Measuring Injury Magnitude and Patterns in a Low-Income Country:

Experiences from Nicaragua

Francisco Tercero

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“Neurosurgery needs traumatic brain injuries for its future posterity as much as patients with traumatic brain injuries need neurosurgeons for their survival and recovery.”

_Bryan Jennett_
Abstract

MEASURING INJURY MAGNITUDE AND PATTERNS IN A LOW-INCOME COUNTRY: EXPERIENCES FROM NICARAGUA

About 16,000 people around the world die every day from injuries. For every person that dies, several thousands more are injured, many suffering with permanent disabilities. However, like many other health problems, the magnitude and pattern of injuries in a certain population are often difficult to assess. While in many high-income countries, regular health registries may provide accurate figures, other approaches are often needed in low-income countries. Therefore, the overall aim of this thesis is to measure the magnitude and pattern of injuries in a defined population (mainly the municipality of Leon, Nicaragua) through the use of different methodologies.

The first step in this study was to conduct an exploratory analysis (Paper 1) to compare the existing nationwide data sources on injury surveillance with respect to validity and prevention-relevance. However, these results were discouraging due to low validity and the lack of information for prevention purposes.

In part due to the above, it was considered important to collect injury data in the municipality of León in other ways. One of the objectives of this second step was to describe the development of a hospital-based injury surveillance system aimed at prevention and to study the incidence of injuries based on data obtained from this data collection system (Paper 2). About 16% of emergency room visits were due to injuries in this low-income country context. For every death due to injury, 31 inpatients and 253 outpatients were reported. Homes and traffic areas were the main arenas where injuries occurred. The main causes were falls, traffic accidents and violence. The underreporting rate was 6%, and in 20.3% of the cases, no E-code was recorded. This study shows that hospital-based injury surveillance is an effective and potential means available for the prevention and control of injuries. However, its low coverage is a concern due to people’s limited access to hospital services.

Next, a study was conducted to provide a reliable estimation of traffic-related injuries in the same catchment area by capture-recapture analysis (using hospital and traffic police records) (Paper 3). This study demonstrated that neither police records nor hospital records nor the aggregate database provide acceptable coverage of traffic-related injuries.

Limitations of coverage in both these data sources justified the realization of a survey in a representative sample in Leon municipality (Paper 4). Ninety-three percent of injuries were minor and seven percent were moderate or severe. The overall incidence rate was 414.2 per 1,000 inhabitants per year, but decreased to 27.6 per 1,000 when minor injuries were excluded. Most of the injuries were unintentional and only 1.2 percent were intentional. The main places of injury occurrence were homes and streets. Nine percent of all injured persons sought hospital treatment. The main causes of nonfatal cases were falls, traffic, and cuts, whereas fatalities were associated with intentional injuries. For every death due to injury, there was one permanent disability, 25 moderate/severe injuries, and 354 minor injuries. The seeking of hospital treatment depended on the severity of the injury.

A complementary study on mortality and disability shows that the leading causes of mortality overall were non-communicable diseases (176/100,000), injuries (55/100,000) and communicable diseases (55/100,000). The incidence of disability-related injuries was 75/100,000, and the main types were skeletal, disfiguring, and blindness. Their causes were falls, traffic, and violence. Around three-quarters of disabilities and half of injury deaths
received hospital attention. The leading causes of years of potential life lost (YPLL) and
disability-adjusted life year (DALY) were traffic, falls, drowning, and violence (Paper 5).
Based on these findings, the ascertainment and validity of data sources and injury indicators
must be evaluated carefully when planning injury prevention measures.

When results from these studies are compared, the distribution of causes of injury vary by
severity and source. The main causes of injury deaths among different data sources were
similar; however, these causes differ in non-fatal injuries. A methodological issue in hospital-
based surveillance is that it often fails to capture most of the extreme outcomes on the injury
spectrum. On the other hand, household surveys can capture most of the injury spectrum, which
sometimes is missing in traditional data sources, but they cannot establish temporal variations
of injuries, especially in fatal cases. Due to the cost associated with carrying out hospital or
population-based studies, capture-recapture methods represent a good option for measuring the
magnitude and pattern of injuries, especially in low-income countries where resources are
scarce. In conclusion, methodological issues involving the sources of injury data, injury
severity, and research methods must be assessed carefully to be able to measure injuries
properly as a basis for effective interventions.

**Key words:** Injury, surveillance, research methods, injury indicators, developing countries,
Nicaragua,
List of papers

This thesis is based on the following papers:


The original papers, except paper II, are reprinted in this thesis with permission from the publishers: Taylor and Francis (Paper I) and Elsevier (Papers III-IV).

Paper II is not reprinted in this thesis due to lack of approval by the relevant ethics committee prior to the study, which was conducted in 1992. However, the study has later been approved by UNAN (Universidad Nacional Autónoma de Nicaragua) according to its current principles.
<table>
<thead>
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<th>Abbreviations</th>
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<tr>
<td>AIS</td>
<td>Abbreviated Injury Scale</td>
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<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<td>CI</td>
<td>Confidence Interval</td>
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<td>DALY</td>
<td>Disability-Adjusted Life Year</td>
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<td>ED</td>
<td>Emergency Department</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GNP</td>
<td>Gross National Product</td>
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<tr>
<td>HEODRA</td>
<td>Hospital Escuela Dr. Oscar Danilo Rosales Argüello</td>
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<tr>
<td>ICD</td>
<td>International Classification of Diseases.</td>
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<td>INSSBNI</td>
<td>Nicaraguan Institute of Safety and Welfare</td>
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<td>MoH</td>
<td>Ministry of Health</td>
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<td>PAHO</td>
<td>Pan-American Health Organization</td>
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<td>RTA</td>
<td>Road Transport Accidents</td>
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<tr>
<td>SAREC</td>
<td>Swedish Agency for Research Collaboration with Developing Countries</td>
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<tr>
<td>SILAIS</td>
<td>Integrated Local Health System</td>
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<tr>
<td>(Sistemas Locales de Atención Integral en Salud)</td>
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<tr>
<td>UNAN</td>
<td>National Autonomous University of Nicaragua.</td>
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<tr>
<td>(Universidad Nacional Autónoma de Nicaragua)</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<td>YLD</td>
<td>Years lived with disabilities</td>
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<td>YPLL</td>
<td>Years of potential life lost</td>
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1. Introduction

Around five million people worldwide died from injuries in 2000 accounting for 9 percent of the world’s total deaths and 12 percent of the world’s burden of disease.¹ Traffic, violence, and suicide account for half of all injury deaths, and in economic terms, the cost of these injuries represents roughly between 2 and 4 percent of the world’s gross national product (GNP).²,³ However, fatal injuries constitute just “the tip of the iceberg” and represent less than one percent of all injuries⁴ of which many result in permanent disabilities.⁵

In Nicaragua, one death out of six results from injuries. Cardiovascular diseases rank first as cause of death followed by injuries and communicable diseases, but injury is the leading cause of death among young people.⁶ This situation is extremely important because Nicaragua not only has the lowest income in Central America, but also was the only country that showed a reduction in the overall expenditure on health as a percentage of the gross domestic product (GDP) from 7.5 percent in 1995 to 3.6 percent in 2001.⁷ At the same time, the out-of-pocket expenditure percentage of total expenditure on health increased from 2.6 percent to 5.9 percent.⁸ The development of injury prevention programs must be a priority considering their high burden on medical services.

Public health surveillance has advanced in recent decades in terms of its concepts, scope, and methods of collection, analysis, and dissemination of data. Historically, communicable diseases were the first to be measured by surveillance systems; however, more recently, surveillance has also been applied to a wide variety of other conditions, such as non-communicable diseases and injuries. This tool has been useful to identify health problems in order to implement prevention and control measures.⁹

The availability of data sources and the development of surveillance systems and research methods vary greatly among countries. While reliable information systems about the incidence and nature of injuries exist in many high-income countries, little is known about the accuracy and extent of underreporting of injuries in current data sources in most low-income countries.¹⁰,¹¹ Therefore, an urgent challenge for low-income countries is to validate and select adequate data sources and injury indicators for injury research to characterize the burden of injuries and contribute to the development of useful intervention strategies.¹²

This thesis, presents the development of some injury surveillance and descriptive research approaches and discusses their limitations and strengths in terms of their applicability in low-income countries.
2. Background

2.1 INJURY AS A PUBLIC HEALTH PROBLEM IN HIGH-INCOME VERSUS LOW-INCOME COUNTRIES

Injury is a major public health problem throughout the world, however the distribution of injuries is skewed since more than 90 percent of deaths occur in low- and middle-income countries.¹

Currently, communities in high-income countries enjoy an effective control of infectious diseases, which has led to a remarkable rise in life expectancy. The model of these countries characterized by “modernization”, implying socioeconomic progress, has led to a rise in living standards.¹³ Consequently chronic diseases, mainly cancer and cardiovascular diseases, have increased, representing the main causes of mortality in older people. Unlike cancer and cardiovascular diseases, injuries disproportionately strike the young.¹⁴,¹⁵,¹⁶ The potential years of life lost (YPLL) and the disability adjusted life years (DALY) were proposed to measure premature death and the burden of injuries in order to aid health planners in defining priorities for prevention.⁵,¹⁷ It has been estimated that one death out of every 14 in the United States results from injury,¹⁴ and injuries are responsible for 10 percent of all direct expenditures for medical care in the United States.¹⁸

Low-income countries are different from technologically advanced high-income countries in many ways. Most people are poorer, less educated, more likely to die at a young age, and less knowledgeable about factors that cause, prevent, or cure disease. In addition, biological and physical hazards are more common, which results in higher incidence of disease, disability, and death. Although disease is common, both people and governments have considerably fewer resources for prevention or medical care. The scarcity of resources is a dominant concern that is reflected in both unemployment rates and low salaries.¹⁰ On the other hand, the process of economic globalization, rapid population growth, and urbanization are trends that may affect health in low-income countries.¹⁰ It was estimated that by the year 2000, 60 percent of the world’s population would be living in periurban or illegal settlements. This situation may affect health because of inaccessibility of health facilities, deterioration of the environment, prostitution, illiteracy, crime, unsafe work conditions, and so on.¹⁹,²⁰

2.2 SURVEILLANCE VERSUS RESEARCH

Surveillance is the ongoing systematic collection, analysis, and interpretation of health data, essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know. The final link in the surveillance chain is the application of these data to prevention and control (CDC definition).²¹

Surveillance information can trigger epidemiological research by identifying problems in need of research. Thus, surveillance is not the same as epidemiologic research. The CDC definition explicitly points out the need for timeliness and for dissemination, while it clearly links surveillance to public health action. Whereas surveillance may identify problems in need of research, it is a problem-finding process with an immediate relationship to public health action, rather than a problem-solving process.²²
2.3 PUBLIC HEALTH TRANSITION

2.3.1 Transitions

The mortality and fertility transitions together make up the so-called demographic transition. This term describes the historical process whereby fertility and mortality rates declined from the high levels that they exhibited in times past, to the low levels that they exhibit in high-income countries today. Omran described the epidemiologic transition in three well-defined phases: 1) The “age of pestilence and famine;” 2) the “age of receding pandemics;” 3) the “age of degenerative and man-made diseases.” The cause of the rapid increase in life expectancy in this century was a substitution of degenerative causes of death such as heart diseases and cancer for deaths that were previously caused by infectious and parasitic diseases. According to this theory, as nations modernize they tend to improve their social, economic and health conditions. Olshansky and Ault proposed a fourth period, “the age of delayed degenerative diseases”, where the age at which degenerative diseases become lethal is postponed to such an extent that life expectancy is propelled into or even beyond the eighth decade of life.

Health transition is a new term that focuses not just narrowly on death and illness but more broadly on the positive condition of health and well-being, an altogether larger condition than survival or even the absence of ill health. The use of the word “transition” was intended to carry echoes of demographic transition, mortality transition, and epidemiological transition. This term refers also to the determinants of changing health and, in particular, to its cultural, social, and behavioral determinants.

2.3.2 Health Transition in Latin America and other low- and middle-income countries

The older populations of low-income countries are now growing faster than in high-income countries, due to health advances and declining fertility rates. Further, the impact of health interventions in low-income countries has improved child survival, although these children are increasingly exposed to risks associated with chronic diseases and injuries. Latin America and the Caribbean are experiencing demographic and epidemiologic changes typical of societies in transition. These countries are facing the aging of their populations, declining fertility rates, and urbanization phenomena. The infant mortality rate has decreased from 55.3 to 35.5 per 1000 live births, with variations from country to country and within a given country. Nowadays non-communicable diseases account for around two-thirds of the general mortality in Latin America and the Caribbean.

The emergence of new agents, pathogens, and illnesses (HIV/AIDS), the reemergence of tuberculosis, cholera, malaria, dengue fever, among others, and the impact on public health of unintentional and intentional injuries constitute a range of concerns for health authorities of the region and worldwide.

The income distribution in Latin America and the Caribbean is the most inequitable in the world. Furthermore, in countries with high mortality among children and adults, injury represents 10.5 percent of all deaths and 12.8 percent of DALYs. Recent studies have found a strong negative relationship between unintentional injury mortality rates and gross national product (GNP) per capita, except in the poorest countries where the correlation is positive.
2.3.3 Health transition in Nicaragua

The most remarkable achievements are evidenced when comparing the period 1950-55 with the period 1990-1995, with reduction in mortality (22.7 vs. 6.6 per 1000), fertility (7.3 vs. 4.9 per 1000), natality, (54.2 vs. 39.0 per 1000) and infant mortality (131 vs. 48 per 1000). Further, life expectancy at birth increased (from 42.3 to 66.0 years). Peña and colleagues in Nicaragua provided evidence that the decrease in fertility rates was explained by an increase in women’s education, while the decline in infant mortality rates seemed to be the result of increased health care accessibility, especially for mothers with little or no education.


2.4 AVAILABILITY AND VALIDITY OF DATA SOURCES

The availability and reliability of data sources vary within and among countries. In most countries the main sources of injury data are vital statistics, hospital statistics, police records, occupational statistics, insurance statistics, and newspapers.

High-income countries, with high levels of education and advanced communication networks, normally have complete death registration systems. However, in low-income countries, the situation is less documented, and with differences within and between countries. For example, the coverage of vital statistics in Latin America and the Caribbean is 43 percent, like Nicaragua. But some countries in the region have acceptable statistics on causes of death: Argentina, Costa Rica, Chile, Cuba, Uruguay, Mexico, Trinidad and Tobago, and Barbados. The quality of information on causes of death depends on the number of deaths without medical certification, incorrect medical certification, codification bias, high proportion of ill-defined causes, and so on. Although injury mortality is a valuable indicator for action, it represents only a small fraction of injuries, and says little or nothing about the occurrence of nonfatal injuries.

Newspapers have been used as a complementary source for injury surveillance and research in both high- and low-income countries. They are cheap, available, and provide information about the events, but may seriously underreport the number of cases.

Police registers represent a valuable source for traffic- and violence-related injury data, but the ascertainment is biased towards cases of greater severity or costs. In high-income countries, occupational statistics have also proved to be a valuable source for injury surveillance, but low-income countries report only a small proportion of the at-risk population. As a result, caution must be used with regard to the representativeness of these.

Hospital data, including emergency room visits and hospital discharges, have frequently been used as a source of injury morbidity data in high-income countries. Although in low-income countries, some shortcomings concerning coverage, ill-defined catchment areas, lack of trained personnel on codification, injury severity, and so on, are also found, Rahman, found it possible to conduct a hospital-based injury surveillance system in Bangladesh, but proposed including only inpatients on a regular basis, for feasibility and sustainability reasons. Linking data sources may have advantages over the use of a single data set. The capture-recapture method has demonstrated its value for injury research and permits evaluation of existing data sources. Nevertheless, this method depends on the quality of data sources and requires satisfy assumptions, for example, that the study population is closed population, lists
are independent, all members of the population have the same probability of being captured, and all identified elements are members of the population.56-62

Few hospital-based injury surveillance systems in regular operation have been reported in low-income countries, but several epidemiological studies have shown the magnitude of specific injuries or focused generally on the treatment of injuries.63-68 While much is known about the nature of injuries, there is little knowledge about the external causes which would be necessary for prevention purposes. Another limitation is that fatal cases are often not registered because victims die at the scene, limiting the ascertainment of the problem.

Even though traditional health system-based data sources may not by themselves be useful for injury surveillance, several steps can be taken to validate them and to improve their usefulness. For instance, if resources can be allocated for the purpose of estimating the amount of misclassification of cause of death on death certificates, a verbal autopsy study can be conducted to ascertain the cause of death more accurately. Household surveys provide population data that are not generally available from any other source, and could be used to evaluate surveillance systems. However, limitations to this source include costs, recall bias, dependence on proxy respondents, and the inability to ascertain temporal variations.10

2.5 INJURY INDICATORS AND CLASSIFICATIONS

Currently there is a need to obtain information to monitor trends in injury events, identify emerging health and safety issues, and determine the costs of injury to society. However, this effort requires valid injury indicators. Therefore, in answer to this demand, specialized teams in the injury field make efforts towards developing more useful and valid injury indicators.73-78

Indicators are statistics designed to measure public health problems, or problems of specific injuries. Their aim is not to describe a situation but to alert and warn of the direction of change. They are a means for making comparisons, for example, between two points in time. Thus, statistics with no counterparts in another timeframe are not indicators because they cannot be used to make a comparison over time. Some purposes of indicators include helping to establish goals and priorities, providing information on areas of interest, identifying problems, and predicting effects of initiatives.73

There are several definitions of “injury indicators”. For the National Center for Injury Prevention and Control at Centers for Disease Control, CDC, an injury indicator describes a health outcome of an injury, such as hospitalization or death, or a factor known to be associated with an injury, such as risk or protective factor among a specified population.74 At the International Collaborative Effort on Injury Statistics, Cryer proposed that an injury indicator is a summary measure that denotes or reflects, directly or indirectly, variations and trends in injuries, or injury related or injury control-related phenomena.79

The International Collaborative Effort (ICE) on Injury Statistics was formed in 1994, and its mission is to improve international comparability and quality of data to better assess the causes and consequences of injury, differences in injury occurrence over time and place, and the most effective means of prevention and control. Injury ICE participants are an active international network of specialists in the injury field for addressing issues related to injury and its measurement. A goal of this project is to identify reliable and valid indicators relevant to injury prevention aimed at target monitoring, surveillance, priority setting, evaluation, and international information exchange.79 Standardized methods of classification and quantifying injuries in terms of mortality, economic costs caused by the casualty, morbidity (impairment and disability) as well as quality of life afterwards are fundamental to the objective assessment of the societal impact of the burden of injury. The use of internationally accepted definitions...
and classification systems for injuries seems important not only in the field of research but also in terms of policy, public health, and legal issues.

The WHO Family of International Classifications provides a valuable tool to describe and compare the health of population in an international context. The information on diseases/injuries provided by the International Classification of Diseases (ICD-10)\(^{80}\) and on health outcomes provided by the International Classification of Impairments, Disabilities, and Handicaps (ICIDH-2)\(^{81}\) may combine in summary measures of population health for monitoring the health of populations and their distribution, and assessing contributions of different causes. A newly adopted classification, the International Classification of External Causes of Injury (ICECI),\(^{82}\) was developed to produce an internationally accepted, multi-axial, modular, and hierarchical system to enable classification of external causes of injury, primarily to support injury prevention.

The fact that the ICD-9\(^{83}\) was limited in its ability to describe important circumstances surrounding injuries contributed to the development in the Nordic countries of the Nomesclo Classification for Accident Monitoring (NOMESCO).\(^{84}\) Improvements in ICD-10 have overcome many of the limitations of ICD-9 with regard to injury surveillance.\(^{33}\)

In low-income countries, the severity level of injuries is increasingly being quantified by the use of measures such as the Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), and most recently, the New Injury Severity Score (NISS). Other important classifications of the consequences of injury most frequently mentioned in the literature are related to injury costs and quality of life.\(^{33,85,86}\)

Although injury indicators are not free from being debated,\(^{87-91}\) members of the ICE continue working towards the development of a tool for assessing the validity of injury outcome indicators because not only the choice of indicator is important, but also the choice of valid indicators.\(^{92}\)

### 2.6 INJURY RESEARCH IN HIGH- AND LOW-INCOME COUNTRIES

Descriptive injury research experiences vary in methodology, scope, and purposes. Some theses produced in high-income countries have been written to determine the magnitude of all injuries in specific age groups, or specific types of injuries such as traffic and suicide.\(^{93-96}\) Others have utilized epidemiological data from community-based studies in order to develop intervention programs and injury control.\(^{97-102}\) Two monographs written by Laflamme and Engström focused on social inequality in injury risk and violence.\(^{103,104}\)

In Bangladesh, Rahman measured the magnitude of intentional and unintentional injuries through different injury research approaches. After comparing different sources of data, he found that police records were a potential source for injury mortality but not for morbidity, while hospital data were a reliable source of information about morbidity but suffer from lack of representativeness. Newspapers and police records provided more information useful for prevention than postmortem reports. A household survey showed that most injuries were minor and the main places of occurrence were the home and workplace. The incidence rate was 311 per 1,000 and the mortality rate was 24 per 100,000. The leading causes of injury were cuts, being hit by objects, falls and burns. The verbal autopsy method was used, and injury accounted for 2.9 percent of all mortality. The main causes were drowning and homicide. Severity was associated with seeking hospital treatment, but 61 percent of fatalities were not directly preceded by any hospital care. Further, hospital injury surveillance reported that the leading causes were violence, traffic, falls, and poisoning. The incidence rate of admission was 269/100,000. The case fatality ratio of inpatients was 1.1 percent.\(^{105}\)
Hang and her colleagues in Vietnam carried out a comprehensive population-based study focused on unintentional injuries in a rural community in Vietnam.\textsuperscript{106} They found an incidence rate of 89 per 1,000 per year, with high incidence in older people and males. Severity was associated with care-seeking behaviour. They also found significant seasonal variations in injury incidence, which may cause invalid assessment of injury issues if only one cross-sectional household survey is used, demonstrating the need for longitudinal approaches to injury incidence research. Poverty was associated with unintentional injury morbidity, but the relationship varied by sex, age, and type of injury. Poverty was a risk for home, work, and other injuries, while the risk of traffic injuries was not affected. The measure of severity was based on temporary disability and perception of the victim. Ninety percent of the economic burden of injury fell on households, eight percent on government and two percent on health insurance agencies. Self-treatment was the most common way of treating injuries (52%), even in some cases of severe injury. There was a low rate of use of public health services among injury patients, similar to private healthcare. The highest unit cost was related to traffic injuries. Houng\textsuperscript{107} applied verbal autopsy in the same catchment area, and she found that the leading causes of death were cardiovascular (20.6%), infectious (17.9%), accidents (13.8%), and neoplasm (13.2%). Drowning was prevalent in children under 15.

In Tanzania, the injury research work performed by Moshiro\textsuperscript{108} was based on a large population-based study focused on fatal and nonfatal injuries in rural and urban areas. Verbal autopsies revealed that injury deaths accounted for five to eight percent of all deaths, of which 74 percent were unintentional and 26 percent intentional. The leading causes were traffic, animal attacks, violence and suicide, and drowning. Concerning non-fatal injuries, the incidence rates for one month and one year recall periods were 72 and 32.7 per 1000 person-years, respectively, which revealed that long recall periods are more likely to affect non-severe injuries. Restricted activity was considered a proxy of severity. The ranking order of the three leading causes in urban areas was traffic, falls, and cuts/stabs, but in rural the rank order was the opposite. The proportions of violence-related injuries in urban and rural areas were 3.4 percent and 0.9 percent, respectively. Poverty was not associated with experiencing non-fatal injury.

In Karachi, Pakistan, Razzak found that ambulance records for road traffic injuries provided better information about the burden of injuries than did hospital or medical examiner reports. He applied the capture-recapture method to estimate the magnitude of fatal and nonfatal road traffic accidents.\textsuperscript{109}

### 2.7 INJURY-RELATED RESEARCH IN NICARAGUA

During the 1990s, PLAGSALUD, a program funded by the Danish government and run by the Pan American Health Organization (PAHO), supported pesticide poisoning surveillance systems in Central America. In Nicaragua, a census-based sample of 3,196 interviews showed that only six percent of the poisoning attended in public health centers appeared in the official statistics.\textsuperscript{110}

In Nicaragua, several dissertations have reported the impact of injuries from different perspectives. Ellsberg (2000)\textsuperscript{111} studied the magnitude and severity of domestic violence against women and presented evidence to develop health policy and laws to provide protection for these victims. Additionally, Valladares (2005)\textsuperscript{112} described the effect of partner violence during pregnancy, and she found that the ratio of sexual, physical, and emotional abuse was 1:2:5. Consequently, the child outcomes were low birth weight and small size for gestational age, which were associated to increased levels of cortisol due to violence exposure. The effects in the mother were emotional distress, suicide attempts, and low social resources. Caldera
studied mental disorders related to war and natural disasters, as well as the pattern of suicide based on a hospital data. Aragón (2005) described risk factors and reasons for dangerous practices and evaluated the dermal exposure among Nicaraguan subsistence farmers. Furthermore, she proposed suitable methods for low-income countries.

2.8 PROBLEM STATEMENT

The magnitude of injury as a global public health problem is increasingly being recognized, which disproportionately affects low-income countries.\textsuperscript{1,2,3,14,33,115} In these countries, however, injury statistics, if available at all, are based mainly on mortality data and provide little or no knowledge about the injury spectrum and related information needed for prevention.\textsuperscript{33} In addition, little is known about the validity of data sources and injury indicators.\textsuperscript{73-76}

This lack of knowledge about the magnitude and patterns of injury in a typical low-income setting, as well as about the validity of various data sources and methods available, is addressed in this thesis. Hopefully, guidance will be provided for future research on possible approaches for gaining an overview of the injury situation, thus assisting decision makers in the allocation of scarce resources for injury prevention and control.
3. **Aims and objectives of the thesis**

3.1 **MAIN AIM**

The main aim is to assess the magnitude and pattern of injury in Nicaragua, through different injury research approaches, as well as to discuss their rationales, potentials and limitations, in order to provide evidence for prevention.

3.2 **SPECIFIC OBJECTIVES WERE:**

- To compare the existing nationwide data sources on the occurrence of injuries with respect to validity and relevance for prevention (paper 1).
- To describe the epidemiology of injuries in a local community based on data obtained from a hospital-based injury surveillance system (paper 2).
- To ascertain the incidence of traffic-related injuries using the capture-recapture method, and to compare results using this method when data at different levels of severity are used (paper 3).
- To describe the epidemiological magnitude and injury severity in León municipality using a household-based survey design (paper 4).
- To measure the overall mortality and the burden of injuries in the municipality of León, as well as their causes and patterns (paper 5)
- To discuss the rationales, potentials, and limitations of different injury research approaches, reported in this thesis, in order to provide evidence for prevention (Discussion).
4. Materials and methods

4.1 SETTING DESCRIPTION

Nicaragua is a small country located in the middle of Central America, with coastlines on both the Pacific Ocean and the Caribbean, with an area of 130,000 square kilometers and a population of 5.4 million inhabitants (2004). The population density is 42 inhabitants per square kilometer. Sixty percent of the population lives in urban areas. The annual population growth is 2.4 percent. Nicaragua is currently in a transitional period. Poverty, illiteracy and health problems are increasing, while cuts are being made in the budgets for health and social affairs. León province is situated in the northwestern part of Nicaragua, about 93 kilometers from the capital of Managua, and comprises ten municipalities with a total population of 389,628 inhabitants.\(^{116}\)
In the aftermath of eleven years of civil war, the economy is still struggling. Coffee and bananas are the main export crops. As a product of the war, natural disasters, depreciation of its export products, and political and economic uncertainty, Nicaragua is among the group of highly indebted poor countries, occupying the penultimate place in the Americas, being surpassed only by Haiti.

The municipality of León (sharing the same name as the province), is the second largest urban center of Nicaragua, with a population of 157,149 inhabitants. The population density of 69 inhabitants per square kilometer (for the city) is higher than the national average. For the period 1990-1995, the gender distribution was 50.6 percent women and 49.4 percent men; 47 percent of the population was below 15 years of age. The life expectancy for the same period was calculated at 64.8 years for both sexes. The illiteracy rate was 22.8 percent for the entire county.\textsuperscript{116}

Nationally, health care is organized in SILAIS (Integrated Local Health System),\textsuperscript{117} which is found in all provinces and is divided into two levels: 1) primary health care (health centers and health posts) and 2) secondary health care, within which services are mainly provided by hospitals. In León municipality, there is only one general hospital, which is a teaching hospital named Hospital Escuela Dr. Oscar Danilo Rosales Argüello (HEODRA).

### 4.2 STUDY PERIOD AND REFERENCE POPULATION

For **Paper I**: All injury-related cases reported in four national data sources (newspapers, health statistics, occupational injury statistics, and traffic police records) were studied. However, due to availability of data sources, two of them (health and police statistics) were divided into two one-year periods, 1989 and 1991. Population data were based on national census.

For **Paper II**: The experiences reported in this paper were carried out from April 1992 to March 1993. All fatal and non-fatal injury cases in different age groups in León municipality, which were registered at the emergency room were included in this study. The estimated population was 157,149 inhabitants.\textsuperscript{116}

For **Paper III**: This study was carried out in the same catchment area where the hospital-based injury surveillance system was conducted from January to December 1993. The estimated population was approximately 160,530 inhabitants (1993).

For **Papers IV and V**: A household-based survey was conducted from March to May 1995 in León municipality. The sample size was calculated using an incidence of injury of any severity of 50 percent, with a precision of 0.5 percent. A randomized cluster sampling method was used and the design effect considered was two. The resulting sample size required was 62,068 inhabitants, with the final study sample being 63,886 inhabitants (53,183 urban and 10,703 rural inhabitants). Households were the basic sampling units with all individuals in each sampled household being included. In total, 10,797 households were surveyed (9,150 lived in urban areas and 1,647 in rural). The denominator used to estimate incidence rates was based on the census carried out as part of the survey.
4.3 CASE DEFINITIONS AND STUDY DESIGN

Injury is usually defined as follows: “Injuries are caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance. In some cases (for example, drowning and frostbite), injuries result from the sudden lack of essential agents such as oxygen or heat”. 14

In addition to the previous conceptual definition, injuries are also divided into two categories: unintentional injuries (accidental) and intentional injuries that are results from deliberate acts of violence against oneself or others.

The operational definition of injury were:

In Paper I, injury was defined as a sudden series of occurrences in interplay between individual, object, and environment that resulted in personal injury that could be intentional or unintentional, and which was registered in different data sources. The validity was estimated by comparing these sources. Injury Severity was based on a broad description of fatal and non-fatal cases. To assess the prevention relevance, their content was assessed using the pre-event periods of Haddon’s Matrix. 85 The design can be described as explorative.

In Paper II, cases were defined as all individuals who received care in the emergency department (ED) of HEODRA for injuries. Injuries due to complications from surgical or medical therapy (N996-N999) and the late effects of accidental injury (E929) were excluded. All other injuries and poisoning in chapter XVII of the International Classification of Disease
(ICD-9)$^{83}$ were included. Severity was based on the level of treatment: fatal, inpatient, and outpatient. The design was based on a cross-sectional study.

In **Paper III**, cases attended to in emergency rooms or hospitalized for diagnoses within the codes ranging from E800-E819 to E826-E829 as well as cases reported by traffic police during 1993 were included. Only injuries among León municipality residents were recorded. The type of road user was coded on traffic police forms and could also be discerned from the fourth-digit of the code for external cause in hospital database. The classification of N-codes and E-codes was based on the ICD-9.$^{83}$ The severity of cases was based on the Abbreviated Injury Scale (AIS) (Association for the Advancement of Automotive Medicine, 1990).$^{118}$ The design was based on the capture-recapture model.$^{56}$

In **Paper IV and V**, injury cases were defined as all intentional or unintentional injuries during the six weeks preceding the survey, affecting any member of the household, classified according to ICD-9.$^{83}$ Impairments and severity were assessed by the International Classification of Impairments, Disabilities and Handicap,$^{119}$ and the Abbreviated Injury Scale (AIS), respectively.$^{118}$ Paper IV also included disability- and death-related injuries registered during the recall period of six weeks. Paper V included all deaths and only permanent disability-related injuries registered during a five year recall period. The design was based on a household survey.

### 4.4 STATISTICAL METHODS AND INJURY INDICATORS

In **Paper I**, a simple comparison (absolute and relative) of injuries among different sources of data was conducted to validate them. Case-fatality ratios and mortality rates were estimated.

In **Paper II**, cumulative incidence rates and 95 percent confidence interval (CI) were calculated based on the number of outpatients and inpatients injured as the numerator, divided by the population of León municipality.$^{120}$

In **Paper III** the ascertainment of the number of fatal and nonfatal traffic-related injuries, including missing cases, were derived using the simplest form of a two-sample capture-recapture model.$^{56,59,60}$ Thus, injury rates and CI were calculated using the estimated number of cases (n) as numerator and the population of Leon as denominator.

In **Paper IV**, both incidence and mortality rates (per 1000 and per 100 000 inhabitants per year) and CI were calculated. The numerator (the estimated annual number of cases) was obtained by dividing the numbers of cases by recall days and multiplying the quotient by 365.25. The ascertainment of severity was based on the AIS and the level of treatment. The denominators were based on a parallel census carried out during the survey.

In **Paper V**, mortality indicators used were death rates and years of potential life lost (YPLL). The estimated annual death rate and the incidence of impairment were obtained by dividing the average number of deaths or impairments registered during the study period by the sample. Other indicators used to measure the burden of injuries were the years lived with disabilities (YLD) and disability adjusted life years (DALY).$^{5}$ Rates and 95 percent confidence intervals were also calculated. The YLD and YPLL were defined as the number of year between the age of disability or death, and age 65. DALYs were calculated as the sum of YPLL and YLD.

The software used in all five papers was Epi info version 6.04 (Centers for Disease Control and Prevention, Atlanta, Ga).$^{121}$ Table 2 shows a summary of indicators.
4.5 ETHICAL CONSIDERATIONS

The research project was reviewed and approved by the Ethics Committee on Biomedical Research from the National Autonomous University in León, Nicaragua. Access to injury data sources was obtained through previous consent of the authorities. During the fieldwork each interview was initiated after the verbal consent of the interviewee.

Table 2 Quantitative measures of the burden of injury in Leon, Nicaragua.

<table>
<thead>
<tr>
<th>Injury outcome</th>
<th>Type of measure</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>Number of deaths</td>
<td>Deaths</td>
</tr>
<tr>
<td></td>
<td>Proportionate mortality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case-fatality ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Death rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YPLL</td>
<td>Deaths before 65</td>
</tr>
<tr>
<td>Morbidity</td>
<td>Outpatients</td>
<td>Fatal and non-fatal injury</td>
</tr>
<tr>
<td></td>
<td>Inpatients</td>
<td>Permanent injury-related disabilities before 65</td>
</tr>
<tr>
<td></td>
<td>Incidence rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Years lived with disability</td>
<td></td>
</tr>
<tr>
<td>Morbidity and mortality-related</td>
<td>DALYs</td>
<td>Injury deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent injury-related disabilities before 65</td>
</tr>
</tbody>
</table>

14
5. Results

The main results presented here provide answers to the research questions presented in table 3:

Table 3 Research questions for each paper.

<table>
<thead>
<tr>
<th>Papers</th>
<th>Research questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Is it possible to obtain a valid picture from current sources of injury data?</td>
</tr>
<tr>
<td>II</td>
<td>How can an injury surveillance system be developed under prevailing conditions in a low-income country?</td>
</tr>
<tr>
<td></td>
<td>What is the magnitude of injuries obtained from a hospital-based injury surveillance system?</td>
</tr>
<tr>
<td>III</td>
<td>What is the magnitude and pattern of traffic injuries obtained from a capture-recapture analysis?</td>
</tr>
<tr>
<td>IV</td>
<td>What is the magnitude and pattern of injuries obtained from a household-based survey?</td>
</tr>
<tr>
<td>V</td>
<td>How can the burden of injuries be measured in a population-based study?</td>
</tr>
</tbody>
</table>

5.1 PAPER I

In 1989, the Ministry of Health (MoH) reported 1,651 injury deaths (intentional and unintentional) in all age groups, while newspapers reported only 489 fatal injuries and 954 nonfatal ones. The injury mortality rate reported in health statistics was more than three times higher than in newspapers (44.1 vs. 13.1 per 100,000 inhabitants). In both data sources, the ranking order of the leading causes of death was similar: violence, traffic, war, suicide and drowning/foreign body, respectively. Nevertheless, traffic- and war-related deaths were over-reported by newspapers, but falls were severely under-reported. Non-fatal cases could not be compared since health statistics reported only the nature of injury and not their external causes.

In the same year the Nicaraguan Institute of Safety and Welfare reported 5,081 non-fatal occupational injuries and 66 fatalities (Case-fatality ratio was 1.3 percent). When compared to the number of non-fatal injuries reported in newspapers, the incidence of occupational injuries was almost four times higher in occupational statistics. This demonstrated also a serious lack of validity in newspapers with regard to morbidity.

In 1991, the National Department of Traffic Police reported 2,128 traffic-related injuries, of which 390 died (Case-fatality ratio 22.4 percent). This number of deaths was 26 percent higher than cases reported by the MoH.

Although the validity of the MoH to ascertain all fatal injuries was better than newspaper clippings, it does not help to ascertain specific injuries, such as traffic and occupational. In the case of the former type of injury, police records are a more valid data source, while for the latter occupational statistics function better.
It was found that police records and occupational statistics provided better quality of information concerning the circumstances of injury occurrence than the other sources. In addition, they were more reliable and valid for measurement of the burden of injury mortality due to traffic and occupational injuries.

5.2 PAPER II

Results from paper 1 resulted in the establishment of an injury surveillance system (ISS) in the emergency department of the only general hospital in the municipality of León, Nicaragua. During the first year of operation, around 16 percent of emergency department visits (n=9,970) concerned injuries. For every death due to injuries, 31 inpatients and 253 outpatients were reported. The main types of injuries were wounds, fractures, contusions, and intracranial injuries, respectively. The leading causes of fatal injuries were traffic, intentional injuries and falls, respectively, whereas non-fatal injuries were dominated by causes such as falls, traffic, cuts, intentional, striking/being stuck, and bites/stings. Home and streets were the main arenas where injuries occurred.

The overall incidence and mortality rates were 56.2 per 1,000 and 20.0 per 100,000, respectively. Mortality in men was three times higher than in women, and the incidence was higher in men in all age groups, except among patients aged 65 and older. About one quarter of all fatalities occurred among children. In 20.3 percent of the cases, no E-code was assigned.

Intentional injuries (violence and self-inflicted) were responsible for 23 percent of deaths and 7 percent of non-fatal outcomes. Traffic-related injuries ranked first and second in fatal and non-fatal outcomes, while falls ranked the opposite.

Causes with higher proportions of hospitalization were burns, poisoning, intentional injuries, and traffic. Although the proportion of hospitalization by falls was low, in absolute terms falls represented one-third of all patients hospitalized from injuries. The median length of stay was four days, varying with the type of injury; for example, suicide attempts (8), traffic (6), violence (5), and falls (3). The most vulnerable road users were cyclists and pedestrians. Firearms were the main mechanism of homicide, while in suicide it was poisoning by pesticide.

Eighteen out of 24 amputations were due to firecracker-related injuries, of which only half required hospitalization. (This reveals that hospital studies that included only inpatients may miss an important proportion of disabilities)

This surveillance system coincided with two natural disasters (volcanic eruption in April 1992 and tsunami in September 1992), providing information for the prevention of severe and fatal post-volcanic and post-seismic injuries. For example, four out of seven fatalities by falls were due to falls through or from roofs when ash was being removed from roofs following the volcanic eruption.

5.3 PAPER III

A comparison was made of the most reliable data sources for monitoring traffic-related injuries: Hospital data (inpatient and outpatient) and traffic police records. Characteristics available for matching included name, age, sex, and date of occurrence. The methodology of capture-recapture was used to estimate the ascertainment degree of both data sources, as well as mortality and incidence rates.

The estimations varied according to the type of hospital users included. When estimates included police records coupled with both inpatient and outpatient records, the death and
incidence rates were 35.5 per 100,000 and 43.7 per 1,000 per year, respectively. However, when outpatients were excluded from the analysis, the corresponding estimates declined to 28.6 per 100,000 and 7.5 per 1,000, respectively. When both inpatients and outpatients were included, then ascertainment-corrected coverage of non-fatal cases through police and hospital records was 2.6 percent and 19.0 percent, respectively, and in fatal cases the corresponding figures were 56.1 percent and 22.8 percent.

The pattern of injury varied by source and injury outcomes. Traffic police data disproportionately over-reported adults and motorized road users, whereas hospital data reported more children and non-motorized road users. Record linkage revealed that most fatal and nonfatal cases occurred among young males, pedestrians, and cyclists. The main types of injuries were wounds, fractures, and contusions. Head injuries were involved in one tenth of nonfatal cases and two-thirds of fatalities.

According to the Abbreviated Injury Scale (AIS) score, 64 percent of cases were classified as minor injuries and 18 percent as moderate/severe. Unexpectedly, there was no relationship found between the status of hospital care and severity. For example, 18 percent of outpatients were classified as moderate/severe, whereas 21 percent of inpatients had minor injuries. In relative terms, if outpatients are excluded from the analysis, underreporting may affect around four-fifths of moderate and two-thirds of severe cases.

In summary, our findings suggest that neither police statistics nor hospital data, or the corresponding record linkage, provide acceptable coverage of traffic-related injuries in Nicaragua. Therefore, a better approach to represent the magnitude of traffic-related injuries is the capture-recapture method, with the inclusion of both outpatients and inpatients among the hospital records examined.

5.4 PAPER IV

The sample provided information from 10,797 households (63,886 inhabitants), of which 0.9 percent were non-participants. During the six-week recall period, 3,045 injuries were registered involving 2,901 individuals, of which 4.6 percent were repeaters. In total seven impairments- and eight death-related injuries were reported. According to the AIS score, 93 percent were classified as minor injuries and 7 percent as moderate or severe. However, after triangulation between severity by AIS and the level of treatment, minor, moderate and severe injuries were found to have sought medical treatment (hospital or other medical care) for 9.9 percent, 35.4 percent and 87.5 percent, respectively. The leading causes of minor injuries that led to medical treatment were wounds, contusions, burns, fractures/dislocations and intracranial injuries. On the other hand, cases without AIS scores such as poisoning and near drowning/suffocation led to medical care in 89 percent and 50 percent of the cases, respectively. If minor cases that led to medical care are added to those with an AIS score ≥2 then the incidence rate doubles.

The overall incidence rate of injuries was 414.2 per 1,000 (95% CI: 410.4-418.0), but when minor injuries were excluded, the incidence rate of moderate/severe cases dropped to 27.6 per 1,000 (95% CI: 26.4-29.2). Injury mortality and impairment rates were 108.9 (95% CI: 71.4-119.2) and 95.3 (95% CI: 83.3-134.4) per 100,000 inhabitants, respectively. The case fatality ratio was 3.9 percent (AIS ≥2). Home and traffic arenas were the main sites of occurrence. Most affected groups were older people, children, and males. No differences were found according to residence area.

Only 9 percent of cases led to hospital care, which was influenced by the degree of their severity. The leading causes of nonfatal cases were falls, traffic, and cuts, whereas fatal outcomes were due to intentional injuries. For every death due to injury, there was one disability, 25 moderate/severe injuries and 354 minor injuries.
During the study period, 1,130 deaths were identified through the survey. The average annual death rate was 354 per 100,000 inhabitants per year (95% CI: 308-400). Non-communicable diseases had the highest mortality rate (176 per 100,000), followed by communicable diseases and injuries with 55 per 100,000 each. The mortality for communicable diseases was higher in rural areas, but non-communicable disease and injury were higher in urban areas. The burden of mortality according to age varied within causes. Almost half of communicable diseases occurred among children less than one year, while more than half of non-communicable diseases occurred among those older than 65, and around three-fourths of all injuries occurred among children and younger adults under the age of 40. Mortality in men was higher than in women, but the largest gender difference was observed for injuries.

The ranking order of mortality varied by indicators. Thus, non-communicable disease ranked first (62%) based on the number of deaths, but ranked third (29%) based on YPLL, surpassed markedly by communicable disease (41%) and slightly by injury (30%). Among women, the proportion of death and YPLL by communicable and non-communicable diseases was higher than in men, while it was the opposite for injuries.

Among children under one year, injuries ranked second, after perinatal conditions, accounting for 11 percent of deaths, most due to falls, poisoning and suffocation. For people aged 1-64, injury was the leading cause of death and accounted for 27 percent of deaths, with the main causes being traffic, violence, and drowning, respectively. In older people, injury accounted for only 3 percent.

In the same study period, 238 impairment-related injuries were reported, with an incidence rate of 75 per 100,000 inhabitants per year (95% CI: 53-96). Boys and male adults from urban areas sustained the most impairment from injuries. The main disabilities were skeletal, disfiguring, and blindness. The leading causes were falls, traffic, and violence. Around three-quarters of these persons sought medical treatment at the hospital.

When injury deaths were analyzed by intent and mechanism, firearms and cutting/piercing instruments were the main mechanisms of homicide, whereas in suicide the main mechanisms were suffocation, firearms, and poisoning. The average annual death rates from unintentional injuries, homicide and suicide were 44, 8 and 3 per 100,000, respectively.

The leading causes of the burden of injury were unintentional 80 percent, violence 14 percent, and suicide 6 percent. The leading causes of injury death and YPLL were traffic, drowning/suffocation, and intentional injuries. Falls, traffic and violence were responsible for nearly two-thirds of YLD and DALYs. Children and young people sustained 65 percent of injury-related DALYs under 20 years. The male-female ratio of DALYs in children and the older people was 2:1, but in young adults, it was 4:1. The total number of calculated YLD was approximately 30 percent higher than the number of YPLL.
6. Discussion

The main aim of this thesis was to assess the magnitude and pattern of injury in a defined Nicaraguan population, through different injury surveillance and research approaches, as well as to discuss their rationales, potentials, and limitations, in order to provide evidence for prevention. Several sources have been used and methodologies applied and evaluated, and they all produced different results. Below follows a discussion on the principal findings regarding injury mortality and morbidity in terms of magnitudes and patterns, in light of parallel results from other relevant studies. An attempt to compare the different results within the injury pyramid framework is also made, as well as to discuss other more practical strengths and weaknesses of the various sources and methodologies applied, for use in public health surveillance and planning.

6.1 INJURY MORTALITY

Discrepancies in magnitude and ranking order of injury deaths were found when using different injury research methods (Table 4). First, almost half of all injury deaths reported by the MoH, in study 1, were due to traffic, violence and suicide, similar to figures reported by the WHO. On the contrary, falls, poisoning, and drowning/suffocation were under-represented, but not in hospital- or population-based data. The proportion of these causes reported by hospital data (Study 2) and household survey (Study 5) was higher. All injury death rates reported through the household survey were higher than hospital data and higher than national estimates from the MoH, with the exception of bites/stings in the former and violence in the latter. This finding demonstrates the low validity of health statistics and hospital data, compared to population-based data. However, the higher rates in traffic, and lower in violence, obtained by the household survey may be explained by both sociopolitical changes in Nicaragua and by methodological issues. The former because the U.S. economic embargo against Nicaragua was withdrawn in 1989, generating an increase in commercial relations and a growth of the vehicle fleet, as well as the government policy to reduce firearms in the hands of the population. Methodological explanations relate to the use of different research methods, settings (national vs. local), and to the time of investigation (secular trends may cause transitions in risk patterns). Mortality data issued by the MoH is based on vital statistics which are marred by severe underreporting of deaths (57%). This not only leads to underestimated death rates, but also to biased distribution of injury deaths in terms of magnitude and patterns across different regions, especially between urban and rural areas.

When comparing the case fatality ratio (CFR) between the hospital and community studies (Table 5), the former was found to be higher for traffic, falls, and bite/stings, while the latter was higher for violence, poisoning, drowning and suicide. This can be due to several possible explanations. For example, underreporting of suicide attempts in the community, coupled with underreporting of suicides at hospitals may explain the large suicide-related CFR differences. Similarly, most cases of drowning and near-drowning are not registered at the hospital, which make hospital-based data less reliable with regard to the drowning problem. Although methodological issues may hamper the comparability of the magnitude of CFR between both studies, it is noteworthy that the rank of causes showed some similarities between both studies. Suicide and poisoning were found to be the most lethal categories.

The pattern of the overall mortality reported in papers 2 and 5 also showed similarities. The death rate was higher in older age groups and males, and differences between urban and rural areas were insignificant. Around three-quarters died before age 45. In both studies, traffic accidents were the leading cause of death affecting mainly adult men, and the most vulnerable
road users were cyclists and pedestrians. Similar results were found in study 3. Other important causes of death, as found in study 5, include intentional injuries, drowning, falls, and poisoning. Falls emerged as the leading cause of premature death followed by traffic, accounting for two-thirds of YPLL.

The proportion of injury death (15.5%) found in study 5 was higher than those reported in Vietnam and by Rahman in Bangladesh, but lower than in Uganda. Premature death in León was the double than the rate found in Vietnam.

Table 4 Injury death rate (/100,000/year) by causes and injury data source in Nicaragua.

<table>
<thead>
<tr>
<th>External Causes</th>
<th>Paper I</th>
<th>Paper II</th>
<th>Paper III</th>
<th>Paper V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic</td>
<td>9.7</td>
<td>7.6</td>
<td>35.5</td>
<td>13.1</td>
</tr>
<tr>
<td>Drowning/foreign body</td>
<td>1.8</td>
<td></td>
<td></td>
<td>10.3</td>
</tr>
<tr>
<td>Violence</td>
<td>13.3</td>
<td>2.5</td>
<td></td>
<td>7.8</td>
</tr>
<tr>
<td>Fall</td>
<td>1.0</td>
<td>4.4</td>
<td></td>
<td>5.9</td>
</tr>
<tr>
<td>Poisoning</td>
<td>0.6</td>
<td>1.3</td>
<td></td>
<td>5.9</td>
</tr>
<tr>
<td>Suicide</td>
<td>2.8</td>
<td>1.9</td>
<td></td>
<td>3.4</td>
</tr>
<tr>
<td>War</td>
<td>3.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bites/stings</td>
<td></td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>11.8</td>
<td>1.3</td>
<td></td>
<td>8.1</td>
</tr>
<tr>
<td>All injuries</td>
<td>42.6</td>
<td>19.7</td>
<td>54.8</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 Case-fatality ratio (percent) in León municipality, Nicaragua.

<table>
<thead>
<tr>
<th>External Causes</th>
<th>Hospital-based data (Inpatient and outpatient)</th>
<th>Population-based data (All severities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suicide</td>
<td>4.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Poisoning</td>
<td>3.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Drowning/foreign body</td>
<td>0.0</td>
<td>6.2</td>
</tr>
<tr>
<td>Violence</td>
<td>0.7</td>
<td>2.6</td>
</tr>
<tr>
<td>Traffic</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Fall</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Bites/stings</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Others</td>
<td>0.06</td>
<td>0.0</td>
</tr>
<tr>
<td>All injuries</td>
<td>0.35</td>
<td>0.26</td>
</tr>
</tbody>
</table>
6.2 INJURY MORBIDITY

The difference in incidence reported in study 2 and 4 is mainly explained by inclusion criteria, since the former study included all cases regardless of severity while the latter excluded minor injuries. The incidence rates obtained are also influenced by different data collection systems (hospital registration vs. household survey). Nevertheless, table 6 shows that the leading causes of incidence and disability are similar and follow the same rank, both in hospital and population-based data. The three leading causes of morbidity - fall, traffic and violence - are also important causes of death, disability and DALYs. The most vulnerable groups were males and older people. These findings are consistent with those reported in Uganda \textsuperscript{123} and developed countries.

Injuries from cuts were the second most common cause of moderate and severe injuries, which is similar to results in studies from Bangladesh, \textsuperscript{55} Uganda, \textsuperscript{123} Ghana, \textsuperscript{124} Tanzania \textsuperscript{108} and Vietnam. \textsuperscript{106}

Important urban-rural discrepancies were observed. Most traffic accidents occur in urban areas, affecting mainly pedestrians, passengers and cyclists, which is consistent with other studies in similar settings. \textsuperscript{33,55,108} Although the incidence of falls in the elderly from urban and rural areas was similar, fracture of lower limbs were found only in urban women, which could be due to the protective effect of physical activity in people from rural areas. In rural areas poisoning prevailed among adults due to exposure during agricultural activities, which is common in low income countries. \textsuperscript{33}

Injury-related disabilities were not compared with other causes due to the complicated task of measuring disease-related disability. Thus, only permanent injury-related disabilities were included in the attempt to obtain more reliable information about their nature and causes, which may be in turn be used to measure incidence and to develop prevention policies and rehabilitation needs. Further, the measurement of disability was incidence-based instead of prevalence-based, which can help to make projections regarding disability. International comparisons are difficult, due to the lack of standardized methods. Nevertheless, in Pakistan, injuries rank second in disability, eleventh in premature death, and fifth in loss of healthy life-years. \textsuperscript{125}

The low coverage of hospital data suggests that incidence rates are underestimated, especially for minor and fatal injuries. Similarly, the magnitude of permanent disability was underestimated because only immediate disabilities such as amputations were included. Permanent disabilities which emerge in a longer perspective after treatment is received are not reported by the hospital but were captured by the household survey.
Table 6 Incidence rate (/1,000/year) of injury by causes and injury data source in León, Nicaragua.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>16.1</td>
<td>11.6</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic</td>
<td>5.3</td>
<td>8.2</td>
<td>43.7</td>
<td>4.9</td>
<td>0.24</td>
</tr>
<tr>
<td>Striking\struck\caught</td>
<td>3.3</td>
<td></td>
<td>2.4</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Violence</td>
<td>3.4</td>
<td></td>
<td>0.4</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Cuts</td>
<td>3.7</td>
<td></td>
<td>6.9</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Bites/stings</td>
<td>2.6</td>
<td></td>
<td>1.9</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Drowning/foreign body</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poisoning</td>
<td>1.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suicide</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td>0.3</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>All injuries</td>
<td>56.2</td>
<td>27.6</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.3 STRUCTURE OF THE INJURY PYRAMID BY LEVEL OF TREATMENT AND SEVERITY

After the first year of operation of the hospital-based injury surveillance system in León two approaches were used to evaluate the completeness of its coverage. First, a household survey revealed that the overall coverage of all injuries through the hospital surveillance was only nine percent, but increasing severity increased the likelihood of capturing cases (Table 7). These findings suggest that the seeking of medical care or hospital attention is a reasonable proxy of severity. As a result, hospital-based surveillance is a fairly representative source to ascertain the more severe injuries sustained by the population. However, this measure may also be affected by the access to health facilities and socio-economic factors, which has been observed in other studies in both low- and high-income countries. Some limitations that may hamper the comparison between both approaches include different study periods and the fact that surveys are one-time events.
Table 7 Percentage distribution of medical help seeking patterns of injury by severity in Leon municipality, Nicaragua.

<table>
<thead>
<tr>
<th>Injury spectrum</th>
<th>Hospital</th>
<th>Other medical treatment</th>
<th>Without medical treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor (n=2832)*</td>
<td>7</td>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>Moderate/severe (n=203)*</td>
<td>33</td>
<td>5</td>
<td>62</td>
</tr>
<tr>
<td>Death (n=175)**</td>
<td>44</td>
<td>3</td>
<td>53</td>
</tr>
<tr>
<td>Permanent disability (n=238)**</td>
<td>77</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>All (n=3045)*</td>
<td>9</td>
<td>3</td>
<td>88</td>
</tr>
</tbody>
</table>

* 6-week recall period
** 5-year recall period

Secondly, the capture-recapture method measured the coverage of traffic injuries in police and hospital data. The coverage of traffic fatalities was found to be higher in the former source compared to the latter, but the opposite was found in non-fatal cases, similar to other studies. As found in similar studies in high income countries police records were more likely to report adult people, motorized road users and more severe injuries, whereas hospital data captured younger, non-motorized road users and less severe injuries. However, diversity of inclusion criteria in the two data sets may hamper comparisons. This study also shows that the use of simple record linkage is an invalid approach to the measurement of the magnitude of injury morbidity and mortality.

Next, the degree of ascertainment of traffic-related injuries was compared using the capture-recapture method and the household survey, and the incidence of traffic injuries was found to be similar in both studies (including all degrees of severity). The mortality rate obtained was higher in the capture-recapture method. This discrepancy may be attributed to differences in time when the studies were carried out.

Figures 2 and 3 show the injury pyramid based on the level of treatment and severity, through AIS, with data provided in studies 2 and 4. In the former, the pyramid is quite similar to other countries (Table 8). The latter shows the injury pyramid by severity, regardless of level of treatment. Table 7 shows the positive association between injury severity and seeking hospital care.
Fig. 2 Injury pyramid of treatment levels in León municipality, Nicaragua. 1995. (Paper 2 and 4)

Fig. 3 Injury Severity (AIS) of population data (all injuries) in Leon municipality, Nicaragua. (Paper 4)
Table 8  Comparison of Injury Pyramid in León with other countries.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>Year</th>
<th>Death</th>
<th>People with disabilities</th>
<th>Inpatients</th>
<th>Outpatients</th>
<th>Other Medical Care</th>
<th>Without Medical Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Union-25</td>
<td>2002-2004</td>
<td>1</td>
<td>13</td>
<td>29</td>
<td>161</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Australia</td>
<td>1992</td>
<td>1</td>
<td>?</td>
<td>40</td>
<td>800</td>
<td>4,000</td>
<td>?</td>
</tr>
<tr>
<td>USA</td>
<td>2002</td>
<td>1</td>
<td>?</td>
<td>11</td>
<td>205</td>
<td>511</td>
<td>?</td>
</tr>
<tr>
<td>San Salvador</td>
<td>2004</td>
<td>1</td>
<td>?</td>
<td>73</td>
<td>279</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>2004</td>
<td>1</td>
<td>?</td>
<td>14</td>
<td>129</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>León</td>
<td>1990-1995</td>
<td>1</td>
<td>1.4</td>
<td>31</td>
<td>253</td>
<td>94</td>
<td>2,857</td>
</tr>
</tbody>
</table>

* Pediatric hospital
** Five hospitals

6.4 STRENGTHS AND WEAKNESSES OF SOURCES AND METHODOLOGIES APPLIED

Hospital data is prone to selection bias because they exclude cases of people who die before they reach the hospital, or minor cases where medical care sought at other health facilities but do not require medical care. One advantage was that the hospital under study was the only provider of public hospital care, which guaranteed the representativeness of the target population. Furthermore, this source provided detailed information on diagnoses, severity, causes and medical care, as well as comprehensive patterns and trends of severe injuries. Although most surveys overcome selection bias and provide a baseline data, they are usually one-time events and cannot be useful for monitoring trends. This situation increases the likelihood of missing seasonality-linked variations or clusters. This methodological issue could be addressed by a panel survey, or longitudinal design, which make possible the detection of time trends in injury occurrence, as was performed by Hang in Vietnam. The panorama of the injury spectrum was more reliable from household survey than from hospital surveillance.

Initially, the rationale to include both inpatients and outpatients in study 2 and 3 was to have a broad estimate of injury severity based on the level of treatment. This had been applied in other settings when estimating the burden of injury, as well as more informed prioritization of injury control efforts. Although the AIS score was not initially considered for measuring the severity of injuries in study 2, the assessment of this severity score was possible in study 3 because the nature of injuries was coded with four-digits, in a fashion similar to that used by MacKenzie. In addition, the severity of inpatients and outpatients was evaluated by AIS, and we found that a considerable proportion of inpatients were classified as minor, while a considerable proportion of outpatients were moderate or severe. A similar analysis has not been reported in low-income countries.

After assessing the injury surveillance and research approaches in this thesis, it was found that capture-recapture is the most cost-effective method to ascertain the magnitude of the most important injuries, like traffic or violence, mainly in low-income countries. Nevertheless, a careful evaluation must be made of the quality of data sources that will be used, as well as of the assumptions that must be fulfilled. A methodological issue related to injury severity that must be addresses when using the capture-recapture method is not only the inclusion of inpatients and outpatients, for avoiding underestimation (one-quarter in our findings), but also
The application of an anatomical indicator of severity like the AIS, because there always exist the possibility of classification bias (one-fifth in our analysis), always exist, as we found in this research.

The seeking of medical care or the level of treatment received had been used as a proxy measure of severity, but this measure also depends on the access to health care facilities, socio-economic factors, or variation in the use of services besides severity.\textsuperscript{90,135} For example, the capture-recapture study on traffic-related injuries showed that one-fifth of outpatients were classified as moderate or severe injuries, while one-fifth of inpatients were classified as minor injuries. This finding provided evidence that the status of hospital admission is an invalid proxy of severity, which suggests that studies only based on inpatients could diminish the magnitude of injury considerably. However, the inclusion of outpatients demands more effort and training from the staff to classify the severity of injuries. The rationale to apply an anatomical indicator of severity, like the AIS, is because studies 3-5 have shown that around nine in ten non-fatal cases, two in three fatalities and almost all permanent disabilities were due to mechanical energy. This finding is similar to those reported elsewhere.
Table 9 Summary of validity, preventive-oriented information and practical feasibility of different injury data sources and research methods used in León, Nicaragua.

<table>
<thead>
<tr>
<th>Data source / Methods</th>
<th>Validity</th>
<th>Preventive information</th>
<th>Practical feasibility and potentials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Official statistics</td>
<td>Low coverage of mortality, and morbidity was based only on the nature of injury.</td>
<td>Host: age, sex, residence, Injury: Broad external cause, time.</td>
<td>They are free, but they do not provide timely information. Represent only the tip of the pyramid.</td>
</tr>
<tr>
<td>2. Newspapers</td>
<td>Low and biased towards reporting more severe injuries, or/and focused mostly on alarming news.</td>
<td>Include broad information on pre-injury circumstances, such as events and causal agents.</td>
<td>They are accessible and cheap/free.</td>
</tr>
<tr>
<td>3. Hospital data (emergency room-based surveillance)</td>
<td>Moderate for more severe cases, but low for deaths, minor injuries and permanent disabilities.</td>
<td>Host: age, sex, residence. Injury: nature, severity, time, cause, immediate disability. Safety: agents, environment, external causes.</td>
<td>Data potentially available, but the implementation of injury surveillance system require time, effort, money, and training. It is possible to have estimates of most severe injuries and their trends. This source can be used to monitor the impact of safety promotion intervention.</td>
</tr>
<tr>
<td>4. Police records</td>
<td>Moderate in fatal cases and nonfatal cases associated with material losses. Low for minor injuries. Report motorized road users rather than non-motorized.</td>
<td>Host: age, sex, residence. Injury: broad classification of fatal and nonfatal, time. Safety: external causes, environmental conditions, use of seat belt, etc.</td>
<td>Data are available and free</td>
</tr>
<tr>
<td>5. Capture-recapture</td>
<td>High for fatal and nonfatal cases. However, the degree of ascertainment may be affected by the exclusion of outpatients, if hospital records are used as one source.</td>
<td>Depend of the data sources used.</td>
<td>Two or more independent sources are needed. Require specific competence.</td>
</tr>
</tbody>
</table>
7. **Conclusions**

1. Health statistics represent an invalid source of injury mortality and morbidity in Nicaragua. Police and occupational statistics provide better and more preventive-oriented data on specific types of injuries such as traffic and occupational injuries.

2. Although hospital data provided limited coverage with regards to most injuries, this source represent a potential source to measure the magnitude of more severe injuries with reliable data on external causes and the nature of injury.

3. Due to the limited coverage of police and hospital data, as well as the corresponding record linkage, the capture-recapture method represents a valid method to ascertain the magnitude of traffic-related injuries. However, the extent of this ascertainment could be affected if outpatient data are excluded from the analysis, in case of hospital data being used as one of the sources.

4. Household surveys represent a valid approach for measuring the magnitude of injuries of the injury spectrum and its patterns. However, the main limitation is that they are normally performed only occasionally and not on an ongoing basis. Surveys also tend to underreport certain culturally sensitive injury categories, such as domestic violence and suicide attempts.

5. A common limitation of measuring the burden of diseases is the lack of reliable indicators to determining the second component of the burden of disease, such as disabilities. However, within the injury category, it is possible to ascertain the YLD, YPLL and DALY to compare the causes of the burden of nonfatal and fatal injuries.
8. Acknowledgements

In completing this piece of research I would like to acknowledge the kind assistance of the following people:

First and foremost, I would like to thank my supervisor and friend, Professor Ragnar Andersson, for his immeasurable guidance, patience, and support throughout the course of my Ph.D. program. I have learned much as a direct result of working with him. Throughout my doctoral work, he encouraged me to develop independent thinking and research skills. He continually stimulated my analytical thinking and greatly assisted me with scientific writing.

No person deserves more credit for my doctoral work than my best friend, co-author and co-supervisor Dr. Rodolfo Peña, who has been like a brother. He introduced me to research and gave me a great deal of support, care-giving to my study plan and finding solutions to problems concerning the financing of my PhD studies at Karolinska Institutet. He has been present at special and critical moments in my life. With his fellow students and colleagues, he shares not only his knowledge and expertise, but also his friendship. Based on my experience, he represents the best example of the true of the quotation “Friendship is much better than money”.

It is difficult to overstate my gratitude to Professor Leif Swanström, for his injury research encouragement, for sharing his enormous experience, and for stimulating research collaboration. Professor Svanström with his scientific expertise, his enthusiasm, his inspiration, and his great efforts to explain things clearly and simply, gave invaluable assistance to the research team in Nicaragua in the development of the first hospital-based injury surveillance system in Nicaragua in 1992.

I would also like to express appreciation to my tireless friend and co-author, Julio Rocha. Over the past fifteen years, he has been witness to the many ups and downs of the implementation and development of the hospital-based injury surveillance system in Nicaragua. These acknowledgements are also extended to Alberto Concha-Eastman, regional advisor of the PAHO/WHO and Carme Clavel-Arcas (CDC), who provide injury surveillance assistance in Nicaragua.

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This achievement would not have been possible without Gunmaria Löfberg, my best friend at Karolinska Institutet, who has been like my Swedish mom since the beginning of my training. Her support and encouragement has seen me through difficult times. I thank her for consistently helping to control my insecurities and problems, and for improving my stay in Stockholm in so many different ways.

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I would also like to express my deep appreciation and love for my life partner, Gloria Duarte, and my daughters Frania Maria and Maria Antonieta, who always showed me their support and patience during my PhD studies. For me, quality of life is good when they are safe and healthy. I am indebted to my parents Jesús and Leticia, who passed away, for grounding in me the dedication and discipline to do well whatever I undertake to do. I cannot thank my grandmother Amelia enough for showing me that the best legacy that I could receive from my family was education. She still has a deep influence in every aspect of my life.

Thanks to God and the Virgin Mary for giving me one more chance to do better things in this world.
9. References


84. NOMESCO. Classification for Accident Monitoring. Copenhagen: NOMESCO. 1990.
88. Sim F, Mackie P. It were to be wished the flaws were fewer… But the main thing is, does it hold good measure? Public Health 2002;116:251.


10. Appendices
Emergency registration form, Teaching Hospital in León, Nicaragua.

I  General data of the patient

| Number of form:_______________ |
| Name:__________________________________________________________________________ |
| Address:_________________________________________________________________________ |
| Neighborhood or community:____________________________________________________ |
| Municipality:__________________________ Occupation:_____________________________ |
| Sex:   F ___    M ___    Age:_____ |
| Date:______________________________ Day of the week:__________________________ Time:_____
| Cause of visit:  Illness ___  Injury ___ |

(If non injury, pass to the part IV)

II  Injury patient  (to be filled by the physician)

<table>
<thead>
<tr>
<th>Cause of contact:</th>
<th>Place of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Unintentional o accidental</td>
<td>0  Traffic area</td>
</tr>
<tr>
<td>2  Violence</td>
<td>1  Home</td>
</tr>
<tr>
<td>3  Self-inflicted</td>
<td>2  Work</td>
</tr>
<tr>
<td>4  Other</td>
<td>3  Commercial area</td>
</tr>
<tr>
<td>4  School</td>
<td>9  Other</td>
</tr>
<tr>
<td>5  Sport area</td>
<td>6  Recreational area</td>
</tr>
<tr>
<td>7  Field, forest, mountain</td>
<td>8  Sea, lake, river</td>
</tr>
</tbody>
</table>

III  Description if the injury

Describe shortly how the injury or accident occurs. Make it based on the following example:

A person drinks a lot of alcohol (event 1) After which he drives very fast (event 2) He loose control over the car (event 3) He crashes against a tree (contact) Results in fracture of skull and femur (injuries)

___________________________________________________________________________________________

___________________________________________________________________________________________

___________________________________________________________________________________________

___________________________________________________________________________________________

IV  Clinical data

Diagnostic:__________________________________________________________________________

Physician’s name:____________________________________________________________________

(If you need more space, writes to the reverse)

Figure 1.  Emergency registration form, León Hospital.
FORM 1

HOUSEHOLD-BASED SURVEY ON INJURIES IN LEON MUNICIPALITY (URBAN-RURAL): CENSUS AND SOCIOECONOMIC CHARACTERISTICS

(This form will record some general and socioeconomic data on all inhabitants in the household who have lived there at anytime from 1990 until the moment of the interview)

GENERAL DATA:

Informant: __________________________________________
Date of the survey:_____/_____/_____ Interviewer No.:______
Address:___________________________________________________________

<table>
<thead>
<tr>
<th>TERRITORY</th>
<th>CLUSTER</th>
<th>BLOCK</th>
<th>HOUSE</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HOUSING CONDITIONS</th>
<th>SANITARY CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls:</td>
<td>Disposal of excretion:</td>
</tr>
<tr>
<td>1. Block/cement</td>
<td>1. Toilet</td>
</tr>
<tr>
<td>2. Wood/clay</td>
<td>2. Latrine</td>
</tr>
<tr>
<td>3. Wood</td>
<td>3. None</td>
</tr>
<tr>
<td>4. Palm</td>
<td></td>
</tr>
<tr>
<td>5. Plastic, etc.</td>
<td></td>
</tr>
<tr>
<td>Floor:</td>
<td></td>
</tr>
<tr>
<td>1. Brick cement</td>
<td></td>
</tr>
<tr>
<td>2. Flooring</td>
<td></td>
</tr>
<tr>
<td>3. Brick of mud</td>
<td></td>
</tr>
<tr>
<td>4. Ground</td>
<td></td>
</tr>
</tbody>
</table>

No. Name Last name Sex M/F Position in the family Date of birth dd/mm/yy Occupation > 7 years Education > 7 years

<p>| | | | | | | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>1</td>
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<td></td>
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</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
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<td></td>
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<td>8</td>
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Position: Occupation: Education:

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<tbody>
<tr>
<td>1. Head</td>
<td>1. Unemployed</td>
<td>9. Manager</td>
<td>1. Illiterate</td>
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<tr>
<td>7. Other</td>
<td>7. Students</td>
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<td>8. Professional</td>
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FORM 2

HOUSEHOLD-BASED SURVEY ON INJURIES IN LEON MUNICIPALITY (URBAN-RURAL):
MORBIDITY AND PLACE OF ATTENTION

(This form will record the data on any person who has suffered any injury in this home from any cause over the past six weeks.)

I. GENERAL DATA:
Informant:___________________________________________
Date of the survey:_____/_____/_____ Interviewer No.:______
Address:___________________________________________________________

<table>
<thead>
<tr>
<th>TERRITORY</th>
<th>CLUSTER</th>
<th>BLOCK</th>
<th>HOUSE</th>
<th>CODE</th>
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In this house, some person has injured in the last 6 weeks:

Yes____ No____ (if it is yes, put the quantity of injured people):______
Name of the injured:________________________________________ Sex:____
Address:_______________________________________________________________
Date of birth:____/____/____   Date of injury:____/____/____

II. INJURY DATA:
Intent:                           Place of occurrence:
1. Not intentional   1. Home
2. Intentional        2. Work
3. Suicide            3. Traffic area
4. Commercial area    4. School
5. Sport area         5. Recreational area
6. Field-forest-mountain
7. Sea-lake-river

III. SHORTLY DESCRIBE WHAT HAPPENED (based on injury event):


IV. PLACE OF ATTENTION:
1. Hospital 4. Home
2. Primary health care 5. Other (to specify):________
3. Physician’s office 6. Without medical attention

V. PARTS OF BODY INJURED:
1. Head-face 5. Abdomen
3. Thorax      7. Lower limbs:_______________
4. Genital

VI. TYPE OF INJURY (describes shortly):
FORM 3

HOUSEHOLD-BASED SURVEY ON INJURIES IN LEON MUNICIPALITY (URBAN-RURAL): DISABILITIES

(This form will record data on any person who has suffered impairments or disabilities from any injury type since 1990)

I. GENERAL DATA:

Informant:________________________________________
Date of the survey:_____/_____/_____ Interviewer No. :______
Address:____________________________________________________

<table>
<thead>
<tr>
<th>TERRITORY</th>
<th>CLUSTER</th>
<th>BLOCK</th>
<th>HOUSE</th>
<th>CODE</th>
</tr>
</thead>
</table>

II. INJURY DATA:

Intent:  Place of occurrence:
1. Not intentional 1. Home
2. Intentional 2. Work
3. Suicide 3. Traffic area
4. Commercial area
5. School
6. Sport area
7. Recreational area
8. Field-forest-mountain
9. Sea-lake-river

III. SHORTLY DESCRIBE WHAT HAPPENED (based on injury event):

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</table>

IV. PLACE OF ATTENTION:

1. Hospital  4. Home
2. Primary health care  5. Other (to specify)
3. Physician’s office  6. Without medical attention

V. TYPE OF DISABILITY (describes shortly):

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FORM 4

HOUSEHOLD-BASED SURVEY ON INJURIES IN LEON MUNICIPALITY (URBAN-RURAL):
MORTALITY AND PLACE OF ATTENTION
(This form will record the data on any person who has died for any reason since 1990)

I. GENERAL DATA:

Informant:_____________________________________
Date of the survey:_____/_____/_____ Interviewer No. :______
Address:_____________________________________________________

<table>
<thead>
<tr>
<th>TERRITORY</th>
<th>SECTOR</th>
<th>BLOCK</th>
<th>HOME</th>
<th>CODE</th>
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</table>

Name of the died person: _______________________________________ Sex:____
Address:__________________________________________________________
Birth date: ____/____/____  Date  of death: ____/____/____

II. INJURY DATA:

Intent:  
1. Not intentional.  
2. Intentional.  
3. Suicide.  
Place of occurrence:  
1. Home  
2. Work  
3. Traffic area  
4. Commercial or Service area  
5. School  
6. Sport area  
7. Recreational area  
8. Field-forest-mountain  
9. Sea-lake-river

III. SHORTLY DESCRIBE WHAT HAPPENED (based on injury event):


IV. PLACE OF ATTENTION:

1. Hospital  
2. Primary health care  
3. Physician’s office  
4. Home  
5. Other (to specify):______________________________________________
6. Without medical attention

V. CAUSE OF DEATH:

Did the death certificate confirm the death?  
Yes____ No____
Cause of death
a. ________________________________________________________________
b. ________________________________________________________________
c. ________________________________________________________________