffed systems were as follows: control of corruption, 0.49; effectiveness of government, 0.69; political stability, 0.23; regulatory quality, 0.64; rule of law, 0.59; and voice and accountability, 0.47. In the 18 countries employing advanced life-support systems (27%), the GNI per capita was \$25,288, income level leans toward high income (2.56), and the death rate from road traffic events was 13.31 per 100,000. The scores for governance indicators of ALS-staffed systems were as follows: control of corruption, 0.49; effectiveness of government, 0.56; political stability, 0.08; regulatory quality, 0.49; rule of law, 0.51; and voice and accountability, 0.31.

The five countries with BLS responders (7%) had a GNI per capita of \$17,578, income level leaning toward high income (2.6), and a death rate from road traffic events

of 12.28 per 100,000. The scores for governance indicators of BLS-staffed systems were as follows: control of corruption, -0.13 ; effectiveness of government, 0.08 ; political stability, -0.42 ; regulatory quality, 0.02 ; rule of law, -0.17 ; and voice and accountability, -0.15 . In the 15 countries with minimally or not trained responder systems (22%), the GNI per capita was \$7,527, income level leaning toward middle income (1.93), and the death rate from road traffic events was 18.77 per 100,000. The scores for governance indicators of NT-staffed systems were as follows: control of corruption, -0.06 ; effectiveness of government, -0.20 ; political stability, -0.29 ; regulatory quality, -0.18 ; rule of law, -0.31 ; and voice and accountability, -0.31 . Table 6 presents these findings, and Figure 5 provides box plots of physician, advanced life support, basic life support, and minimally or not trained responder group death rates per 100,000 from road traffic events.

Table 6

Prehospital Response Staffing, GNI per Capita, Country Income Level, Death Rate from Road Traffic Events, and) Governance Indicators

Staffing ¹	<i>n</i>	GNI ²	Inc ³	Death ⁴	Corr ⁵	Eff ⁵	Stab ⁵	Qual ⁵	Law ⁵	Voi ⁵
Spl 2.4 ⁶	67	19,235	2.40	14.26	0.32	0.41	0.02	0.37	0.31	0.21
PHY	29	21,820	2.52	12.67	0.49	0.69	0.23	0.64	0.59	0.47
ALS	18	25,288	2.56	13.31	0.49	0.56	0.08	0.49	0.51	0.31
BLS	5	17,578	2.6	12.28	-0.13	0.08	-0.42	0.02	-0.17	-0.15
NT	15	7,527	1.93	18.77	-0.07	-0.20	-0.29	-0.18	-0.31	-0.31

Note. ¹Staffing: PHY = physicians; ALS = advanced life-support responders (registered nurse, paramedic, or equivalent); BLS = basic life-support responders (emergency medical technician, first responder, or equivalent); NT = minimally or not trained responders.

² GNI = gross national income per capita (WHO, 2013). Low GNI = less than or equal to \$1,225; 2 = middle, \$1,226 to \$12,225; 3 = high, \$12,226 or greater.

³ Income; dummy coded as 1 = low, 2 = middle, and 3 = high. For this sample all but NT are between 2 and 3, or middle to high income. NT is between low and middle income.

⁴ Death rate from road traffic events per 100,000 population calculated from country population provided by WHO (2013) and estimated death rate per 100,000.

⁵ Corr = control of corruption, Eff = government effectiveness, Stab = political stability, Qual = regulatory quality, Law = rule of law, Voi = voice and accountability. World Bank (2013) governance indicators.

⁶ Spl = sample; 2.4 indicates that the sample is made up of more nonphysician responders than physician responders. PHY coded as 1; ALS, 2; BLS, 3; NT, 4.

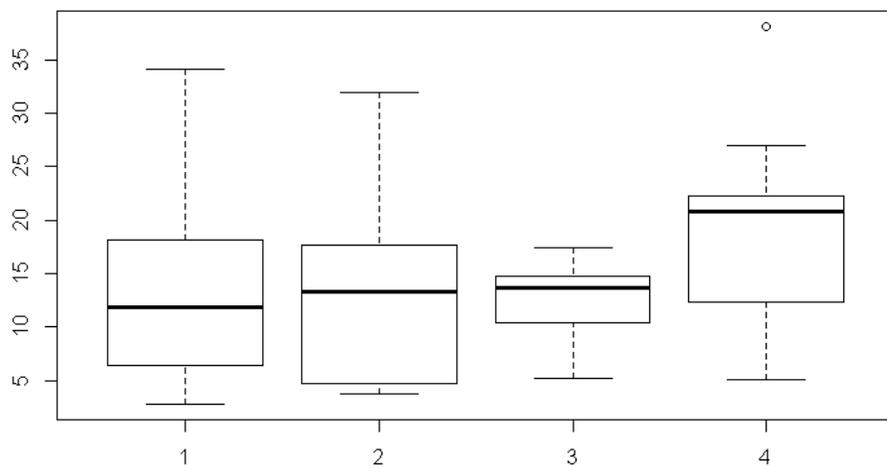


Figure 5. Death rate from road traffic events per 100,000 by Staffing Choice. Physician-staffed system (1), system staffed by advanced life-support responders (ALS: registered nurse, paramedic, or equivalent, 2), system staffed by basic life-support responders (BLS: emergency medical technician, first responder, or equivalent, 3), and system staffed by minimally or not trained responders (NT, 4).

Table 7 provides the results of both correlational evaluation and analysis of variance for physician versus ALS and BLS and for physician versus ALS alone.

Table 7

Correlation, ANOVA, and Bartlett Test of Homogeneity of Death Rate From Road Traffic Events per 100,000 and Systems Using Physician, ALS, and BLS Responders

Physician, ALS, BLS					
Correlation					
<i>r</i>	<i>df</i>	<i>p</i>	95% Conf	β	
0.008	50	0.95	-0.26/0.28	0.042	
Analysis of Variance Table					
	<i>df</i>	Sum of Squares	Mean of Squares	<i>F</i>	<i>p</i>
Staff	2	6.3	3.137	0.0485	0.9527
Residuals	49	3167.0	64.633		
Bartlett test of homogeneity of variances					
K-squared = 2.002, <i>df</i> = 2, <i>p</i> = 0.36					
Physician and ALS					
Correlation					
<i>r</i>	<i>df</i>	<i>p</i>	95% Conf	β	
0.0379	45	0.800	-0.25/0.32	0.277	
Analysis of Variance Table					
	<i>df</i>	Sum of Squares	Mean of Squares	<i>F</i>	<i>p</i>
Staff	1	4.45	4.452	0.0651	0.7998
Residuals	45	3079.25	68.428		
Bartlett test of homogeneity of variances					
K-squared = 0.3475, <i>df</i> = 1, <i>p</i> = 0.56					
<i>Note.</i> ALS = system staffed by advanced life-support responders (registered nurse, paramedic, or equivalent).					
BLS = system staffed by basic life-support responders (emergency medical technician, first responder, or equivalent).					

Pearson correlations between death rates from road traffic events per 100,000 and prehospital staffing did not result in significant correlations of death rate and staffing by physicians, advanced life support, and basic life support, $r(52) = -0.95$, $p = 0.042$, 95% $CI [-0.26, 0.28]$, $\beta = 0.042$, or for death rate and staffing by physicians or ALS, $r(47) = -0.95$, $p = 0.8$, 95% $CI [-0.25, 0.32]$, $\beta = 0.277$. Likewise, one-way between-subjects ANOVA was conducted to compare the effect of the staffing of prehospital responders on the rate of deaths from road traffic events and found no significant difference at the $p < 0.05$ level, either in the physician, advanced life-support, and basic life-support provider conditions, $F(2, 49) = 0.0485$, $p = 0.9527$, or in the physician and advanced life-support provider conditions, $F(1,45) = 0.0651$, $p = 0.07998$.

The homogeneity or relative equal variance of the samples was problematic (Karen, 2010). Although ANOVA is robust to moderate variation from the assumed equal variation of homogeneity because the sample size of the physician (28), ALS (18), and BLS (5) conditions had a large size and population difference, the ANOVA may be incorrect. The Bartlett test of homogeneity for the physician, advanced life-support, and basic life-support conditions resulted in K -squared (2) = 2.02, $p = 0.36$, and for the physician and advanced life-support conditions, K -squared (1) = 0.3475, $p = 0.56$. The Levene test to determine if the Bartlett test was due to a non-normal sample distribution was unavailable at the time of this writing.

Based on the results of both the correlation study and ANOVA, power and homogeneity issues notwithstanding, the null hypothesis must be accepted: there is no

significant difference between the rate of death from road traffic event due to the staffing of physicians, ALS providers, or BLS providers.

Effect of GNI per Capita and Prehospital Staffing on Road Traffic Death

For Question 4. When grouped by income, do countries with physician-staffed response services have a lower rate of road traffic fatalities per 100,000?

H_{a4} : There is a significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

H_{o4} : There is no significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

No significant difference was detected.

Fourteen middle-income countries used physicians for their prehospital response:

Armenia, Belarus, Brazil, China, Colombia, Iran, Kazakhstan, Lithuania, Malaysia, Mauritius, Panama, Russia, Turkey, and Vietnam. Six middle-income countries used advanced life-support prehospital providers: Argentina, India, Indonesia, Peru, South Africa, and Sri Lanka. Two middle-income countries used basic life-support prehospital providers: Mexico and Pakistan.

Fifteen high-income countries had prehospital services staffed with physicians:

Austria, Czech Republic, Finland, France, Germany, Greece, Hungary, Iceland, Israel, Italy, Norway, Poland, Portugal, Spain, and Sweden. Eleven high-income countries used advanced life-support prehospital providers: Australia, Canada, Denmark, Malta, Netherlands, Oman, Saudi Arabia, South Korea, Switzerland, the United Kingdom, and

the United States. Finally, three high-income countries used basic life-support providers: Bahamas, Croatia, and Japan.

Table 1 (p. 116) presents the demographic data for low-, middle-, and high-income countries.

Middle-income countries had an average GNI per capita of \$5,415 with a road traffic death rate per 100,000 of 19.14. The physician-staffed countries had a GNI per capita of \$6,829 and a death rate of 18.91. The advanced life-support middle-income countries had a GNI of \$4,272 with a death rate of 18.43. The middle-income countries with basic life-support providers had a GNI of \$4,990 and a death rate of 16.05.

High-income countries had an average GNI per capita of \$35,812 with a road traffic death rate per 100,000 of 8.39. The physician-staffed countries had a GNI per capita of \$35,812 and a death rate of 6.85. The advanced life-support high-income countries had a GNI of \$39,006 with a death rate of 10.36. The high-income countries with basic life-support providers had a GNI of \$25,970 and a death rate of 9.77.

Figure 6 provides the box plot of the physician, advanced life-support, basic life-support, and combined advanced life-support/basic life-support conditions. Table 8 reproduces the ANOVA results of the physician, advanced life-support, and basic life-support conditions, and the physician and advanced life-support/basic life-support combined conditions for middle-income countries. Table 9 presents the results for high-income countries for the road traffic death rate per 100,000. Figure 6 plots the physician, advanced life-support, basic life-support, and combination advanced life-support/basic life-support data.

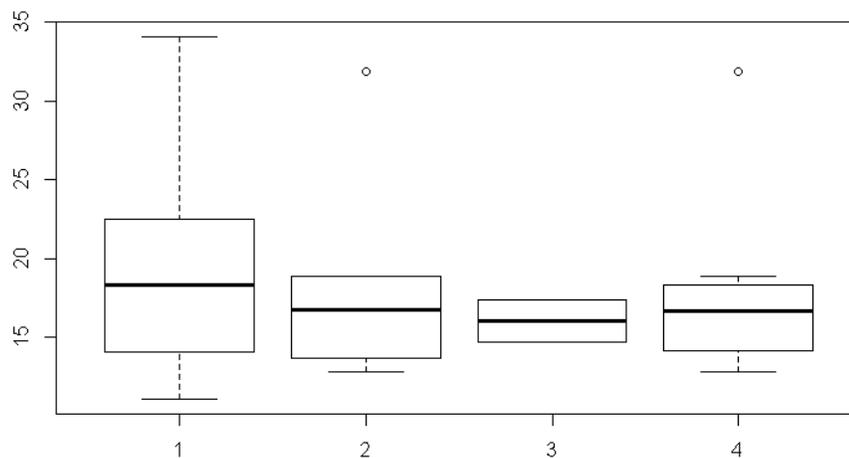


Figure 6. Death rate from road traffic events per 100,000 for middle-income countries grouped by prehospital responder staffing. 1 = physician responders, 2 = advanced life-support responders (ALS: registered nurse, paramedic, or equivalent), 3 = basic life-support responders (BLS: emergency medical technician, first responder, or equivalent), 4 = ALS/BLS combined responders.

Table 8

ANOVA for Middle-Income Country Death Rate From Road Traffic Events for Physician Responders, ALS Responders, BLS Responders, and for Physician and ALS/BLS Responders

2010 Death Rate for Physician, ALS responders

	<i>df</i>	Sum of the Squares	Mean of the Square	<i>F</i>	<i>p</i>
Staff	1	0.78	0.78	0.181	0.8946
Residuals	18	777.31	43.184		

t test Physician versus ALS

means	<i>t</i>	<i>df</i>	<i>p</i>	95% conf	β
18.91	0.13	8.84	0.55	-Inf /6.53	0.4349
18.48					

2010 Death Rate for Physician and ALS/ BLS Responders Combined

	<i>df</i>	Sum of the Squares	Mean of the Square	<i>F</i>	<i>p</i>
	1	5.50	5.499	0.1392	0.713
	20	789.83	39.492		

t test Physician versus ALS/BLS

means	<i>n</i>	<i>df</i>	<i>p</i>	95% conf	β
18.91	0.3796	15.472	0.6453	-Inf 5.829	0.289
17.88					

Table 9 reproduces the ANOVA results for the physician, advanced life-support, and basic life-support conditions and physician and advanced life-support/basic life-support combined conditions in high-income countries. Figure 7 plots those results.

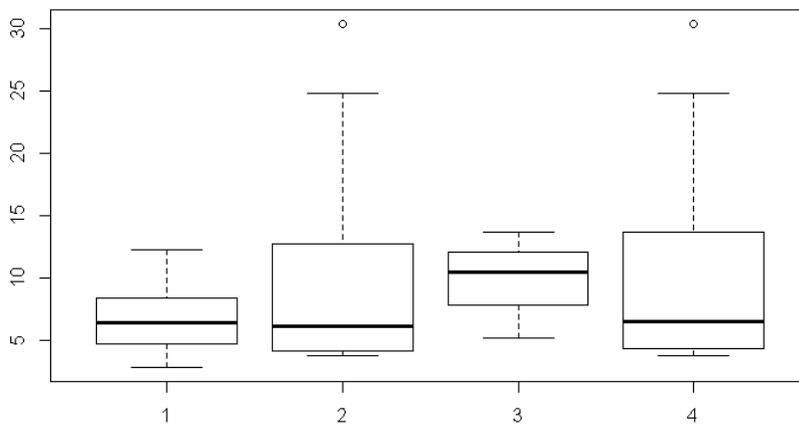


Figure 7. Death rate from road traffic events per 100,000 for high-income countries grouped by prehospital responder staffing: 1 = physician responders, 2 = advanced life-support responders (ALS: registered nurse, paramedic, or equivalent), 3 = basic life-support responders (BLS: emergency medical technician, first responder, or equivalent), 4 = ALS/BLS combined responders.

Table 9

ANOVA and t Test for High-Income Country Death Rate From Road Traffic Events for Physician Responders, ALS Responders, BLS Responders, and for Physician and ALS/BLS Responders

2010 Death Rate for Physician and ALS Responders					
	<i>df</i>	Sum of the Squares	Mean of the Square	<i>F</i>	<i>p</i>
Staff	1	78.55	78.496	1.9036	0.1804
Residuals	24	989.66	41.236		
means	<i>t</i>	<i>df</i>	95%conf	<i>p</i>	β
6.837/10.36	-1.2128	11.68	-inf,1.663	0.12	0.98
2010 Death Rate for Physician and ALS/BLS Responders Combined					
	<i>df</i>	Sum of the Squares	Mean of the Square	<i>F</i>	<i>p</i>
	1	83.17	83.172	2.1861	0.1508
	27	1027.23	38.046		
means	<i>t</i>	<i>df</i>	95% conf	<i>p</i>	β
6.83, 10.24	-1.4393	16.393	-Inf 0.716	0.08445	0.99

Note. The statistical software reports inf or -inf in cases where the data are skewed and not in a normal distribution.

Wilcox *t* test did not result in significance in either middle- or high-income countries for road traffic death rate per 100,000 between physicians or advanced life-support providers. For middle-income $t(8/84) = -0.13$, $p = 0.55$, 95% *CI* [-Inf 6.53], $\beta = 0.043$, or those using physicians, advanced life support, or basic life support, $t(15.47) = 0.38$, $p = 0.65$, 95% *CI* [-Inf 5.829], $\beta = 0.289$. Likewise, one-way between-subjects analysis of variation (ANOVA) was conducted to compare the effect of the staffing of prehospital responders on the rate of death from road traffic events; no significant difference was found at the $p < 0.05$ level in the physicians, ALS, and BLS provider conditions, $F(1, 20) = 0.139$, $p = 0.713$, or in the physician and ALS provider conditions, $F(1, 18) = 0.181$, $p = 0.8946$. In the high-income group, no significant difference was

found in the death rate between physicians and advanced life-support responders $t(11.68) = -1.213$, $p = 0.12$, 95% $CI [-Inf 1.663]$, $\beta = 0.98$, or between physicians and advanced life-support/basic life-support combined provider countries, $t(16.39) = -1.434$, $p = 0.084$, 95% $CI [-Inf 0.716]$, $\beta = 0.99$. One-way between-subjects ANOVA was also conducted to compare the effect of prehospital staffing on the rate of death in high-income countries and found no significant difference at the $p < 0.05$ level in the physicians and ALS/BLS provider conditions, $F(1, 27) = 1.904$, $p = 0.18$, or in the physician and ALS provider conditions, $F(1,27)=2.1861$, $p = 0.1508$.

Based on these findings the null hypothesis must be accepted: there is no significant difference between the staffing of physician, advanced life-support, or basic life-support responders in the prehospital setting when income is held constant.

Effect of Governance and Prehospital Staffing on Road Traffic Death

For question 5. When grouped by the sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_a5 : When grouped by the sign of standardized governance indicators, there is a significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

H_o5 : When grouped by the sign of standardized governance indicators, there is no significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

Results showed a significant difference in death rate for prehospital services in the positive and negative conditions, but no other significant difference among the groupings.

For conditions grouped by sign of the average governance value and physician-staffed services, there were ten countries with negative signs: Armenia, Belarus, China, Colombia, Iran, Kazakhstan, Mauritius, Pakistan, Russia, and Turkey. They had an income level of 2.1 (slightly greater than middle income), an average GNI per capita of \$8,597, and a death rate from road traffic events of 18.99 per 100,000. Their average scores on governance factors were as follows: control of corruption, -0.61 ; effectiveness of government, -0.29 ; political stability, -0.68 ; regulatory quality, -0.36 ; rule of law, -0.50 ; and voice and accountability, -0.81 . Their average overall score was -0.54 . Sixteen countries with positive signs use physician-staffed services; these countries had an income level of 2.7 (approaching high income): Austria, Czech Republic, Finland, France, Germany, Greece, Hungary, Iceland, Israel, Italy, Malaysia, Norway, Panama, Poland, Spain, Sweden. They had an average GNI per capita of \$27,771, and a death rate from road traffic events of 9.83 per 100,000. Their average scores on governance factors were as follows: control of corruption, 0.99; effectiveness of government, 1.13; political stability and control of violence, 0.64; regulatory quality, 1.10; rule of law, 1.07; and voice and accountability, 1.04. Their average overall score was 0.99.

Eight countries with negative signs use advanced life-support services: Argentina, India, Indonesia, Peru, Saudi Arabia, Sri Lanka, Vietnam, and Zimbabwe. They had an income level of 2 (middle income), an average GNI per capita of \$5,233, and a death rate from road traffic events of 16.91 per 100,000. Their average scores on governance factors

were as follows: control of corruption, -0.51 ; effectiveness of government, -0.32 ; political stability and control of violence, -0.77 ; regulatory quality, -0.45 ; rule of law, -0.50 ; and voice and accountability, -0.79 . Their overall average score was -0.50 .

Eleven countries with positive signs used advanced life-support services: Australia, Denmark, Malta, Netherlands, Oman, Singapore, South Africa, South Korea, Switzerland, UK, and USA. They had an income level of 2.91 (close to high income), an average GNI per capita of \$38,050, and a death rate from road traffic events of 11.019 per 100,000. Their average scores on governance factors were as follows: control of corruption, 1.13; effectiveness of government, 1.12; political stability and control of violence, 0.62; regulatory quality, -1.10 ; rule of law, 1.15; and voice and accountability, 0.78. Their average overall score was 0.98.

Three countries with negative signs use basic life-support services: Bahamas, Mexico, and Pakistan. They had an income level of 2.5 (between middle and high income), an average GNI per capita of \$11,460, and a death rate from road traffic events of 14.05 per 100,000. Their average scores on governance factors were as follows: control of corruption, -0.55 ; effectiveness of government, -0.28 ; political stability and control of violence, -0.74 ; regulatory quality, -0.23 ; rule of law, -0.55 ; and voice and accountability, -0.45 . Their average overall score was -0.47 .

Two countries with positive signs used basic life-support services: Croatia, and Japan. They had an income level of 3 (high income), an average GNI per capita of \$27,970, and a death rate from road traffic events of 7.80 per 100,000. Their average scores on governance factors were as follows: control of corruption, 0.77; effectiveness

of government, 1.08; political stability and control of violence, 0.72; regulatory quality, 0.79; rule of law, 0.75; and voice and accountability, 0.73. Their average overall score was 0.81.

Eleven countries with negative signs used minimally or not trained responder services: Angola, Bosnia and Herzegovina, Comoros Islands, Cuba, Ecuador, Kenya, Lebanon, Nicaragua Philippines, Rwanda, and Thailand, They had an income level of 1.7 (slightly less than middle income), an average GNI per capita of \$3,219, and a death rate from road traffic events of 20.13 per 100,000. Their average scores on governance factors were as follows: control of corruption, -0.53; effectiveness of government, -0.63; political stability and control of violence, -0.75; regulatory quality, -0.59; rule of law, -0.76; and voice and accountability, -0.58. Their average overall score was -0.64.

Four countries with positive signs used minimally or not trained responder services: Botswana, Ghana, New Zealand, and Singapore. They had an income level of 2.5 (between middle and high income), an average GNI per capita of \$19,190, and a death rate from road traffic events of 14.30 per 100,000. Their average scores on governance factors were as follows: control of corruption, 1.42; effectiveness of government, 1.12; political stability and control of violence, 0.84; regulatory quality, 1.05; rule of law, 1.04; and voice and accountability, 0.57. Their average overall score was 1.01.

Table 10 summarizes the demographics of countries grouped by governance sign and prehospital staffing preference. Figure 8 plots the death rates of countries with

negative and positive governance signs when staffed by physician, advanced life support, basic life support, and minimally or not trained responders.

Table 11 shows the t Test results between positive and negative staffing conditions. Only physician staffing conditions reached a significant difference between governance indicator groupings. The ALS and BLS conditions approached significance, but failed to reach it.

The Wilcox t test comparing death rates and prehospital staffing within negative or positive governance conditions found a significant death rate between negative and positive conditions for physicians, $t(11.52) = -4.12, p > 0.001, 95\% CI [6.27, Inf], \beta = 1$. There was a near significant death rate between negative and positive ALS, $t(14.0) = 1.67, p = 0.058, 95\% CI [-0.31, Inf], \beta = 0.96$. Death rate between negative and positive BLS was $t(-1.37) = 2.64, p = 0.086, 95\% CI [-4.04, Inf], \beta = 0.83$. As Table 12 reveals, no significant findings were obtained when comparing staffing by physicians versus ALS or combined ALS/BLS.

Table 10

Staffing, GNI, Income, Death Rate From Road Traffic Events per 100,000, and Sign of Governance Indicators

Staff	<i>n</i>	GNI ²	Inc ³	Death ⁴	Corr ⁵	Eff ⁵	Stab ⁵	Qual ⁵	Law ⁵	Voi ⁵	Avg ⁵
Phys n	10	8,597	2.1	18.99	-0.61	-0.29	-0.68	-0.36	-0.50	-0.81	-0.54
Phys p	16	27,771	2.7	9.83	0.99	1.13	0.64	1.10	1.07	1.04	0.99
ALS n	8	5,233	2	16.91	-0.51	-0.32	-0.77	-0.45	-0.50	-0.43	-0.50
ALS p	11	38,050	2.91	11.01	1.13	1.12	0.62	1.10	1.15	0.79	0.98
BLS n	3	11,460	2.5	14.05	-0.55	-0.28	-0.74	-0.23	-0.55	-0.45	-0.47
BLS p	2	27,970	3	7.8	0.77	1.08	0.72	0.79	0.75	0.73	0.81
NT n	11	3,219	1.7	20.13	-0.53	-0.63	-0.75	-0.59	-0.76	-0.58	-0.64
NT p	4	19,190	2.5	14.3	1.42	1.12	0.84	1.05	1.04	0.57	1.01

*Note.*¹ Staffing: Phys = physician-staffed prehospital response; ALS = system staffed by advanced life-support responders (registered nurse, paramedic, or equivalent); BLS= system staffed by basic life-support responders (emergency medical technician, first responder, or equivalent); NT= minimally or not trained responders. *n* = negative average World Bank (2013) governance indicator group; *p* = positive average governance indicator group.

² GNI = gross national income per capita (WHO, 2013). Low GNI = less than or equal to \$1,225; 2 = middle, \$1,226 to \$12,225; 3 = high, \$12,226 or greater.

³ Income; dummy coded as 1 = low, 2 = middle, and 3 = high. ⁴ Death rate from road traffic events per 100,000 population calculated from country population provided by WHO (2013) and estimated death rate per 100,000.

⁵ Corr = control of corruption, Eff = government effectiveness, Stab = political stability, Qual = regulatory quality, Law = rule of law, Voi = voice and accountability. World Bank (2013) governance indicators average (Avg) is calculated from the average of the indicators.

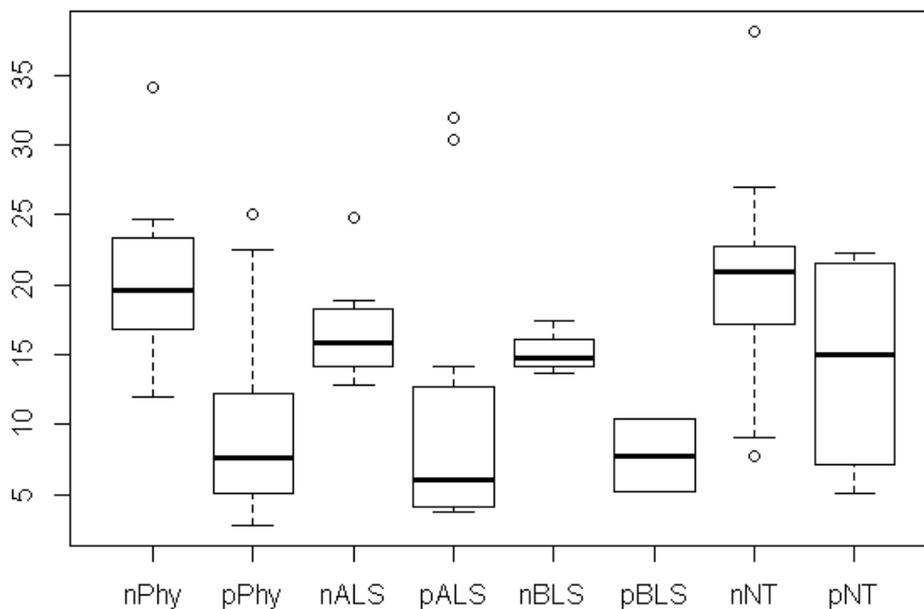


Figure 8. Death rate by sign of average governance indicator for staffing preference. nPhy= negative signed physician responder service; pPhy= positively signed physician staffed service; nALS= negatively signed advanced life-support service; pALS= positively signed advanced life-support service. nBLS= negatively signed basic life-support service; pBLS= positively signed life-support service; nNT= negatively signed minimally or not trained service; pNT= positively signed minimally or not trained service.

Table 11

t-Test Comparing Negative and Positive Governance Signs With Prehospital Staffing

	<i>n</i> neg	<i>n</i> pos	<i>t</i>	<i>df</i>	<i>p</i>	95% conf	Mean negative, positive	β
PHY	8	21	4.12	11.52	>0.001	6.27, Infinity	20.69, 9.62	1
ALS	7	11	1.67	14.00	0.058	-0.31, Infinity	16.91, 11.01	0.96
BLS	3	2	2.64	-1.37	0.086	-4.04, Infinity	15.27, 7.80	0.83
NT	11	4	-1.24	5.23	0.134	-3.72, Infinity	20.4, 14.3	0.83

Note. PHY= physician, ALS= advanced life support (registered nurse, paramedic or equivalent), BLS= basic life support, NT= minimally or not trained responders.

Table 12

t-Test Comparing Negative and Positive Governance Signs With Prehospital Staffing by Physicians or ALS Responders

Test Tail $x > y$	<i>n</i>	<i>T</i>	<i>df</i>	<i>p</i>	95% conf	means	β
nPHY/nALS	8/7	1.34	11.79	0.102	-1.25, inf	20.69,16.91	0.892
nPHY/nNPHY	8/10	-1.64	10.14	0.066	-0.45, inf	20.69,16.42	>0.001
pPHY/pALS	21/11	-0.41	13.44	0.654	-7.44, inf	9.62,11.01	0.244
pPHY/pNPHY	21/13	-3.00	17.61	0.616	-6.09, inf	9.62,10.52	>0.001

Note. *n* signifies negative standard governance indicator value.

p signifies positive standardized governance indicator value.

PHY = physician responder, ALS = advanced life-support responder (registered nurse, paramedic, or equivalent), NPHY = combined advanced and basic life-support providers.

Based on the results of this analysis, the alternative hypothesis must be accepted, that there is a difference in the death rate from road traffic events between physician staffing in countries with negative governance signs versus physician staffing in countries with positive governance signs and nearly for advanced life-support providers in the same conditions. The null hypothesis must be accepted in the case of physicians versus

advanced life-support or advanced life-support/basic life-support providers within each of the governance groups. This turns out to be a poorly conceived and worded question.

Income, Governance Sign, and Staffing Interaction

For Question 6. When grouped by income and sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response?

H_a6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

H_o6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services do not have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

I could not properly analyze this question due to the inconsistent sample size and group sizes available.

The grouping of road traffic deaths per 100,000 by income, governance sign, and staffing preference yielded 18 groups. Four low-income countries with negative governance signs could be split into two groups. Alone in its own group was Zimbabwe, with a road traffic death rate per 100,000 of 14.6. It used paramedic or nursing personnel to staff its prehospital response and had an average governance value of -1.54 , calculated

from the following scores: control of corruption, -1.31 ; effectiveness of government, -1.50 ; political stability and control of violence, -1.12 ; regulatory quality, -2.05 ; rule of law, -1.81 ; and voice and accountability, -1.48 . In the other group were the Comoros Islands, Kenya, and Rwanda, with a road traffic death rate per 100,000 of 20.87. These countries used minimally or not trained personnel in their prehospital response systems. They had an average governance value of -0.64 , calculated from the following scores: control of corruption, -0.41 ; effectiveness of government, -0.78 ; political stability and control of violence, -0.62 ; regulatory quality, -0.56 ; rule of law, -0.79 ; and voice and accountability, -0.67 .

Among the middle-income countries 32 could be divided into six groups. Eight countries with prehospital physician responders and a negative average governance sign were Armenia, China, Colombia, Iran, Kazakhstan, Russia, Turkey, and Vietnam. These countries had an average road traffic death rate per 100,000 of 20.696 and an average governance value of -0.55 , calculated from the following scores: control of corruption, -0.63 ; effectiveness of government, -0.27 ; political stability and control of violence, -0.71 ; regulatory quality, -0.35 ; rule of law, -0.51 ; and voice and accountability, -0.86 .

Six middle-income countries with positive governance signs had physician-staffed prehospital response systems: Belarus, Brazil, Lithuania, Malaysia, Mauritius, and Panama. These countries had a road traffic death rate per 100,000 of 14.10 and an average governance value of 0.67 , calculated from the following scores: control of corruption, 0.65 ; effectiveness of government, 0.74 ; political stability and control of

violence, 0.50; regulatory quality, 0.81; rule of law, 0.62; and voice and accountability, 0.70.

There were five countries with advanced life-support prehospital responders and a negative average governance sign: Argentina, India, Indonesia, Peru, and Sri Lanka. These countries had an average road traffic death rate per 100,000 of 15.80 and an average governance value of -0.34 , calculated from the following scores: control of corruption, -0.46 ; effectiveness of government, -0.15 ; political stability and control of violence, -0.81 ; regulatory quality, -0.25 ; rule of law, -0.39 ; and voice and accountability, -0.05 .

One middle-income country had a positive governance sign, South Africa; it used advanced life-support responders to staff its prehospital system. It had a road traffic death rate per 100,000 of 31.9 and an average governance value of 0.25 , calculated from the following scores: control of corruption, 0.09 ; effectiveness of government, 0.39 ; political stability and control of violence, -0.02 ; regulatory quality, 0.36 ; rule of law, 0.11 ; and voice and accountability, 0.58 .

Two countries used basic life-support prehospital responders and had a negative average governance sign: Mexico and Pakistan. These countries had an average road traffic death rate per 100,000 of 16.05 and an average governance value of -0.65 , calculated from the following scores: control of corruption, -0.72 ; effectiveness of government, -0.31 ; political stability and control of violence, -1.71 ; regulatory quality, -0.16 ; rule of law, -0.65 ; and voice and accountability, -0.35 .

Eight countries used prehospital responders that were minimally trained or not trained and had a negative average governance sign: Angola, Bosnia and Herzegovinian, Cuba, Ecuador, Lebanon, Nicaragua, Philippines, and Thailand. These countries had an average road traffic death rate per 100,000 of 20.23 and an average governance value of –0.69, calculated from the following scores: control of corruption, –0.68; effectiveness of government, –0.64; political stability and control of violence, –0.74; regulatory quality, –0.66; rule of law, –0.81; and voice and accountability, –0.69.

Two middle-income countries had prehospital response systems that used minimally trained or not trained staff and a positive governance sign: Botswana and Ghana. These countries had a road traffic death rate per 100,000 of 21.5 and an average governance value of 0.38, calculated from the following scores: control of corruption, 0.53; effectiveness of government, 0.21; political stability and control of violence, 0.49; regulatory quality, 0.29; rule of law, 0.30; and voice and accountability, 0.47.

Fifteen high-income countries with a positive governance sign used physicians as prehospital responders: Austria, Czech Republic, Finland, France, Germany, Greece, Hungary, Iceland, Israel, Italy, Norway, Poland, Portugal, Spain, and Sweden. These countries had a road traffic death rate per 100,000 of 6.85 and an average governance value of 1.11, calculated from the following scores: control of corruption, 1.12; effectiveness of government, 1.28; political stability and control of violence, 0.62; regulatory quality, 1.22; rule of law, 1.26; and voice and accountability, 1.41.

Saudi Arabia was the lone high-income country with a negative governance sign that used advanced life-support staff in its prehospital response system. It had a road

traffic death rate per 100,000 of 24.8 and an average governance value of -0.24 , calculated from the following scores: control of corruption, 0.06; effectiveness of government, 0.03; political stability and control of violence, -0.22 ; regulatory quality, 0.18; rule of law, 0.25; and voice and accountability, -1.74 .

There were 10 high-income countries with a positive governance sign that used advanced life-support staff in their prehospital response systems: Australia, Canada, Denmark, Malta, Netherlands, Oman, South Korea, Switzerland, the United Kingdom, and the United States. They had a road traffic death rate per 100,000 of 8.92 and an average governance value of 0.20, calculated from the following scores: control of corruption, 1.52; effectiveness of government, 1.52; political stability and control of violence, 0.79; regulatory quality, 1.46; rule of law, 1.55; and voice and accountability, 1.32.

The Bahamas was the lone high-income country with a negative governance sign that used basic life-support prehospital response. It had a road traffic death rate per 100,000 of 13.7 and an average governance value of -0.96 , calculated from the following scores: control of corruption, 0.73; effectiveness of government, -1.13 ; political stability and control of violence, -0.13 ; regulatory quality, -1.16 ; rule of law, -1.04 ; and voice and accountability, -1.54 .

There were two high-income countries with a positive governance sign that used basic life-support prehospital response systems: Croatia and Japan. They had a road traffic death rate per 100,000 of 10.4 and an average governance value of 0.38, calculated from the following scores: control of corruption, 0.77; effectiveness of government, 1.07;

political stability and control of violence, 0.72; regulatory quality, 0.79; rule of law, 0.74; and voice and accountability, 0.81.

Finally, there were two high-income countries with a positive governance sign that used minimally trained or not trained prehospital responders: New Zealand and Singapore. They had a road traffic death rate per 100,000 of 7.1 and an average governance value of 1.63, calculated from the following scores: control of corruption, 2.30; effectiveness of government, 2.03; political stability and control of violence, 1.18; regulatory quality, 1.81; rule of law, 1.78; and voice and accountability, 0.67.

Table 13 summarizes the findings of the demographic results for road traffic event deaths in relation to income, governance, and prehospital staffing for these countries.

Table 13

Road Traffic Deaths by Income Level, Governance, and Staffing Preference

Inc	n	Avg	Staff	Death	Cor	Eff	Stab	Qual	Law	Voi
Low	1	-1.54	ALS	14.6	-1.31	-1.50	-1.12	-2.05	-1.81	-1.48
Low	3	-0.63	NT	20.87	-0.41	-0.78	-0.62	-0.56	-0.78	-0.67
Middle	8	-0.55	PHY	20.69	-0.63	-0.27	-0.71	0.35	-0.51	-0.85
Middle	6	0.67	PHY	16.55	0.65	0.74	0.50	0.81	0.62	0.70
Middle	5	-0.34	ALS	15.80	-0.46	-0.15	-0.81	-0.25	-0.40	0.05
Middle	1	0.25	ALS	31.9	0.09	0.39	-0.02	0.36	0.11	0.58
Middle	2	-0.65	BLS	16.05	-0.72	-0.31	-1.71	-0.16	-0.66	-0.35
Middle	8	-0.69	NT	20.23	-0.68	-0.64	-0.74	-0.66	-0.82	-0.61
Middle	2	0.38	NT	21.5	0.53	0.21	0.49	0.29	0.30	0.47
High	15	1.11	PHY	6.85	1.12	1.28	0.63	1.22	1.26	1.18
High	1	-0.24	ALS	24.8	0.06	0.03	-0.22	0.18	0.26	-1.74
High	10	1.32	ALS	8.92	1.52	1.52	0.78	1.46	1.55	1.08
High	1	-0.96	BLS	13.7	-0.73	-1.14	-0.13	-1.16	-1.04	-1.54
High	2	0.81	BLS	7.8	0.77	1.08	0.72	0.79	0.75	0.73
High	2	1.63	NT	7.1	2.30	2.03	1.18	1.80	1.78	0.67

Note. Inc = Income level of low, middle, or high.

n = Number of observations per group.

Avg = Average sign of standardized governance indicator used to categorize countries.

Staff = ALS: system staffed by advanced life-support responders (registered nurse, paramedic, or equivalent); BLS: system staffed by basic life-support responders (emergency medical technician, first responder, or equivalent), NT: system staffed by minimally or not trained responders, PHY: system staffed by physicians.

Death = death rate from road traffic events per 100,000.

Cor = control of corruption, Eff = effectiveness of government, Stab = political stability and control of violence, Qual = regulatory quality, Law = rule of law, Voi = voice and accountability.

Figure 9 plots road traffic deaths for the sample grouped by income, sign of governance indicator, and prehospital staffing. The figure demonstrates the inconsistent pairing of groups and lack of sufficient sample size in some of the groups.

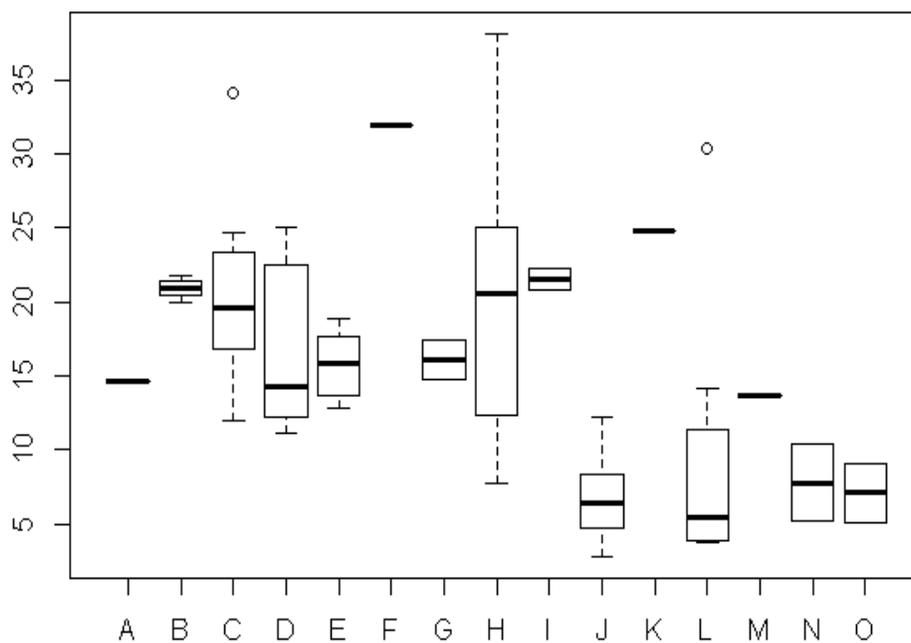


Figure 9. Death by income, governance sign, and staffing by comparable grouping.

A. Low-income, negative governance, ALS.

B. Low-income, negative governance, NT.

C. Middle-income, negative governance, physician. D. Middle-income, positive governance, physician.

E. Middle-income, negative governance, ALS.

F. Middle-income, positive governance, ALS.

G. Middle-income, negative governance, BLS.

H. Middle-income, negative governance, NT.

I. Middle-income, positive governance, NT.

J. High-income, positive governance, physician.

K. High-income, negative governance, ALS.

L. High-income, positive governance, ALS.

M. High-income, negative governance, BLS.

N. High-income, positive governance, BLS.

O. High-income, positive governance, NT.

ALS=advanced life support, NT=minimally or not trained, BLS= basic life support.

Only one analysis, a *t* test, was feasible for these groups (Table 14). It suggested a significant difference between the death rates from road traffic events of middle-income countries with a negative governance sign using advanced life-support prehospital staff and middle-income countries with a negative governance sign using physician prehospital staff: $t(9.78) = 1.865$, $p = 0.046$, 95% *CL*[0.13, Inf], $\beta = 0.998$. In Table 15, we can see a difference between governance and income for rate of road traffic deaths, but the difference is not due to prehospital staffing.

Table 14

X<Y	means	<i>T</i>	<i>df</i>	<i>p</i>	95% confidence	β	<i>t-</i> <i>Tes</i> <i>t of</i> <i>Mi</i>
m1A/m1P	20.6875 15.8000	1.8652	9.783	0.04619	0.1275745 Inf	0.9982	

ddle-Income Countries With a Negative Governance Sign Using Physician versus ALS Providers

Note. m1A/m1P= middle-income negative governance advanced life support is greater than middle-income negative physician staffed services.

Table 15

ANOVA Table for Death Rate by Income and Governance Sign Groupings

	<i>df</i>	Sum Sq	Mean Sq	<i>F</i> value	Pr(> <i>F</i>)
Income and sign	14	2618.4	187.030	4.9355	1.062e-05 ***
Residuals	52	1970.5	37.895		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Although the look of Figure 9 is intriguing, it is not possible to analyze its question based on the available data. Looking at the World Health Organization's (2013) evaluation of road traffic deaths by income and governance sign (ignoring the staffing preference by country), Figure 9 graphically demonstrates there is no significant difference in the death rate among the groups.

The only significant interaction reported in Table 16 is the interaction between middle-income, negative indicator (2) and high-income, positive indicator (5) countries, $p = 0.0047$. This is represented in Figure 8 by the letters C, E, G, H and J, L, N, O: the middle-income, negative indicator, physician, ALS, BLS, and NT groups and high-income, positive indicator, physician, ALS, BLS, and NT groups.

A look at what can be gleaned from analyzing income, governance, and prehospital responder preference is presented in Figure 10, which plots income, governance, and prehospital staffing, and Figure 11, <introduce following tables and figures> the Tukey stepwise comparison of groups.

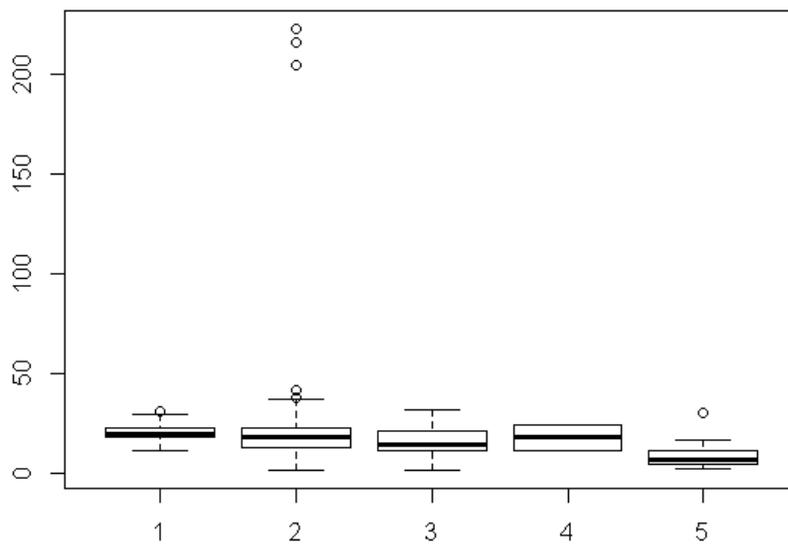


Figure 10. Death rate by income and sign of governance indicator. 1 = low-income, negative indicator; 2 = middle-income, negative indicator; 3 = middle-income, positive indicator; 4 = high-income, negative indicator; 5 = high-income, positive indicator.

Table 16

Tukey Multiple Comparisons of Means 95% Family-wise Confidence Level

Group 1	Group 2	difference	lower	upper	<i>p</i> adj
Middle-income negative	High-income positive	7.262	-10.5410	25.064	0.793
High-income negative	High-income positive	9.616	-42.793	62.025	0.987
Low income-negative	High-income positive	12.351	-4.5092	29.211	0.261
Middle-income negative	High-income positive	17.567	3.872	31.262	0.005
High-income negative	Middle-income positive	2.354	-50.888	55.597	0.100
Low-income negative/	Middle-income positive	5.090	-14.206	24.385	0.950
Middle-income negative	Middle-income positive	10.306	-6.296	26.907	0.430
Low-income negative/	High-income negative	2.735	-50.199	55.670	0.100
Middle-income negative	High-income negative	7.951	-44.062	59.9648	0.993
Middle-income negative	Low-income negative	5.216	-10.371	20.803	0.888

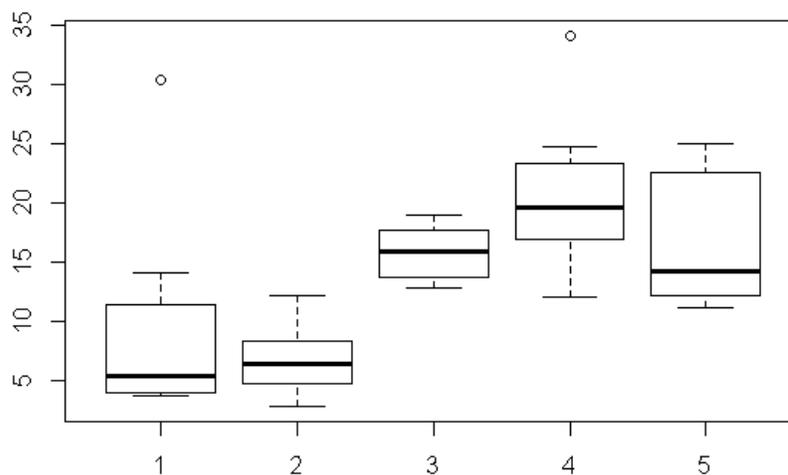


Figure 11. Income governance and prehospital staffing. 1 = high-income, positive governance, physician staffing; 2 = high-income, positive governance, ALS staffing; 3 = middle-income, negative governance, ALS staffing; 4 = middle-income, negative governance, physician staffing; 5 = middle-income, positive governance, physician staffing.

Table 17

Tukey Multiple Comparisons of Means 95% Family-wise Confidence Level

Group		differenc e	lower	upper	p
high-income positive ALS	high-income positive physician	-2.073	-8.717	4.570	0.898
middle income negative ALS	high-income positive physician	6.880	-2.033	15.793	0.198
middle income negative physician	high-income positive physician	11.768	4.049	19.486	0.001
middle income positive physician	high-income positive physician	7.630	-0.773	16.0332	0.091
middle income negative ALS	high-income positive ALS	8.953	0.550	17.357	0.032
middle income negative physician	high-income positive ALS	13.841	6.717	20.965	0.000
middle income positive physician	high-income positive ALS	9.703	1.843	17.564	0.009
middle income negative physician	middle income negative ALS	4.888	-4.389	14.164	0.563
middle income positive physician	middle income negative ALS	0.750	-9.104	10.604	0.999
middle income positive physician	middle income negative physician	-4.138	-12.926	4.651	0.665

Note. 1=high-income positive physician, 2= high-income positive ALS, 3= middle income negative ALS, 4= middle income negative physician, and 5= middle income positive physician. ALS= registered nurse, paramedic, or equivalent,

There were significant differences between middle-income countries with negative governance and physician staffing and high-income countries with positive governance and physician staffing, $p > 0.001$; between middle-income countries with negative governance and advanced life-support staffing and high-income countries with advanced life-support staffing, $p = 0.032$; and between middle-income countries with negative governance and physician staffing and high-income countries with positive governance and advanced life-support staffing, $p > 0.001$. The difference between physician and advanced life-support providers was difficult to interpret because of the variation in the sample size, but it appears that income and governance were the factors responsible for the difference in death rate, not prehospital staffing. Middle-income countries with positive governance and physician staffing and high-income countries with positive governance and advanced life-support staffing had a significant difference, $p = 0.01$. The difference between physician and advanced life-support providers was difficult to interpret; here too the income and governance factor appear to be the determining factor.

Based on the data for this question, there seems no way to interpret the findings. Neither the null nor the alternative hypothesis can be accepted.

Summary

Sixty-seven countries were identified as having English-language profiles and complete data for income, road traffic deaths, governance values, and prehospital staffing preferences. The literature review of country emergency medicine profiles resulted in a

finer distinction of prehospital staffing than was anticipated. Trained nonphysician response staff was separated into advanced life-support and basic life-support categories. All but four of the sample countries had middle or high income. Statistical analysis of the first five of the six research questions was conducted. The final research question had too many groups with too few data per group to perform reliable computations.

1. Is there a significant association between income level of a country and the rate of road traffic fatalities per 100,000?

H_{a1} : There is a significant negative correlation between income level of countries and road traffic fatalities.

H_{o1} : There is no association between income level of countries and road traffic fatalities.

The literature review resulted in 67 countries with usable data. Comparing the total estimated deaths from road traffic events and the death rate per 100,000 (WHO, 2013) as well as the total deaths and death per 100,000 for the 182 countries in the WHO (2013) resulted in a significant correlation between death rate per 100,000 from road traffic events and country income measures as GNI per capita.

2. Is there an association between the sign of standardized governance indicators of a countries and road traffic fatalities per 100,000?

H_{a2} : There is a significant negative correlation between the sign of standardized governance indicators of countries and road traffic fatalities.

H_{o2} : There is no association between the sign of standardized governance indicators of countries and road traffic fatalities.

Based on the sample data, there was a negative correlation between the value of the governance indicator and the death rate per 100,000 from road traffic events.

3. Does the staffing of prehospital response services by physicians reduce the rate of road traffic fatalities per 100,000?

H_a3 : There is a significant reduction in the rate of road traffic fatalities per 100,000 when prehospital services are staffed by physicians.

H_o3 : There is no significant difference between physician-staffed and nonphysician-staffed prehospital services and the rate of road traffic fatalities per 100,000.

Based on correlation and ANOVA of the sample, no significant difference in the death rate from road traffic events per 100,000 was found between staff conditions for middle- or high-income countries. Low-income data were too sparse to analyze.

4. When grouped by income, do countries with physician-staffed response services have a lower rate of road traffic fatalities per 100,000?

H_a4 : There is a significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

H_o4 : There is no significant reduction in the rate of road traffic fatalities per 100,000 in physician-staffed prehospital services when countries are grouped by income.

Based on the sample data, there was a significant difference between the death rate per 100,000 from road traffic events between the middle- and high-income countries, but not among the staffing preferences within each group.

5. When grouped by the sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road

traffic deaths per 100,000 than countries with trained nonphysician–staffed prehospital response?

H_a5: When grouped by the sign of standardized governance indicators, there is a significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

H_o5: When grouped by the sign of standardized governance indicators, there is no significant reduction in road traffic fatalities per 100,000 in countries with physician-staffed prehospital services.

Base on the sample data, there was a significant difference between the negative and positive groups of averaged governance indicators in the death rate from road traffic events for all staffing preferences. The significance within groups (staff preference) is, as yet, undetermined.

6. When grouped by income and sign of standardized governance indicators, do countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician–staffed prehospital response?

H_a6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services have a significantly lower rate of road traffic deaths per 100,000 than countries with trained nonphysician–staffed prehospital response.

H_o6: When grouped by income and sign of standardized governance indicators, countries with physician-staffed prehospital services do not have a significantly lower

rate of road traffic deaths per 100,000 than countries with trained nonphysician-staffed prehospital response.

The analysis of the sixth question was not available. The group sizes and composition did not allow for any meaningful comparison. The only group difference that could be found was for middle-income countries with negative governance and physician-staffed response systems versus middle-income countries with negative governance and advanced life-support responders.

In Chapter 5 these results are discussed and conclusions drawn. Recommendations based on the conclusions are presented. Additionally, limitations of the study are highlighted.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

In this archival cross-sectional study, I looked at the influence of income, governance, and style of prehospital services on the death rate from road traffic events in 67 countries. The literature review revealed that there is a great variety in the provision of prehospital services, making a comparison of styles difficult.

In this study, the commonly referenced factors of vehicle safety, seat belt use, speeding, and alcohol and drug use (Anbarci et al., 2009; Chrisholm & Naci, 2009; Kopitis, 2004; Moeller, 2005; WHO, 2009) were represented by country income level (Kopitis, 2004) or governance (Law, 2010).

Income and governance indicators (control of corruption, effectiveness of government, political stability and lack of violence, regulatory quality, rule of law, and voice and accountability) were negatively correlated with road traffic death, in line with Kopitus (2009) for the former and Law (2009) and Gaygisiz (2010) for the latter. Although Law (2009) found an inverted U when comparing governance and road traffic deaths, this study could not corroborate that observation. These findings do support those of Gaygisiz (2010) and Bishai (2006), that higher governance scores are related to lower rates of road traffic death. The results did not form a Kuznets curve, as found by Law (2009), which may be due to the absence of data for low-income countries in this study.

Law (2009) identified corruption as a contributing factor in road traffic deaths, and this study corroborates that finding. Indeed all of the governance factors had a

negative correlation with road traffic deaths: corruption $r = -0.61$, government effectiveness $r = -0.63$, political stability and control of violence $r = -0.48$, regulatory quality $r = -0.59$, rule of law $r = -0.63$, and voice and accountability $r = -0.64$. All correlations had $p < 0.01$, and all except political stability and control of violence ($\beta = 0.66$) had a power of 0.95 or greater. These correlations are also in keeping with Al-Marhubi's (2005) negative correlations for governance indicators.

No significant difference was found with regard to style of emergency medical or prehospital service, echoing Timmermann et al. (2008), and the null hypothesis was accepted. This finding would suggest that, especially if funding or medical staffing is an issue for a country, nonphysician emergency staff provide suitable out-of-hospital care for victims of road traffic accidents and may be more cost-effective for resource-stressed countries, supporting Holliman et al. (2011) and other authors.

All the findings in this study support Sarlin and Alagappan (2010), Brown and Devine (2008), Holliman et al. (2011), Jennings (2010), Kobusingye et al. (2005), O'Reilly and Fitzgerald (2010), and Razzak and Kellermann (2002).

The results of this study neither support nor refute Hass and Nathens's (2008) conclusion that patients benefit more from the resources in the emergency room than at the scene of the accident. Nor do they support the fourfold difference in outcome Roudsari et al. (2007) found for physician-staffed services.

O'Reilly and Fitzgerald's (2010) claim that prehospital systems are becoming more like the Anglo-American system was not seen in this study. In the countries

analyzed in this study, there were more physician-staffed than nonphysician-staffed services, although this result may be due to the limitation that only country profiles in English were considered and also because middle-income countries had a preponderance of physician-staffed services and high-income a preponderance of nonphysician-staffed services.

The factors contributing to road traffic death, such as type and number of vehicles on the roadways, infrastructure of road systems, vehicle design and safety features, and laws and law enforcement, were all combined into the variables of income per capita and governance quality across the pre-event, event, and postevent times in Haddon's (1968) original matrix and also occupy strategic positions in the political and social arenas included by Runyan (1998). This study looked at the pre-event structure of the prehospital system and the postevent outcome of road traffic events measured as road traffic deaths per 100,000 people, focusing on the environmental, political, and policy cells of the Haddon matrix. In the postevent areas, I covered the agents and environment in the policy and social cells. Based on the data collected in this study, the staffing preference did not make a significant difference in any area. A significant difference was seen in the income per capita and the governance quality of the same cells.

The conclusion from the analysis of these data with respect to the Haddon matrix is that countries get the same benefit from physician-staffed services as they do from nonphysician-staffed services. In the social and political arenas, this results in a recommendation to increase the number of personnel trained in advanced life-support

skills and concentrate physicians in the hospital, where they can have an impact on a greater number of patients.

The findings of this study support the notion that income and governance are the major determinants of death from road traffic incidents. Based on the available data, there is a significant negative correlation between a country's rate of road traffic fatalities and that country's income and between the rate of road traffic fatalities and a country's governance indicators.

The final question was difficult to analyze due to the grossly unequal sample size. However, what could be analyzed pointed to a significant difference in rates of road traffic death when countries are grouped by income and sign of the standardized governance indicators, but not by prehospital staffing within each of the income and governance groupings.

Insignificant Results

The data in this study were not normally distributed. At modest levels, this is not a problem, but in extreme cases, it makes the statistical analysis invalid (Karen, 2010). For analysis of income, governance, and prehospital staffing as individual factors, the group sizes and distribution may meet the modest normal distribution requirement of valid statistics. However, as the groupings become greater in number and more complex, the normality of distribution disappears; in fact, the lack of a representative low-income group skews the results right from the onset.

When trying to compare means, the degrees of freedom (based on the number of observations per group) need to be close among the groups, or the resultant population

means can be underestimated and the mean difference overestimated (Hsiung, Olejnik, & Huberty, 1994). Additionally, because this is a convenience sample, the similarity in the population variance is difficult to guarantee (Hsiung et al., 1994). Figure 8 graphically demonstrates the problem of group size and variability and the extreme of the problem of group size in this study: there are not enough groups to compare against each other.

The conservative conclusion of this study, based on these results, is that the traffic safety laws and enforcement and the quality of the health care system (including prehospital and hospital treatments) in high-income countries result in lower death rates from traffic events than in middle-income countries. A conclusion about the merits of different types of prehospital staffing—whether by physicians, advanced life-support responders, or basic life-support responders—is hard to make. Yet efforts to improve health care capacity and policy, regulation, and enforcement of road safety can be reasonably recommended from this analysis.

At the onset of this study, capacity building was not foreseen as a possible recommendation, yet the results clearly point to capacity building as a way to reduce road traffic fatalities. This will be a daunting challenge for low- and middle-income countries. The goals of capacity building are “autonomy and self-reliance, local capacity, and sustainability” (Guha-Sapir, 2005, p. 480). Five elements for building sustainable capacity are “training for identified key competencies, country-specific approaches, targeted technical assistance, qualification and quality control, and funding” (Guha-Sapir, 2005, p. 481). Areas where capacity building should be undertaken are organizational and

managerial, human resource development, leadership, partnership development, and networks (Guha-Sapir, 2005).

Grindle (2004, p. 525) stated, “It is all too clear that when governments perform poorly, resources are wasted, services go undelivered, and citizens—especially the poor—are denied social, legal, and economic protection.” Governance is difficult to change. Guha-Sapir (2005) agreed, remarking that capacity building is a complex topic that quickly comes to a standstill when all of the stakeholders desire to have their priorities represented.

Limitations of the Study

This is a cross-sectional study that only recorded observations on the chosen variable across many subjects during one specified time period, a snapshot of the population (Institute for Work and Health, 2009). Cross-sectional studies do not allow for a look at the history of precursors or subsequent development of the variables over time, limiting or prohibiting determinations of cause and effect. Similarly, as a correlational study this work was able to demonstrate relationships among factors but was not able to attribute cause (Research Limitations, n.d.).

The nature of the data sets is also a limitation, as data were collected using a variety of methods and definitions (Koziol & Arthur, n.d.). The latter issue, however, is the same for other researchers using the data; therefore, results will be comparable to results in other studies (World Bank, 2013).

Additionally, using secondary data poses limitations on the resulting analysis because there is uncertainty injected into the data collection (Atkinson & Brandolini,

2001; Bhalla, 2010). However, this uncertainty is spread across all countries that have data, and other researchers have used the data, giving some continuity to cross-study analysis.

There is also a bias built into the study caused by lower-income countries not reporting data to the databank managers as frequently as higher-income countries report. There are fewer results for income, governance, road traffic fatalities, and prehospital staffing to be found from lower-income countries. This shifted the burden of evidence toward middle- and high-income countries. Given the data available, there was little that could be done to overcome this difficulty.

The grossly unequal sample size made the data difficult to analyze with confidence. Confounding and bias could be introduced by the presence of more and possibly erroneously larger or smaller observations from the groups (Lane, n.d.). In this case, having data from only four low-income countries adds uncertainty to the conclusions.

Another limiting factor is the lack of data on the death rate from road traffic events after the patient reaches the hospital. Had some measure that separated the hospital and prehospital deaths been available, a result with greater fidelity could have been obtained.

Recommendations

A fuller search of country prehospital systems could be undertaken, searching for data from ministries of health and literature that is not in English. A more detailed search

for the costs associated with providing prehospital care might also provide a keener sense of whether physician response is cost-efficient in the long run.

Anderson et al. (2011), Brice et al. (2010), and Jakubasko et al. (2010) advocated optimizing existing resources in prehospital systems. This research supports the further investigation of prehospital staffing as a resource to be strengthened and for the development of effective staffing patterns that reduce the burden placed on families affected by road traffic deaths.

Jennings (2010) encouraged the expansion of advanced life-support professionals as a cost-effective and rapidly implementable intervention to reduce the burden of road traffic and other forms of death, especially for countries struggling to provide for the health of their people. The results of this study support additional investigation into the best training and practice standards for prehospital health providers. No significant difference was detected between physician responders and trained nonphysician providers, so training advanced life-support responders should be a valuable asset for a country. Kobusingye et al. (2002), Brown and Devine (2008), Sterling et al. (2007), Holiman (2010), and Sarlin and Alagappan (2010) are all in concurrence that best practices and cost-effective health care can be provided by paramedics, nurses, and their equivalents and should be considered as the approach to prehospital care for developing countries.

Anderson et al. (2012) suggested five strategies for developing good prehospital health care:

1. Encourage governments to plan and provide for a basic level of emergency services.
2. Develop data and tracking to provide objective outcomes for emergency care services.
3. Develop or encourage standardized protocols and procedures for prehospital and hospital treatment.
4. Support World Health Organization member states "with assessing and improving their emergency care system."
5. Encourage member states to establish evidence-based intervention. (Adapted from Anderson et al., 2012, p. 6)

Implications

Social Change

This research is intended to give governments and policymakers information to evaluate the system of and control over prehospital systems with respect to traffic death. This knowledge will be beneficial to countries in developing policies, funding, and training endeavors that will provide cost-effective and beneficial results for their people. I hope people injured in road traffic accidents will benefit from a prehospital response that meets their immediate needs and reduces the burden placed on families from the loss of loved ones, family structure, and income. The social change will be improved recovery from road traffic crashes and reduced burden caused by road traffic deaths.

Conclusion

Based on the data from this study, personal wealth and positive standardized governance indicators are the main determinants of death from road traffic incidents. The staffing of the prehospital response within income and governance groupings had no effect on the death rate per 100,000. Improving wealth and governance practices should be the main goal for decision makers. The cost-effectiveness of the responder's credentials ought to be considered, especially when budgetary constraints are an issue. Increased capacity in a country to provide for the welfare of its people needs to be at the forefront of interventions aimed at reducing the burden of road traffic deaths.

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Appendix A: Disability Adjusted Life Years Saved and Cost by Intervention and Subregion

	African Region (AfrE)				American Region (AmrA)				Southeast Asia (SearD)				Western Pacific (WprB)			
	DALYs		Cost ³		DALYs		Cost ³		DALYs		Cost ³		DALYs		Cost ³	
	Total ¹	/mi ll ²	Tot al ⁴	Per capi ta	Tot al ¹	/mi ll ²	Tot al ⁴	Per capi ta	Total ¹	/mi ll ²	Tot al ⁴	Per capi ta	Total ¹	/mi ll ²	Tot al ⁴	Per capi ta
Speed limit camera	67,310	167	112	0.28	27,191	79	625	1.28	116,418	79	185	0.13	145,445	91	967	0.61
Alcohol enforcement	45,929	114	103	0.26	22,566	66	592	1.72	59,273	43	162	0.12	89,895	56	824	0.52
Seat belt enforcement	20,041	50	92	0.23	6,623	19	384	1.12	39,661	29	99	0.07	55,138	35	533	0.33
Motorcycle helmet laws	7,774	19	52	0.13	6,197	18	118	0.34	793	62	146	0.10	105,338	66	603	0.38
Bicycle helmet laws	46,013	114	57	0.14	415	1	123	0.36	26,651	19	98	0.07	26,131	16	242	0.15
Cameras and alcohol enforcement	113,413				49,953				175,921				235,883			
Cameras, alcohol and seat belt enforcement	133,935				56,696				216,067				291,770			
Cameras, alcohol enforcement, and helmet laws	121,259				56,262				262,383				342,597			

Note. Adapted from:

1. Chisholm and Naci (2009, p. 30).
2. Chisholm and Naci (2009, p. 31) per million population.
3. Chisholm and Naci (2009, p. 33, figure 10). Cost in US\$; 4. in US\$ million.

Appendix: B: Countries With Profiles in English

Angola	France	Nicaragua	UK
Argentina	Germany	North Korea	USA
Armenia	Ghana	Norway	Vietnam
Australia	Greece	Oman	Zimbabwe
Austria	Hungary	Pakistan	
Belarus	Iceland	Panama	
Bahamas	India	Peru	
Bosnia and Herzegovina	Indonesia	Philippines	
Botswana	Iran	Poland	
Brazil	Israel	Portugal	
Canada	Italy	Rwanda	
China	Japan	Russia	
China Rep, Taiwan	Kazakhstan	Saudi Arabia	
Colombia	Kenya	Singapore	
Comoros Islands	Lebanon	South Africa	
Croatia	Lithuania	South Korea	
Cuba	Malaysia	Spain	
Czech Republic	Malta	Sri Lanka	
Denmark	Mauritius	Sweden	
Ecuador	Mexico	Switzerland	
Eritrea	Netherlands	Thailand	
Finland	New Zealand	Turkey	

Appendix C: Countries and Author With Complete Prehospital Style, With WHO Traffic
Death, and Governance Data

Country	staff	GNI	income	Death	Ave Gov	Author
Angola	4	3960	2	23.1	-1.01	WHO (2005, Angola)
Argentina	2	8620	2	12.6	-0.29	Monzón et al. (2010)
Armenia	1	3200	2	18	-0.30	Aghababian et al. (1995)
Australia	2	46200	3	6.1	1.60	Trevithick, et al. (2003)
Austria	1	46920	3	6.6	1.55	Weninger et al. (2005)
Bahamas	3	21970	3	13.7	-0.93	Ezenkwele, et al. (2001)
Belarus	1,	5990	2	14.4	-0.96	Derlet & Gratchev (2000)
Bosnia and Herzegovina	4	4740	2	15.6	-0.39	Lasseter et al. (1997)
Botswana	4	6750	2	20.8	0.67	Caruso et al. (2011)
Brazil	1	9540	2	22.5	0.11	Nielsen et al. (2012)
Canada	3	43250	3	6.7	1.61	Page (2013)
China, PR	1	4240	2	204.6	-0.56	Hung, et al. (2009); Page (2013); Sarlin & Alagappan (2010)
Colombia	1	5520	2	15.6	-0.37	Nielsen et al. (2012)
Comoros Islands	4	750	1	21.8	-0.99	Ramalajaona (2008)
Croatia	3	13890	3	10.4	0.39	World Bank (2013,Croatia)
Cuba	4	5460	2	7.7	-0.59	Richards (1997)
Czech Republic	1	18490	3	7.6	0.89	Verner (2008)
Denmark	2	59410	3	4.6	1.82	Dib, et al. (2006); Krüger, et al. (2010)
Ecuador	4	3850	2	27	-0.80	Nielsen et al. (2012)
Finland	1	47460	3	5.1	1.87	Krüger, et al.(2010); Langhella et al. (2004)
France	1	42190	3	6.4	1.26	Adnet & Lapostolle (2004)
Germany	1	42970	3	4.7	1.43	Page (2013)
Ghana	4	1250	2	22.2	0.10	Osei-Ampofo, et al. (2013)
Greece	1	26890	3	12.2	0.40	Papaspyroua et al. (2004)
Hungary	1	12860	3	9.1	0.71	Hung, et al. (2009)
Iceland	1	33890	3	2.8	1.43	Langhella et al. (2004)
India	2	1260	2	18.9	-0.29	Nielsen et al. (2012)

(table continues)

Country	staff	GNI	income	Death	Ave Gov	Author
Indonesia	2	2500	2	17.7	-0.48	Pitt, & Pusponegro (2005)
Iran	1	4520	2	34.1	-1.22	Haghparas-Bidgoli, et al. (2010)
Israel	1	27270	3	4.7	0.57	Ellis & Sorene, (2008)
Italy	1	35530	3	7.2	0.52	Repetto, Casgaranda, Overton, & Gail (1998)
Japan	3	42050	3	5.2	1.22	Tanigawa & Tanaka (2006)
Kazakhstan	1	7500	2	21.9	-0.50	Partridge (1998)
Kenya	4	810	1	20.9	-0.66	Nielsen et al. (2012)
Lebanon	4	8750	2	22.3	-0.62	Baqir & Ejaz (2011)
Lithuania	1	11620	2	11.1	0.72	Page (2013); Vaitkaitis (2008)
Malaysia	1	7760	2	25	0.34	Hisamuddin, Hamzah, & Holliman (2007)
Malta	2	18620	3	3.8	1.21	Spiteri (2008)
Mauritius	1,	7780	2	12.2	-0.89	Ramalanjaona & Brogan (2009)
Mexico	3	8930	2	14.7	-0.19	Garcia-Rosas & Iserson (2006); Nielsen et al. (2012)
Netherlands	2	48920	3	3.9	1.64	Sarlin & Alagappan (2010)
New Zealand	4	29350	3	9.1	1.78	Al-Shaqsi (2010); Sarlin & Alagappan (2010)
Nicaragua	4	1100	2	18.8	-0.64	Gaitan, Mendez, Sirker, & Green (1998)
Norway	1	86390	3	4.3	1.72	Kröger et al. (2010); Langhella et al. (2004)
Oman	2	19260	3	30.4	0.23	Al-Shaqsi (2009); Page (2013)
Pakistan	3	1050	2	17.4	-1.11	Nielsen et al. (2012); Baqir & Ejaz (2011)
Panama	1	7010	2	14.1	0.078	Nielsen et al. (2012)
Peru	2	4900	2	15.9	-0.25	Nielsen et al. (2012)
Philippines	4	2060	2	9.1	-0.55	Peralta & Sinon (1995)
Poland	1	12450	3	11.8	0.78	Hladki, Andres, Trybus, & Drwila (2007)

(table continues)

Country	staff	GNI	income	Death	Ave Gov	Author
Russia	1	19720	3	14.1	-0.76	Townes (1998)
Rwanda	4	520	1	19.9	-0.26	Erickson et al. (1996)
Saudi Arabia	2	16610	3	24.8	-0.24	Alanazi (2012)
Singapore	2	39410	3	5.1	1.48	Lateef (2006)
South Africa	2	6090	2	31.9	0.25	Nielsen et al. (2012); Page (2013)
South Korea	2	19720	3	10.7	0.76	Arnold, Song, & Chung (1998); Choi, Hong, Lee, Jung, & Kim (2007)
Spain	1	31460	3	5.4	0.86	Queipo de Llano et al. (2003)
Sri Lanka	2	2260	2	13.7	-0.38	Nielsen et al. (2012)
Sweden	1	50580	3	3	1.77	Krüger et al. (2010); Langhella et al. (2004)
Switzerland	2	71590	3	4.3	1.71	Osterwalder (1998)
Thailand	4	4150	2	38.1	-0.34	Church & Plitponkarpim (1998)
Turkey	1	9890	2	12	-0.05	Bresnahan & Fowler (1995)
UK	2	38140	3	3.7	1.39	Black & Davies (2005); Page (2013)
USA	2	47350	3	11.4	1.24	Page(2013)
Vietnam	2	1160	2	24.7	-0.57	Nielsen et al. (2012)
Zimbabwe	2	480	1	14.6	-1.54	Thomas (2005)

Curriculum Vitae

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Education

PhD Public Health Community Health and Health Promotion Walden University Minneapolis, Minnesota Prehospital Response to Road Traffic Accidents: Physician versus Nonphysician Responders.	(2015)
Master of Social Work University at Albany Albany, New York	1994
BA Psychology Russell Sage College, Troy, NY	1992
AAS, Respiratory Care Hudson Valley Community College, Troy, NY	1982
EMT-B certificate Community College of Allegheny County, Pittsburgh, PA	2012
Employment: Respiratory Care	
Jefferson Hospital, part of the Allegheny Health Network, Jefferson Hills, PA	2014–present
National Disaster Medical System, Department of Health and Human Services Washington, DC.	2013–present
ePeople health care staffing Sewickley PA	2012–2014
Capital Nursing Solutions Pittsburgh, PA	2012–2014
Butler Memorial Hospital, Butler, PA	2004–2011
Health South of Greater Pittsburgh Monroeville, PA	2002–2004
Glens Falls Hospital Glens Falls, NY	1992–1994
New Medico Rehabilitation Hospital, Niskayuna, NY	1989–1994
Green and Kellogg Home Care, Albany, NY,	1984–1988
Albany Medical Center, Albany, NY	1981–1984

St. Peter's Hospital, Albany, NY	1979–1981
Emergency Medical Technician	
Securitas Pittsburgh, PA	2012–2014
Foxwall EMS Fox Chapel, PA (volunteer)	2012–present
Social Work	
Private practice, Allison Park, PA and Everett, PA	2001–2003
Isaly Counseling, Pittsburgh, PA Pittsburgh, PA	2000–2001
Magellan Behavioral Health, Pittsburgh, PA	1999–2000
Wilson Greene Mental Health, Mental Retardation, and, Substance Abuse Center Wilson, NC	1996–1998
Methodist Home for Children, Raleigh, NC	1995–1996
Whitney M. Young Health Center, Alcohol and Drug Abuse Clinic, Albany, NY	1989–1992