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The epidemiology of moderate and severe injuries in a Nicaraguan community: A household-based survey

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Summary Although injuries constitute a major public health problem worldwide, the magnitude and nature of this problem is difficult to establish in low-income settings due to the lack of valid and representative data. In Nicaragua, several parallel studies have been carried out attempting to assess levels and patterns of injury using various sources of information. The objective of this study was to describe the magnitude and profile of moderate and severe injuries in a well-defined community in Nicaragua.

The study was conducted using a household-based survey design. Randomized cluster sampling provided information from 10,797 households (63,886 inhabitants). The outcomes included fatal and non-fatal injuries registered during a recall period of 6 weeks.

Seven percent of all injuries were classified as moderate or severe. The estimated annual incidence rate of moderate/severe injuries was 27.6 per 1000 [95% confidence intervals (CI): 26.4–29.2], while the mortality and impairment rates were 108.9 (95% CI: 83.5–134.4) and 95.3 (95% CI: 71.4–119.2) per 100,000 inhabitants, respectively. Home and traffic areas were the main environments associated with injury occurrence. The most affected groups were the elderly, children and males. No differences were found between urban and rural areas. Only 9% of all cases, including minor injuries, sought hospital treatment. The main causes of non-fatal injuries were falls, traffic and cuts, whereas fatalities were largely associated with intentional injuries. For every death due to injury,

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there was one permanent disability, 25 moderate/severe injuries and 354 minor injuries.

This study provides a broad description of injury magnitudes and patterns in a defined Nicaraguan community, and demonstrates the aggregate injury pyramid of the same community. It also identifies the issue of severity and concludes with a recommendation to apply different criteria of severity. Our results support the call for a careful evaluation of injury data sources and severity scores when planning injury prevention programmes.

Introduction

Injuries are gradually being recognized as a public health problem in both low- and high-income countries.[1,2] Currently, injuries represent 11% of world mortality and 17% of disability-adjusted life years (DALYs). These proportions are predicted to rise dramatically and are estimated to surpass communicable diseases as the second largest aggregate cause of disease burden after non-communicable diseases.[2] This epidemiological transition is seen to be running parallel with increased industrialization and improved economic conditions. Recent studies have found a strong negative relationship between unintentional injury mortality rates and gross national product per capita, except for the poorest countries for which the correlation is positive.[3,4]

The availability of data varies greatly between 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 under-reporting of injuries in current data sources in most low-income countries. Thus, a challenge for low-income countries is to select adequately representative data sources for injury surveillance to characterize the burden of injuries and develop useful intervention strategies.[5–7]

Household surveys provide population-based data that is not generally available from any other source.[8] Nevertheless, very few household surveys have been performed in low-income countries to explore the impact of injuries. Some of these studies have focused on the health impact of injuries among specific target groups, such as women of reproductive age,[9,10] and children and adolescents,[11] or across a broad range of age groups.[12–14] Other studies have focused on the use of health services,[15,16] and the effect of recall bias on the incidence of injuries.[17,18]

In Nicaragua, several attempts have been made to determine the magnitude of injuries. These efforts have included: comparisons of nationwide data sources on injury occurrence that have revealed severe discrepancies about the magnitude of the problem and the lack of prevention-oriented information;[19] a hospital-based injury surveillance study that demonstrated feasible methods of data gathering, and identified potential issues related to undercoverage and representativeness;[20] and a study, using a capture-recapture approach, which found that neither police records nor a hospital-based injury surveillance system were able to provide more than a limited coverage of traffic-related injuries.[21] The latter study demonstrated that the estimates using a capture-recapture methodology exceeded official figures on traffic-related mortality by two-fold.

The objective of this study was to describe the epidemiological magnitude and profile of moderate and severe injuries in a well-defined community in Nicaragua, based on the results of a household survey.

Materials and methods

A household survey was conducted from March to May 1995 in León municipality, the second largest urban centre in Nicaragua with a population of 161,530 inhabitants (1995).[22] Key informants per household were interviewed, usually the victim or his/her closest relative on injury data, and his/her wife/husband on sociodemographic characteristics.

Injury cases were defined as all intentional or unintentional injuries that had occurred during a 6-week period preceding the survey, and affecting any member of the household, classified according to the International Classification of Diseases (ICD-9).[23] Disabilities and severity were assessed using the International Classification of Impairments, Disabilities and Handicaps,[24] and the Abbreviated Injury Scale (AIS-90), respectively.[25]

Minor, moderate and severe injures were classified using AIS scores of 1, 2 and ≥ 3, respectively.

Impairment-related injuries were defined as any permanent limitations due to injuries. Permanent limitations included psychological, physiological, sensorial or anatomical impairments. Interview questions used to ascertain non-fatal injuries included: 'Has any person living in this house been injured in the last 6 weeks?' With regards to permanent impairments and deaths, interviewees were asked if any injuries in the last 5 years had resulted in permanent impairments or deaths of household members. However, only cases identified during the 6-week period preceding the survey were included in this study.

The sample size was calculated using an incidence of injury of any severity of 50%, with a precision of 0.5%. A randomized cluster sampling method was utilized and the design effect considered was 2.[26] 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 (9150 in urban areas and 1647 in rural).

The selection criteria for the interviewers were that they had completed high school, were female and had previous experience in fieldwork. The preference for women over men was considered to be important for cultural and traditional reasons, and facilitated people allowing the interviewers into their homes.

Four standardized questionnaires were developed. The first contained sociodemographic information on all members of the households. The second questionnaire was used to document non-fatal injuries without disabilities, and the last two questionnaires were used to collect information on impairment- or mortality-related injuries, including the mechanism of injury, place, nature of injury, treatment and outcomes.

Verbal autopsies were used to investigate the causes of injury-related deaths,[27] and were validated in two ways: first, the results of the face-to-face interview were compared, when possible, with the underlying cause of death as stated on the death certificate; and second, 15% of all injuries, including deaths, were investigated and confirmed separately by senior members of the research team. Priority was given to injury outcomes that generated uncertainty in their diagnosis, e.g. the ascertainment of disfiguring or sensorial impairments.

Epi Info software was used for database handling and data processing.[28] Both incidence and mortality rates (per 1000 and per 100,000 inhabitants per year), and their 95% confidence intervals (CI), were calculated. The numerator (estimated annual number of cases) was obtained by dividing the number of cases by the number of recall days and multiplying the quotient by 365.25. Denominators were based on the census carried out as part of the survey.

Results

Table 1 shows the baseline characteristics of the population and injured people. In total, 10,797 households were selected for the survey, of which 0.3% refused to participate and 0.6% of houses were uninhabited or their inhabitants had moved house. The average household size in urban and rural areas was 5.8 and 6.5, respectively. Forty percent of the

Table 1 Baseline characteristics of the population and injury cases in León municipality, Nicaragua, 1995.

Age and sex	Urban		Rural		Total	
	Population	No.	Population	No.	Population	No.
<15 years	20,930	78	5011	15	25,941	93
Male	10,576	43	2581	8	13,157	51
Female	10,354	35	2430	7	12,784	42
15–64 years	30,054	79	5291	17	35,345	96
Male	13,498	40	2667	7	16,165	47
Female	16,556	39	2624	10	19,180	49
≥65 years	2199	13	401	1	2600	14
Male	782	4	199	0	981	4
Female	1417	9	202	1	1619	10
Total	53,183	170	10,703	33	63,886	203
Male	24,856	87	5447	15	30,303	102
Female	28,327	83	5256	18	33,583	101

Number of injury cases registered during a 6-month recall period.

household members were less than 15 years old, and only 4.1% were older than 64 years old. The male:female ratio was 0.90:1.

During the recall period of 6 weeks, 3045 injuries were registered, involving 2901 individuals; 4.6% were repeaters. Seven impairment- and eight death-related injuries (excluding one fetal death) were reported (case:fatality ratio of 0.3%). Considering all cases of the injury pyramid based on the AIS score, 93% were classified as minor injuries, 6.5% as moderate injuries and 0.5% as severe injuries. Regarding level of treatment, 88% of all cases did not receive any medical attention, 9% sought hospital attention, and 3% received medical care at other facilities. For every death due to injury, there was one case of permanent impairment, 25 moderate/severe injuries and 354 minor injuries.

Around 98.5% of moderate/severe injuries were unintentional and 1.5% were intentional. The case: fatality ratio was 3.9%. Table 2 shows the overall distribution of cases across all variables.

The overall incidence rate, including minor injuries, was 414.2 per 1000 inhabitants per year (95% CI: 410.4–418.0). When minor injuries were excluded, the incidence rate of moderate/severe injuries ($n=203$) decreased to 27.6 per 1000 (95% CI: 26.4–29.2). Results presented in Tables 2–5 are restricted to cases with AIS$\geq$2. Total incidence rates in urban and rural areas were similar, but the incidence in urban males was higher than in females, while the gender distribution was opposite in rural areas (Table 3). With regard to age groups, it was found that incidence in children and those over 65 years of age was higher than in those aged 15–64 years in urban areas, in contrast to rural areas where those aged 15–64 years showed the highest incidence rate. It should be underlined that all rates are estimates and that CIs are wide in subgroups where estimates are based on small numbers.

Homes and streets/roads were the main places of injury occurrence. In homes, incidence was higher in the elderly and children, especially in urban areas. In streets/roads, the incidence in urban areas was more equal across age groups, while in rural areas, the incidence was clearly highest in those aged 15–64 years (Table 4).

The main causes of moderate/severe injuries were falls (42%), cuts (25%) and traffic (18%). Around 97% of all moderate/severe injuries resulted in wounds (43%), fractures (32%) and dislocation (22%). Table 5 shows that the incidence of wounds was generally higher in urban than in rural areas, while the opposite pattern was found regarding fractures and dislocations. In elderly people in urban areas, the incidence of fractures and wounds was extremely high, whereas only one case (dislocation) was observed in an elderly person in a rural area. Here too, differences obtained should be interpreted with caution due to small numbers in subcategories.

After triangulation between injury severity by AIS and the level of treatment, we found that 9.9, 35.4 and 87.5% of cases of minor, moderate and severe injuries, respectively, sought medical treatment (hospital or physician's office) (Fig. 1). Among

Table 2 Incidence rates of moderate and severe injuries (/1000/year) by area, sex, age, place, nature, external causes and treatment in León municipality, Nicaragua, 1995.

Variables	No.[a]	Rate	95% CI
Area			
Urban	170	27.8	26.4–29.2
Rural	33	26.8	23.7–29.8
Sex			
Male	102	29.2	27.3–31.1
Female	101	26.1	24.4–27.8
Age			
<15 years	93	31.1	29.0–33.3
15–64 years	96	23.6	22.0–25.2
≥65 years	14	46.8	38.7–54.9
Place			
Home	101	13.7	12.8–14.5
Traffic area	71	9.6	8.9–10.4
Workplace/school	19	2.6	2.1–3.0
Open field/sea	10	1.4	1.1–1.6
Others	2	0.3	0.1–0.4
Nature of injury			
Wounds	88	12.0	11.1–12.8
Fracture	65	8.8	8.1–9.6
Dislocation	44	6.0	5.4–6.6
Internal injuries	3	0.4	0.2–0.6
Politrauma	3	0.4	0.2–0.6
External causes			
Falls	85	11.6	10.7–12.4
Cutting/piercing	51	6.9	6.3–7.6
Traffic	36	4.9	4.3–5.4
Striking/struck/caught	18	2.4	2.0–2.8
Animal bite	8	1.9	0.8–1.3
Violence	3	0.4	0.2–0.6
Others	2	0.3	0.1–0.4
Level of treatment			
Without medical care	127	17.3	16.3–18.3
Hospital	66	9.0	8.2–9.7
Physician's office	10	1.3	1.0–1.6

CI, confidence interval.
[a] Number of injury cases registered during a 6-month recall period.

Table 3 Incidence rates of moderate and severe injuries (/1000/year) by area, age and sex in León municipality, Nicaragua, 1995.

Age and sex	Urban		Rural		Total	
	Rate	**95% CI**	**Rate**	**95% CI**	**Rate**	**95% CI**
<15 years	32.4	30.0-34.8	26.0	21.6-30.4	31.2	29.0-33.3
Male	35.3	31.8-38.8	26.9	20.7-33.2	33.7	30.6-36.8
Female	29.4	26.1-32.6	25.0	18.8-31.2	28.2	25.3-31.0
15-64 years	22.8	21.1-24.5	27.9	23.5-32.4	23.6	22.0-25.2
Male	25.7	23.0-28.4	22.8	17.1-28.5	25.3	22.8-27.7
Female	20.5	18.3-22.6	33.1	26.3-40.0	22.2	20.1-24.3
≥65 years	51.4	42.1-60.6	21.7	7.4-35.9	46.8	38.7-54.9
Male	44.4	30.0-58.9	0.0	-	35.5	23.9-47.0
Female	55.2	43.3-67.1	43.0	15.0-71.0	53.7	42.7-64.6
Total	27.8	26.4-29.2	26.8	23.7-29.8	27.6	26.4-29.2
Male	30.4	28.3-32.5	23.9	19.9-28.0	29.2	27.3-31.1
Female	25.5	23.6-27.3	29.8	25.1-34.3	26.1	24.4-27.8

CI, confidence interval.

minor injuries, medical treatment was sought for 270 cases distributed as follows: wounds (61%), contusions (11%), burns (6%), fractures (3%), closed head injuries (3%), dislocation (2%) and others (14%). Furthermore, cases without an AIS score, such as poisoning and near drowning/foreign body, sought medical care in 89 and 50% of instances, respectively. If these cases, classified as minor but medically attended, are added to those with an AIS score ≥2, the incidence rate of moderate/severe injuries doubles.

Based on the 6-week recall period, the estimated annual incidence of disabilities was 95.3 per 100,000 population (CI 95%: 71.4–119.2) and the mortality rate was 108.9 per 100,000 inhabitants (CI 95%: 83.3–134.4). Again, these numbers reflect considerable statistical uncertainty due to the few cases identified (Table 6).

Discussion

Principal findings

Based on the AIS, 93% of all injuries were classified as minor and 7% were classified as moderate/severe. Most of the severe injuries and one-third of the moderate injuries were medically attended, while only 9% of minor injuries were attended. The use of medical attention as a proxy for severity is problematic,[29] but might be useful as a complementary criterion to capture an important proportion of serious injury cases that may not be detected properly by the AIS score, such as poisoning, drowning, choking and intracranial injuries.

For every death due to injury, there was one case of permanent impairment, 25 moderate/severe injuries and 354 minor injuries. Injury mechanisms

Table 4 Incidence rates of moderate and severe injuries (/1000/year) by place of injury, area and age in León municipality, Nicaragua, 1995.

Residence/ age	**House**		**Street/roads**		**Workplace/school**		**Open field/sea**	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Urban	86	14.1	62	10.1	16	2.6	4	0.7
<15 years	46	19.1	28	11.6	2	0.7	1	0.4
15-64 years	31	9.0	31	9.0	13	3.8	3	0.9
≥65 years	9	35.6	3	11.9	1	4.0	0	0.0
Rural	15	12.2	9	7.3	3	2.4	6	4.9
<15 years	9	15.6	2	3.5	0	0.0	4	6.9
15-64 years	5	8.2	7	11.5	3	4.9	2	3.3
≥65 years	1	21.7	0	0.0	0	0.0	0	0.0
Total	101	13.8	71	9.7	19	2.6	10	1.3

Number of injury cases registered during a 6-month recall period.

Table 5 Incidence rates of moderate and severe injuries (/1000/year) by age, area, external cause and nature of injury in León municipality, Nicaragua, 1995.

Injury	Urban						Rural					
	<15		15-64		≧65		<15		15-64		≧65	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Nature of injury												
Wound	35	14.5	40	11.6	5	19.8	3	5.2	5	8.2	0	0.0
Fracture	26	10.8	21	6.0	6	23.7	7	12.1	5	8.2	0	0.0
Dislocation	16	6.6	15	4.3	1	3.9	5	8.7	6	9.8	1	7.4
Internal injuries	0	0.0	3	0.9	0	0.0	0	0.0	0	0.0	0	0.0
Multiple trauma	1	0.4	0	0.0	1	3.9	0	0.0	1	1.6	0	0.0
External causes												
Falls	42	17.4	22	6.3	5	19.8	9	15.6	6	9.8	1	21.7
Cutting/piercing	19	7.9	24	6.9	4	15.8	1	1.7	3	4.9	0	0.0
Traffic	10	4.1	19	5.5	2	7.9	2	3.5	3	4.9	0	0.0
Striking/struck/caught	4	0.2	8	2.3	2	7.9	1	1.7	3	4.9	0	0.0
Animal bite	2	0.8	3	0.9	0	0.0	2	3.5	1	1.6	0	0.0
Violence	0	0.0	1	0.3	0	0.0	0	0.0	1	1.6	0	0.0
Others	1	0.4	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0

Number of injury cases registered during a 6-month recall period.

varied across areas (urban/rural), age and sex groups, places of occurrence, etc. The main causes of non-fatal injuries and impairments were falls and traffic, while intentional injuries were the main cause of fatalities. These causes also appear globally among the leading causes of DALYs.[7]

Limitations of this study

Injury definitions and severity ascertainment

The spectrum of injuries was broad, and there were no initial inclusion restrictions related to severity. In restricting our analysis mainly to severe and moderate injuries, based on AIS, the latter problem should be addressed properly as this led to a general problem of small numbers and lack of statistical power.

Temporal variations

As for most cross-sectional studies, this study did not establish the temporal variations of injuries during the year. Hang found that repeated cross-sectional studies during a 1-year seasonal cycle could be used to overcome this problem.[14]

Intent of injury

The use of proxy respondents instead of index respondents might bias our findings regarding intentional injuries. Ellsberg, in the same study area, reported a higher proportion of domestic violence by index respondents.[30]

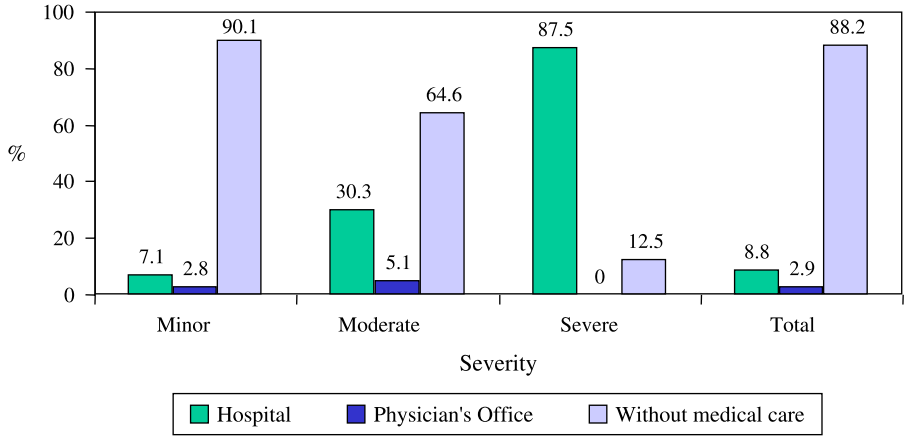

Figure 1 Level of treatment by injury severity. León municipality, Nicaragua, 1995.

Table 6 Main causes of deaths and impairments during a recall period of 6 weeks in León municipality, Nicaragua, 1995.

Causes	No.
Mortality	
Suicide	2
Homicide	1
Traffic	1
Fall	1
Burn	1
Drowning	1
Poisoning	1
Impairments	
Broken teeth	2
Amputation	2
Blindness	2
Deformity and restriction of movement	1

Further methodological considerations

A general concern in injury research is related to the ability to count injuries and ascertain their severity. We acknowledge that most indicators of injury severity have limitations. For example, the seeking of medical care has been suggested as a proxy measure of severity,[31] but this measure also depends on the access to health facilities and socio-economic factors, besides severity.[29] A previous study from the same community has shown that one-fifth of outpatients were classified as having moderate/severe injuries, while one-fifth of inpatients were classified as having minor injuries.[21] An important limitation of the AIS is that is it based purely on anatomical parameters, and is not intended for assessing events such as drowning, poisoning or choking. Furthermore, the AIS does not take into account the neurological status of intracranial injuries. To overcome these shortcomings, we performed a triangulation between both indicators to obtain a better picture of injury severity. This analysis revealed that minor cases that required medical attention exceeded the number of injuries identified as moderate/severe, which is an important aspect to consider when designing injury surveillance systems and analysing injury data for the planning of injury prevention interventions.

Consistency with results from other studies

The mortality and disability rates found in this study are generally higher than those reported in similar studies carried out in other low-[11–13,15,18,32,33] and high-income countries.[34–36] However, international comparisons of incidence rates are difficult to establish due to definitional problems. For example, some authors define injury cases as injuries serious enough to warrant medical treatment,[14] or relate their inclusion criteria to temporal disability.[16,18]

While injuries from cuts were found to be the second greatest cause of moderate and severe injuries in this study, they did not appear among the leading causes of injury in a collaborative study in four Latin American countries. This might be attributed to the higher development level reached in those countries.[11] Studies in Bangladesh,[12] Uganda[13] and Ghana[15] show similar findings to those reported here.

Important discrepancies between urban and rural areas were recognized. Most traffic accidents occur in urban areas, affecting mainly pedestrians, passengers and cyclists, whereas non-motorized accidents prevailed in rural areas, which is consistent with other studies in similar settings.[12,21,33] In urban areas, poisoning was found exclusively among children, probably due to the exposure to toxic products at home. However, in rural areas, poisonings prevailed among adults, most likely due to exposure during agricultural activities, which is a common problem in low-income countries.[33] Although the incidence of falls in the elderly from urban and rural areas was similar, the incidence of fracture of lower limbs was exclusively found in urban women. This could be due to the protective effect of physical activity, which is assumed to be higher in rural areas.[33]

Validity considerations

A previous study from the same community on traffic-related injuries, based on a capture-recapture approach comparing police and hospital data, reported twice the incidence and mortality rates compared with those found in this study.[21] This discrepancy may be explained by the inclusion of minor injuries to ascertain the incidence of non-fatal cases, and the temporal variation of traffic accidents, which sometimes result in multiple deaths, that cannot be adequately detected in cross-sectional studies with short recall periods. It may also be due to the lack of statistical power in this study for mortality estimates among delimited subcategories like traffic.

Although hospital data provide possibilities to overcome the temporal variations that delimit cross-sectional studies, caution must be given when using hospital data in attempts to measure the burden of injuries, especially regarding moderate, severe and even fatal injuries that are not brought to hospital. The previous capture-

recapture study in the same catchment area found that hospital coverage of fatal and non-fatal cases due to traffic was only 20 and 9%, respectively.[21] Similarly, the overall hospital coverage of injuries found in this study was also 9%, but when injuries were disaggregated by severity, it was found that the hospital coverage for minor, moderate and severe injuries was 7.1, 30.3 and 87.5%, respectively.

This is one of the largest studies undertaken with a representative sample in a low-income country. The baseline data obtained in this study may help guide decision-makers to distribute scarce resources appropriately and to focus on the most severe injuries such as violence and traffic. Furthermore, considering that the ascertainment of injury severity is difficult even in near-hospital settings in low-income countries, we propose a triangulation of both methods (AIS score vs level of treatment) to improve the ascertainment of injury severity in cross-sectional studies.

Conclusions

This study provides population-based information on the spectrum of moderate and severe injuries to show the injury pyramid in a Nicaraguan community, where the coverage of hospital data is low. The results reveal that males, children and older people are most at risk, and that preventive initiatives should be targeted at home, traffic and violence.

This study also shows that stratifying injury by severity based on one scale alone may bias the ascertainment of injury at certain levels of severity. Therefore, to overcome this methodological issue, we recommend a combination of criteria to improve the measurement of magnitude and severity of injuries. Our results support the call for a careful evaluation of injury data sources and severity scores when planning injury prevention programmes.

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