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Social and Economic Consequences of Injury in a Developing Nation

by

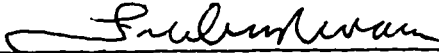
Charles Mock

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Abstract

Social and Economic Consequences of Injury in a Developing Nation

by Charles Mock

Chairperson of the Supervisory Committee
Professor Frederick Rivara
Department of Pediatrics

Efforts to study and prevent injury in the developing world are hampered by lack of adequate data sources. Vital statistics registries are often incomplete and health care data may be of limited value as many injured persons do not receive medical care. To better understand the incidence, characteristics, and outcomes of injury in a developing nation, the author undertook a population based survey of injury in Ghana. Using two stage cluster sampling with probability proportional to size, a sample of 21,105 persons in 431 separate clusters were selected. Information was sought on any injury which resulted in one or more days of loss of normal activity during the preceding year. A total of 1609 such injuries were reported. In the following dissertation, the author reports on: (1) methodologic issues concerning the effect of recall on estimation of incidence rates; (2) characteristics and outcomes of transportation related injuries; and (3) health care utilization patterns. It was found that: (1) There was notable memory decay during the one year recall period. The estimated annual nonfatal injury rate declined from 27.6/100/year for a one month recall period to 7.6/100/year for a 12 month recall period (72% decline). Memory decay was minimal for more severe injuries, those with disability times of 30 or more days. In this setting, shorter recall periods (1-3 months) should be used when estimating the overall injury rate. However, longer recall periods (12 months) may be safely used to study more severe injuries. (2) In urban areas, transportation injuries accounted for 16% of injuries, but were the most severe injuries in terms of disability time and treatment costs. Hence, these injuries should be a priority for prevention efforts. (3) Of the nonfatal injuries, 58% received formal medical care, with such care being less in the rural areas (51%) compared with the urban area (68%). These data indicate that health care records would under-estimate the significance of injury as a health problem in this setting and show the importance of the use of population based surveys.

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INTRODUCTION

In developing nations, infectious diseases have traditionally been the leading cause of death and disability. In recent years this pattern has changed, with decreases in infectious diseases due to successful public health campaigns. However, the rate of mortality and disability due to injury is rising in most developing nations, similarly to its increase in developed nations earlier this century. This is, in part, related to increased use of motorized transportation and increased industrialization [1-3].

Injury is now a leading cause of mortality among older children and working aged adults in most nations, developed or developing [3-6]. It is also a leading cause of disability, accounting for 11% of the disability adjusted life years (DALY) lost world wide [2-6]. Finally, it is also a leading cause of health related economic losses, from both treatment costs and lost productivity [7].

Efforts to combat the problem of injury in developing nations are hampered by lack of adequate data concerning its incidence and outcome. The usual sources which provide information on injury in developed nations are of limited value in developing nations. Vital statistics registries in many developing nations are incomplete, with many deaths from any cause not reported to the government. Health care records may also be of limited value, as many injured persons do not receive formal medical care [1, 3, 8].

The purpose of the current study was to obtain more exact information on the incidence, characteristics, and outcomes of injury in the setting of the developing world. Given the limitations of existing data sources, a population based survey was carried out in both urban and rural areas of the West African nation of Ghana. In the following dissertation, the author reports on several aspects of this study. In the first chapter, methodologic issues concerning the effect of recall are addressed. Surveys rely on retrospective self report by respondents and hence are potentially limited by the effects of incomplete recall due to memory decay. The extent and determinants of such memory

decay are discussed and the appropriate recall periods to use in subsequent studies on injury in developing nation are addressed.

In the second chapter, one of the most common mechanisms leading to serious injury in the study is discussed, namely transportation related injuries. Basic descriptive information is provided on whom the injuries are occurring to, what types of vehicles are involved, what types of injuries are being sustained, and what the human and economic consequences of these injuries are. It is hoped these data will be useful in the design of injury prevention strategies.

In the final chapter, health care utilization by injured persons is examined. Issues addressed include: overall usage of formal medical services, type of facilities used, determinants of use of formal medical services, and differences between urban and rural areas. It is hoped that these data will be useful in the design of injury treatment strategies and will also help to put data from health care records into proper perspective in this environment.

CHAPTER I. THE EFFECTS OF RECALL ON ESTIMATION OF ANNUAL INCIDENCE RATES FOR INJURY IN A DEVELOPING NATION

ABSTRACT

Objectives: Injury is becoming a major public health problem in many developing nations. Health care utilization data is of limited value as many injured persons do not receive formal medical care. Hence, population based surveys must be used and these primarily rely on retrospective self reporting. The value of such studies can be limited by incomplete recall. The nature and extent of such incomplete recall and the most appropriate recall period to use in population based surveys have not been addressed for the topic of injuries in the setting of developing nations.

Methods: A population based survey of injuries in the African nation of Ghana was conducted using household visits and interviews. Stratified, two stage cluster sampling with probability proportional to size was used to select subjects. Denominator information was obtained on 21,105 persons. Information was obtained on injuries resulting in one or more days of lost activity in the prior year. Timing of the injury and its severity in length of disability were obtained. Estimated annual nonfatal injury incidence rates were calculated for 12 recall periods (from 1 to 12 months prior to the interview, with each successively longer period inclusive of the preceding shorter periods).

Results: There was a notable decline in the estimated rate from 27.6 per 100 per year (95% Confidence Intervals (CI) 24.8, 30.4) for a 1 month recall period to 7.6 per 100 per year (95% CI 7.1, 8.1) for a 12 month recall period (72% decline). The extent of this decline was not influenced by age, gender, rural vs urban location, nor whether the information was obtained in person or by proxy. Rate of decline was influenced by severity of injury. Injuries resulting in < 7 days of disability showed an 86% decline (from 14.9/100 from 1 month to 2.1/100 for 12 month recall periods) whereas injuries

resulting in ≥ 30 days of disability showed only 17% decline (from 2.4/100 for 2 month to 2.0/100 for 12 month recall periods).

Conclusions: In this setting, longer recall periods significantly underestimate the injury rate compared to shorter recall periods. Shorter recall periods (1-3 months) should be used when calculating the overall nonfatal injury incidence rate. However, longer recall periods (12 months) may be safely used to obtain information on the more severe, but less frequent, injuries.

INTRODUCTION

In developing nations, infectious diseases have traditionally been the leading cause of mortality. In recent decades, the mortality rates from such diseases have been decreasing due to the success of public health programs. However, as a result of factors such as increased industrialization and increased use of motorized transport, injury related mortality and disability have been increasing in many developing nations. Injury is now one of the leading causes of mortality among adults and older children in most developing nations [1, 6, 9]. It is also one of the leading causes of disability in these age groups, accounting for 11% of the total disability adjusted life year (DALY) losses worldwide [2].

Efforts to combat the problem of injuries in the developing world are hampered by lack of adequate information concerning their incidence and outcome. In developing nations, vital statistics registries are often incomplete with a minority of deaths from any cause reported to the government [1, 3]. Health care utilization data may also be incomplete, as a sizable proportion of injured persons may not receive formal medical care [1, 3, 10]. Hence, population based surveys emerge as an important tool to obtain information about injury in these environments.

Population based surveys on injury usually rely on retrospective self report of injuries by respondents. Information obtained by this method may be subject to bias

from incomplete recall, primarily due to memory decay [11-13]. The extent of memory decay and the optimum recall period to use in population based surveys have been addressed for a variety of other health problems in developing nations [14]. These methodologic issues have also been addressed for population based surveys on injuries in the United States [12, 13]. However, they have not been well addressed for the topic of injuries in the setting of developing nations.

The purpose of this study was to evaluate the effect of memory decay by using different recall periods to estimate the annual incidence rate for injuries in a developing nation. We also sought to determine how the effect of memory decay would vary with different sub-populations and with different injury characteristics. By so doing, we hoped to determine the most reliable approach to handling recall bias in the collection and analysis of injury data obtained by retrospective self report in population based surveys in the setting of the developing world.

METHODS

Study setting: The study setting included an urban and a rural area in Ghana. This nation has a population of 17,000,000 and a per capita gross national product of \$390 (compared with \$25,800 for the USA). The urban area involved the Kumasi Metropolitan Area (population 654,000) and the rural area involved all or portions of four contiguous districts of the Brong-Ahafo Region: Berekum, Jaman, Wenchi, and Dormaa (combined population of 425,000).

Sampling strategy: Those selected to be interviewed were chosen using stratified, two stage cluster sampling with probability proportional to size. This sampling methodology has been used extensively in developing nations, where accurate listings of individual persons or households are not available. It has been found to provide a sufficient degree of statistical precision while minimizing expenditures of person-time in

the sampling process. The methodology used in this study has been adapted from that used by the World Health Organization's Expanded Program on Immunizations [15-18].

The urban and rural areas served as separate strata. In the first stage of the sampling process, subsets of the individual sections (Enumeration Areas) of Kumasi and the villages and towns of the rural areas were randomly selected with probability proportional to their populations [15-17]. This was done by listing the urban Enumeration Areas and the rural villages and towns with their corresponding populations. Cumulative populations were calculated for the list. A sampling interval 2,500 was chosen in accordance with sample size considerations. A random number, n , between 1 and 2,500 was chosen. The starting point for sampling was chosen by proceeding down the list of populations until a cumulative population of n had been accrued. The Enumeration Area or village or town corresponding to this population served as the first "cluster." The subsequent clusters were then systematically chosen at every 2,500 interval of cumulative population. This generated a list of Enumeration Areas (urban) and a list of villages and towns (rural) to be sampled. Each such site functioned as a Primary Sampling Unit in the sampling process.

In the second stage of the sampling process, research assistants visited each of the selected sites. They started in the center of the Enumeration Area or village or town, chose a random direction and a random percent of the distance from the center to the periphery of the sampling unit and chose the nearest household to this point. In the rural areas, determinations of center and periphery were made at the time of the visit. In the urban areas, such determinations were made in accordance with maps of the selected Enumeration Areas provided by the Ghana Statistical Service. The individuals in the first chosen household were then approached to obtain consent for the study and interviewed. The research assistants then proceeded sequentially to the nearest adjacent households, as needed. Research assistants worked for a minimum of two hours and surveyed a

minimum of 30 persons for the denominator at each site. More persons were surveyed at each site, if time permitted. All selected clusters were visited and surveyed.

Interview process: Information was obtained on any injury during the preceding year which had resulted in one or more days of lost activity or for which paid treatment was obtained. For those for whom there were no such injuries, demographic information on household members was obtained. For those to whom an injury had occurred, a six page questionnaire was verbally administered in the vernacular language (Ashanti Twi). This questionnaire concerned the mechanism of injury, injury sustained, treatment obtained, cost of treatment, and length of disability. Timing of the injury was also recorded in terms of time elapsed between the injury and the interview. Information was obtained from either the injured person or from their relatives, if the injured person was absent or was a child. Ten percent of sites were randomly chosen and revisited by the principal investigator (CM) to confirm the findings of the field workers. Data gathering was conducted from May to October, 1995.

Data management: Cluster size ranged from 30 to 131 persons (median 44). As the variable cluster size gave individuals in each cluster varying probability of selection in the study, weighting was performed. The weight for each individual was obtained by using the reciprocal of that individual's probability of selection, calculated as the sampling interval (2,500) divided by the number of individuals surveyed in that cluster. This was equivalent to the number of individuals in the base population represented by each individual surveyed in a given cluster [15, 19-22]. Hence, weights ranged from 19.1 to 83.3 (median 56.8).

Annual rates of injury were calculated for recall periods ranging from 1 month to 12 months in one month increments. Estimated annual rates based on a specific recall period were calculated as follows:

$$R_x = (n_x) / d_x,$$

where R_x = estimated annual incidence rate calculated from data using recall period of x months,

n_x = number of injuries reported as occurring during the preceding x months,

d_x = person-time in denominator for recall period x months.

Note that the recall periods are inclusive of injuries reported in preceding shorter recall periods. For example, all injuries reported in the 1 month recall period are also included in the 2 month recall period. Appropriate personal weights were used in all calculations.

In Kumasi, each cluster was categorized into high, medium, or low socioeconomic status, based on housing type [23]. In rural areas, clusters were ranked by access to motorized transportation: 1 (most access): paved road; 2: major unpaved road; 3: secondary unpaved road, indicating at least one motorized vehicle per day; 4: tertiary unpaved road, indicating motorized transportation less than daily or footpath access only.

Data was entered and formatted using Epi Info Version 6 (Centers for Disease Control, Atlanta, GA, 1994). Calculation of injury incidence rates and their 95% Confidence Intervals (CI) was performed using SUDAAN Version 7.1 (Research Triangle Institute, Research Triangle Park, NC, 1996). Comparison of categorical data was by chi-square. The study was approved by the Ministry of Health of Ghana. It was exempt from Federal Regulations, per Article 45-CFR-46 and per the University of Washington Institutional Review Board.

RESULTS

Denominator surveyed: A total of 21,105 persons living in 431 separate sites (clusters) were surveyed. These represented 2.0% of the 1,079,000 persons living in the

areas from which the sample was drawn. The urban sample included 11,663 persons in 263 clusters and the rural sample, 9442 persons in 168 clusters.

Injury incidence and effect of recall period: During the recall year, there were 13 fatal injuries reported, for a trauma mortality rate of 69/100,000/year (95% CI 30, 108). There were 1596 nonfatal injuries occurring to 1534 persons. 1473 persons reported one injury during the prior year; 61 persons reported two or more injuries. The majority (98%) of respondents were able to provide an estimate of the length of time which had elapsed between the injury and the time of the interview. Thirty six (2%) stated that the injury had occurred sometime during the prior year, but were not able to provide more exact information.

Analysis of the effect of recall period was carried out for the nonfatal injuries. Figure 1 shows the weighted annual injury incidence rates for all 12 recall periods. There was notable decline in the rate over these periods. The estimated annual rate declined from 27.6/100/year for a 1 month recall period to 7.6/100/year for a 12 month recall period. This represented a 72% decline. The largest single decline (28%) occurred between the first and second month. Two thirds of the total decline occurred between 1 and 3 months (49% decline from the total 72% decline). Thereafter the decline was approximately linear.

Figure 1 also indicates the annual injury rate estimated using data on the individuals who could only state that their injury occurred sometime during the prior year. This rate represents a slight increase in the rate estimated using a 12 month recall period. A similar trend was present for all categories in the subgroup analyses described below (data for the "1 year group" will not be shown for these).

The numerator of injury events includes more observations for the longer recall periods than for the shorter ones, which influences the precision of the estimates. It can be seen in Figure 1 that the confidence intervals are wider around the shorter recall period estimates (e.g. $\pm 9.9\%$ of the point estimate for the 1 month recall period) than around the

estimates of the longer recall periods (e.g. $\pm 5.2\%$ of the point estimate for the 12 month recall period).

Demographic characteristics: Injury rates were higher for males than for females for all recall periods (Figure 2). However, the decline in estimated annual rates from 1 month to 12 month recall periods were equal at 72% for both males and females.

Variations in injury rates by age are indicated in Figure 3 for children (<20 years of age) and in Figure 4 for adults (≥ 20 years of age). Injury rates were higher for the elderly (≥ 60 years) than for other age groups for all recall periods. Decline in estimated annual rates from 1 month to 12 month recall periods varied minimally among the different age groups. Such decline ranged from 63% for the 40 - 49 year age group to 75% for children aged < 5 years, with no consistent pattern among the age groups.

Geographic location: Injury rates were higher in the rural areas than in the urban for all recall periods (Figure 5). However, the decline of estimated annual injury rates with longer recall periods was similar for both locations. In the rural areas, estimated injury rates declined from 40.9/100/year with a 1 month recall period to 10.0/100/year with a 12 month recall period (75% decline). In the urban area, estimated injury rates declined from 19.1/100/year with a 1 month recall period to 6.1/100/year with a 12 month recall period (68% decline).

There were also limited differences in the extent of recall bias among the different community types in each geographic area. In the rural areas, communities were classified by their degree of remoteness based on transportation access. There was no difference in decline in estimated annual injury rates with different recall periods for these types of communities (Figure 6).

In the urban area, communities were classified by their socio-economic status based on housing type (Figure 7). There were slight differences among the communities, with middle income areas having higher estimated injury rates for most recall periods and

higher decline in rates for 1 month vs 12 month recall periods (72%) in comparison to either lower (66% decline) or higher (63% decline) income areas.

Respondent: Data was obtained on both persons who were present and those who were absent at the time of the interview. Designation of whether the person surveyed was present or absent for the interview was recorded for 19,748 of those surveyed (e.g. not recorded on the initial 1357 members of the denominator). The category present included both those answering on their own behalf and those who were present but had others provide the information (e.g. children whose parents answered for them). Of those for whom the designation of present vs. absent was recorded, 58% were present at the time of the interview and 42% were absent, with information about them being obtained by proxy from their relatives. Estimated injury rates were higher for those who were present at the time of the interview for all recall periods (Figure 8). This most likely represents under-reporting of injuries for those who were absent at the time of the interview. Such under-reporting most likely affected less severe injuries more so than the more severe ones. Among those who were present for the interview, 27% of reported injuries resulted in disability times of 30 or more days, compared with 31% of injuries among those who absent for the interview ($p=0.07$).

Despite these differences in reported rates, the declines in estimated annual rates from 1 month to 12 month recall periods were almost identical. Such decline was 73% for those who were present compared to 70% for those who were absent.

Severity of injury: Decline in estimated annual rates was most notable for less severe injuries (Figure 9). Estimated incidence rates for injuries with disability times of less than 7 days declined from 14.9/100/year for a 1 month recall period to 2.1/100/year for a 12 month recall period (86% decline). Estimated incidence rates for injuries with disability times of between 7 and 29 days declined from 10.4/100/year for a 1 month recall period to 3.3/100/year for a 12 month recall period (68% decline). Estimated incidence rates for the most severe group of injuries (those with disability times of 30 or

more days) varied minimally with different recall periods. As the disability time of 30 days would not pertain to injuries occurring within the month immediately before the interview, analysis of recall bias for the most severe category begins with a 2 month recall period (Figure 6). The estimated rates decreased minimally from 2.4/100/year with a 2 month recall period to 2.0/100/year with a 12 month recall period (17% decline).

DISCUSSION

Injury is emerging as a leading cause of death and disability in today's developing nations, in a similar fashion to its increase in the earlier parts of this century in developed nations [5, 24]. Efforts to deal with the injury problem in developing nations are hampered, in part, by lack of adequate data concerning its incidence and outcome. Vital statistics and health care utilization data are often incomplete in these nations [1, 3]. Population based surveys emerge as an important method to supplement these sources. Such population based surveys rely primarily on retrospective self report by respondents and hence are prone to a variety of their own shortcomings and potential biases. Among these, one of the most prominent is recall bias.

Recall bias can be introduced by either memory decay, the tendency to forget and to under-report events occurring longer ago, or by telescoping, the tendency to report events occurring outside the recall period as if they had occurred within it. Generally memory decay has been considered the more important of these two [11-13].

In developed nations, population based surveys on injury have been used primarily to provide supplemental data to that available from relatively complete vital registries and from hospital and other health service data [24, 25]. The most extensive of such data comes from the National Health Interview Survey (NHIS) [19, 24, 25]. This survey primarily utilizes a two week recall period. A supplement to this survey focused on children and was entitled "The Child Health Supplement" [12]. A one year recall period was used.

In one of the most extensive analyses of the effects of recall bias on estimated injury rates, Harel et al [12] used the Child Health Supplement data to examine the differences in estimated annual rates using recall periods varying from 1 month to 12 months, in a similar fashion to the current study. They analyzed injuries for which any medical treatment was sought or for which at least 1/2 day of usual activity was lost. They found a nearly linear decline in estimated rates from 24.4/100/year with a 1 month recall period to 14.7/100/year with a 12 month recall period (40% decline). Decline was less with injuries resulting in loss of at least one school day or with those requiring hospitalization or surgery (including suturing) than with more minor injuries [12].

In a similar study, Cash and Moss [13] looked at recall of injuries resulting from motor vehicle crashes in North Carolina and used mention of injuries in police reports as the criterion to which self reports were compared. The percent of self reporting of injuries which were identified in police reports decreased with recall period: 87% for <3 months; 79% for <6 months; and 73% for <12 months. Self reporting of injuries was more complete for more serious injuries. For the recall period of less than 12 months, reports of less serious injuries (bruises, abrasions, swelling, or no visible injury, but complaint of pain on police reports) was 67%. For more severe injuries (bleeding wound, distorted limb, or any ambulance transport), recall was 86%. Moreover, there was only slightly more under-reporting by proxy respondents than by the injured individuals themselves [13]. Both Harel et al [12] and Cash and Moss [13] recommended that shorter recall periods, on the order of 1-3 months, be used in similar survey situations.

In developing nations, population based surveys have been used extensively for a variety of entities, especially infectious diseases and maternal-child health related problems [14]. The issue of memory decay for these studies has been well addressed. Appropriate recall periods vary depending on the nature of the diseases. For events involving death, recall periods have varied from one year [26] to life time experiences,

such as deaths from childbirth occurring to a respondent's sisters within the respondent's life time [27]. However, for nonfatal diseases causing short periods of disability, such as diarrhea and febrile illnesses, short recall periods, on the order of 2-4 weeks, are generally utilized [14].

Population based studies of injury in developing nations have been scarce. The few such studies which have been done have been undertaken primarily in Asia [3, 28-30] and Latin America [31-33]. In studies of farm related injuries in rural Indian, Gordon et al [29] and Mohan et al [30] used 4 weeks recall periods with monthly visits to selected sites. A verbal autopsy study in Papua New Guinea revealed injuries to be the leading cause of death in the 15 - 44 year age group, a fact which was not reflected in official national health statistics. This study utilized existing verbal autopsy data collected from vital registry surveillance, which was carried out with monthly household visits using a one month recall period. This data was supplemented by every third year censuses, which used a three year recall period [3]. In a study utilizing both hospital and community based data in four Latin American nations, Bangdiwala et al used 2 - 3 month recall periods for less severe childhood injuries [31, 32]. Similar population based studies for sub-Saharan Africa have been rare and have focused mainly on burns [34, 35]. In both the study by Courtright et al [34] on burns in all ages and the study by Forjuoh et al [35] on childhood burns, recall periods included lifetime experiences of burned individuals.

The extent of recall bias and the issue of what should be an appropriate recall period to use in studies of injuries in developing nations have not been well addressed thus far. The purpose of the current survey was to obtain more complete information on injuries occurring in an African nation and to assess the extent and nature of recall bias in the resultant data.

The extent of memory decay as manifested by the decline in estimated annual rates from 1 month to 12 month recall periods was more pronounced in the data from Ghana

(72% decline) than in similar data from the USA (40% decline) [12]. Moreover there was a difference in the characteristics of the decline with increasing recall periods (Figure 1). In the data from the USA, the decline in estimated rates was approximately linear from 1 to 12 month periods [12]. In Ghana, there was an initial large decline over the first two months with the rate of decline becoming approximately linear thereafter.

It might be postulated that part of the reason for the greater extent of memory decay in the African data, compared to the USA, is a lower level of education and lower socioeconomic status in the African population studied, compared to the population of the USA. However, within the population studied in Ghana, there was minimal variation in the extent of memory decay between groups with differing socioeconomic status (SES) (Figures 5-7). In the urban area, there was a trend towards higher injury rates and higher extent of memory decay in the middle SES group. There is no apriori reason why this group should be different than both the higher and lower SES groups, which had similar rates and extents of decline (Figure 7). In fact, a higher injury rate might have been expected in the lower SES group. It was the subjective impression of the research assistants that many of those in the lower SES areas were less open in their discussions than were the other groups. This group was heavily comprised of ethnic groups from northern Ghana who were primarily Muslim and hence different from the majority indigenous population who were of Ashanti ethnicity and either Christian or animist. It is possible that members of the lower SES group were reluctant to provide information to the research assistants, who were primarily from the majority indigenous group. Hence, the lower injury rates estimated for this group might be reflective of a tendency toward under-reporting in comparison to the other SES groups. Trends in memory decay might thus be difficult to discern within this context.

It might also be postulated that the differences in the extent of memory decay between the USA and Ghana may be related to the different familial housing patterns and the manner in which the data was gathered. The National Health Interview Survey

employs interviews with nuclear families. One respondent typically answers for their spouse and offspring [12, 19]. In Ghana, many persons live in extended family groups in compound housing. It is typical for respondents in surveys to answer on behalf of brothers and sisters and their respective offspring as well as their own "nuclear" family. As a given respondent might be answering on behalf of more individuals and might be answering for individuals for whom he/she has less accurate knowledge than in the USA, it would be expected that the extent of under-reporting and memory decay would be more extensive [12]. However, data on the number in-person vs proxy respondents is not reported for the data from the USA [12, 19]. Moreover, the extent of decline in estimated annual rates with longer recall periods is similar whether respondents were present or absent for the interview in Ghana (Figure 8). Hence, if there was more use of proxy data in the Ghanaian survey, it could possibly have lead to more under-reporting overall, but is not likely to have contributed to greater memory decay.

Regarding determinants of differential recall, Harel also reported a somewhat higher extent of memory decay for injuries among those aged < 5 years. Otherwise, there was no difference among the different ages nor between males and females for the extent of memory decay [12]. In the present study, there was no meaningful differences in memory decay among the various age groups nor between the sexes (Figures 2-4).

The most significant determinant of memory decay in all studies is the severity of the injury (Figure 9) [12, 13]. In the present study, there was almost no variation in estimated annual injury rates over increasing recall periods for the most severe injuries, those resulting in 30 or more days of disability. It is interesting to note however, that the decline in estimated annual rates between 1 month and 12 month recall periods was actually fairly extensive for the next most serious category of injuries, those resulting in 7 - 29 days of disability (68% decline).

Despite the differences in the extent of recall bias due to memory decay in the above studies, there is little evidence of telescoping in either study. In neither study is

there an increase in estimated rates with 12 month recall period in comparison to 11 or 10 month periods, as might be expected if events occurring greater than a year before were being remembered and reported as occurring within the recall year [12]. Moreover, adding in the data for the individuals who could only remember that the injury had occurred during the past year, but not a specific month of elapsed time, increased the estimated annual injury rate only minimally in the Ghanaian data (Figure 1).

The estimated annual injury rate in Ghana calculated using the one month recall period is 27.6/100/year, almost identical to the rate of 27.2/100/year calculated using a two week recall period in the NHIS in the USA [19]. However, the injuries reported in Ghana were somewhat more severe than in the NHIS in the USA. In the NHIS, the entry criteria included all injuries: (i) which resulted in greater than 1/2 day of loss of normal activities or (ii) for which medical care was sought. Half (51%) reported loss of activity of greater than 1/2 day [19]. In the Ghanaian study, entry criteria were similar, but 99% (all except 4) of the injured reported one or more days of disability. Hence, there was most likely a tendency to under-report the more minor injuries in Ghana compared to the survey in the USA. Had there been equal reporting of injuries with equal severity, it seems likely that the estimated rate in Ghana would be higher than that in the USA.

Both Cash and Moss [13] and Harel et al [12] concluded that shorter recall periods of 1-3 months should be used in surveys of nonfatal injuries. Given that the extent of memory decay in the current study is even more significant than in their studies, similar recommendations pertain. In the setting of this and of other similar developing nations, use of longer recall periods can significantly underestimate the injury rate. Moreover, the drop off in estimated rates is most notable between one and two months. Hence, a one month recall period would seem to be a reasonable period to use in calculation of overall nonfatal injury rates in such settings.

However, population based surveys are used for somewhat different reasons in the environments of the developed vs. the developing world. In developed nations such as the USA, data on more serious injuries is fairly complete and easily obtainable from such sources as vital statistic registries and hospital records. Population based surveys are used to supplement such data sources and to provide data on less serious, nonfatal, nonhospitalized injuries [12, 19, 24, 25]. In developing nations such as Ghana, data on more serious injuries is less complete. Hence, population based surveys are needed to evaluate not only the less serious injuries, but also the more serious ones. Such injuries are less frequent (Figure 9). Use of shorter recall periods would capture less than would longer recall periods. Moreover, for the most severe group of injuries, there is minimal memory decay. For these injuries, longer recall periods would be more appropriate, as more serious injuries would be recorded for analysis, with minimal distortion of estimated rates by memory decay. This is of importance given that most such research work in developing nations is conducted with extreme limitations of finances and availability of person-time for the sampling process. Hence, maximum use of limited resources would be made by utilizing longer recall periods to capture more of the serious injuries for analysis.

It can be expected that the findings and recommendations from this study will vary between different developing nations. For the particular nation in this study and for other similar environments, it can be concluded that a year recall period is appropriate for studies in which information on more severe injuries is being sought, especially when other sources of information on such injuries are limited. However, for estimation of overall nonfatal injury rate (inclusive of lesser as well as more severe nonfatal injuries), shorter recall periods should be used. For studies in which both goals are to be met, use of one year recall period for data gathering, with subsequent re-analysis using a shorter recall period to estimate overall injury rate, is appropriate.

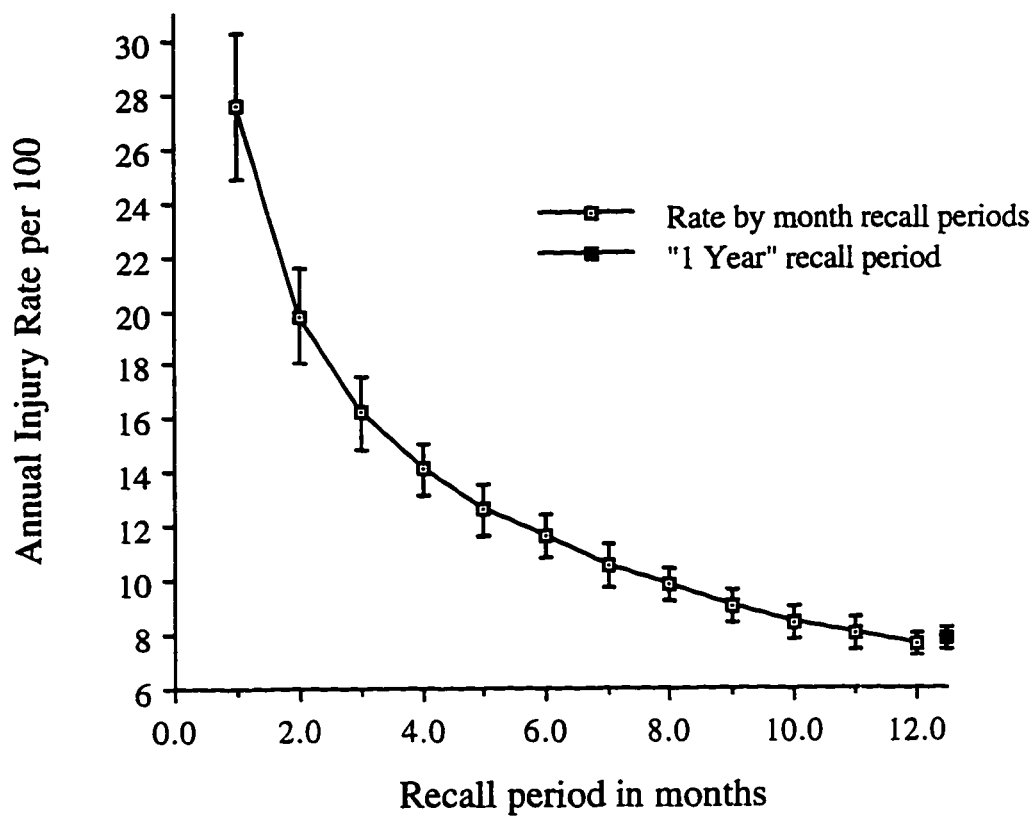


FIGURE 1. Estimated annual injury rate by one month recall periods. Data on individuals not able to recall the exact number of months elapsed since the injury are included in the "1 year" estimate. Bars indicate 95% confidence intervals.

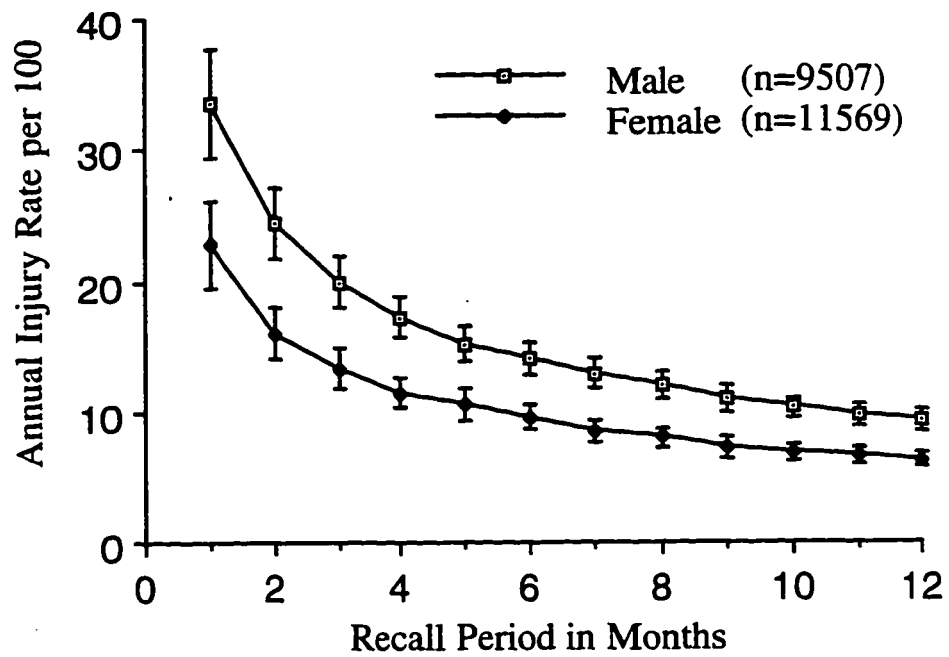


FIGURE 2. Sex specific estimated annual injury rates by one month recall periods. Data on gender missing for 29 members of denominator. Bars indicate 95% confidence intervals.

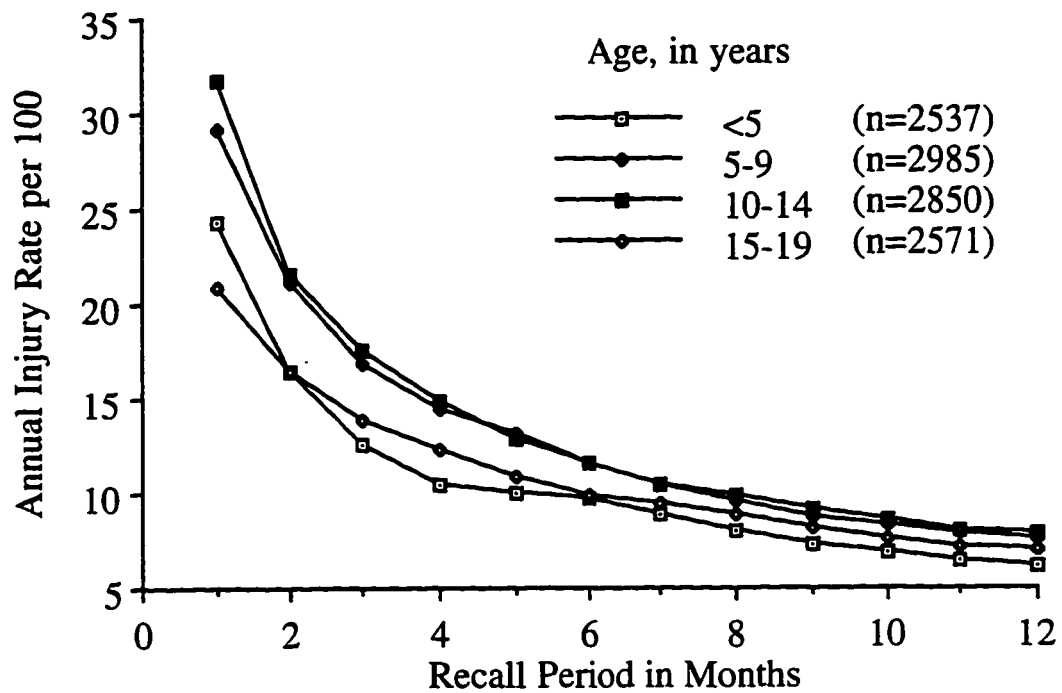


FIGURE 3. Age specific estimated annual injury rates by one month recall periods (for children). Data on age missing for nine members of the denominator.

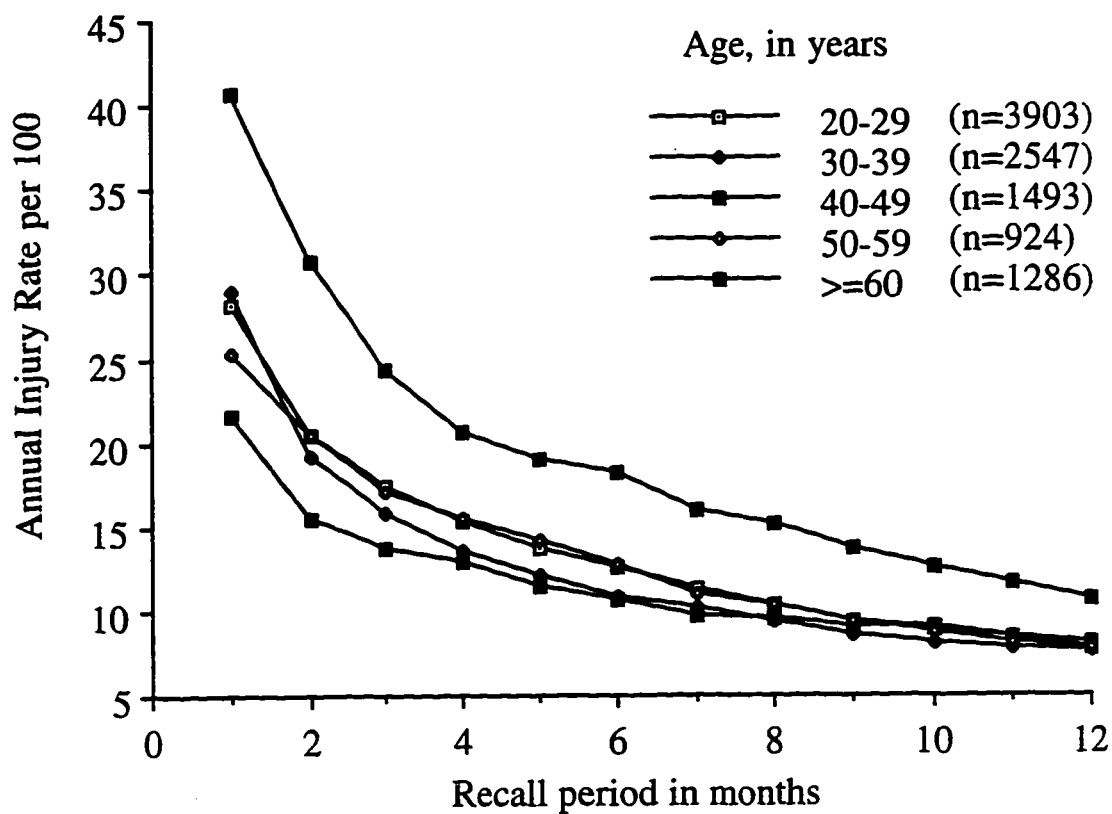


FIGURE 4. Age specific estimated annual injury rates by one month recall periods (for adults).

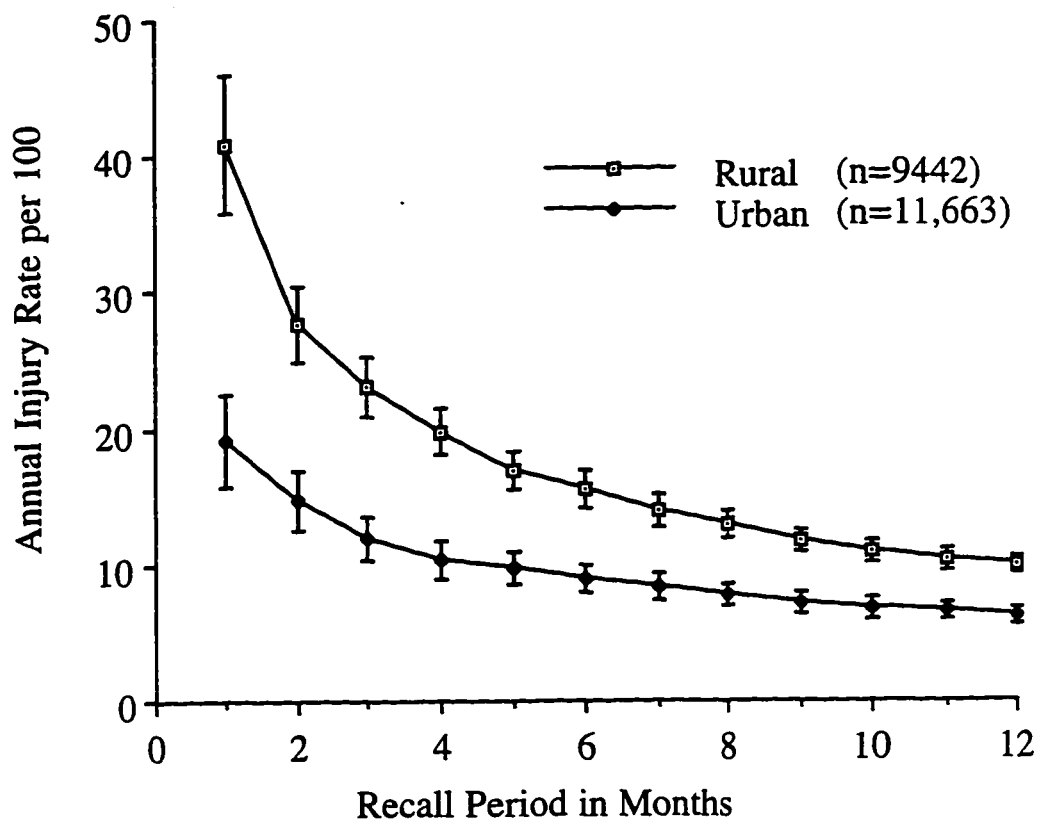


FIGURE 5. Estimated annual injury rates by one month recall periods for urban and rural strata. Bars indicate 95% confidence intervals.

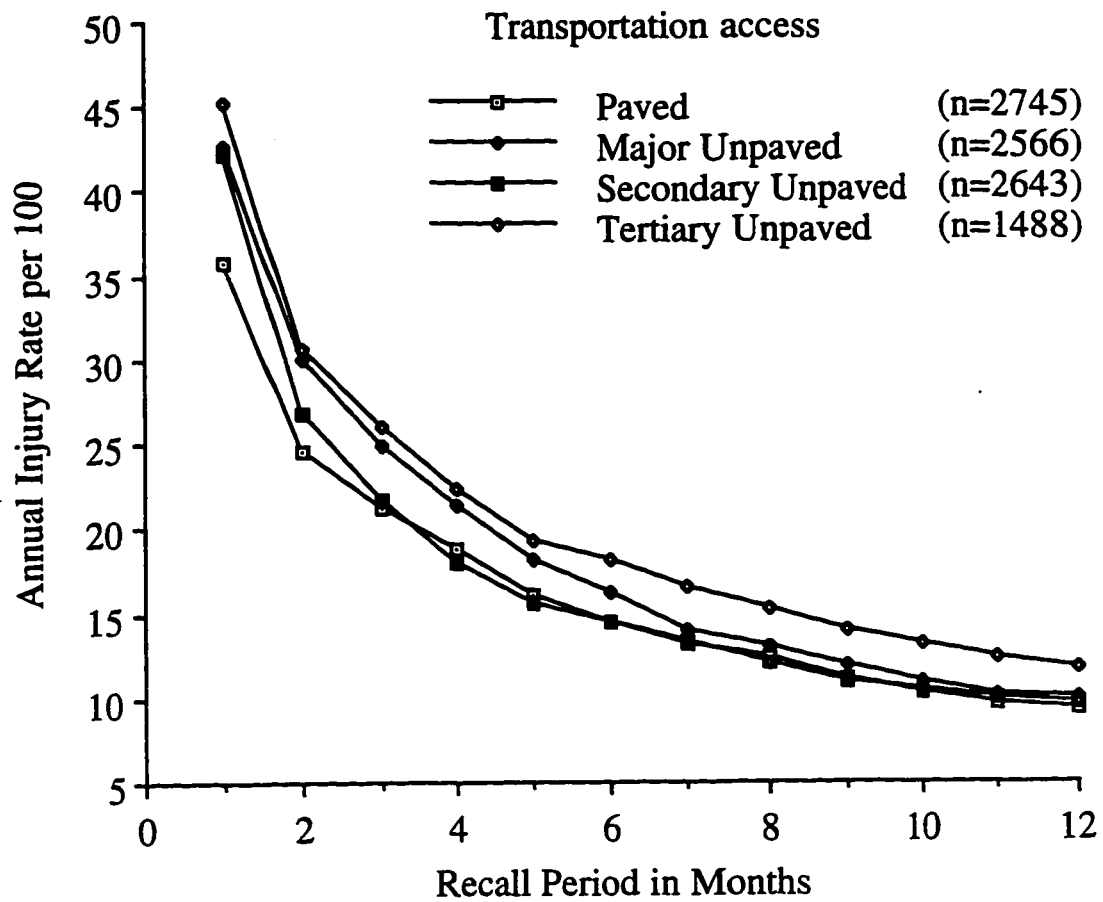


FIGURE 6. Estimated annual injury rates by one month recall periods for rural communities, classified by transportation access.

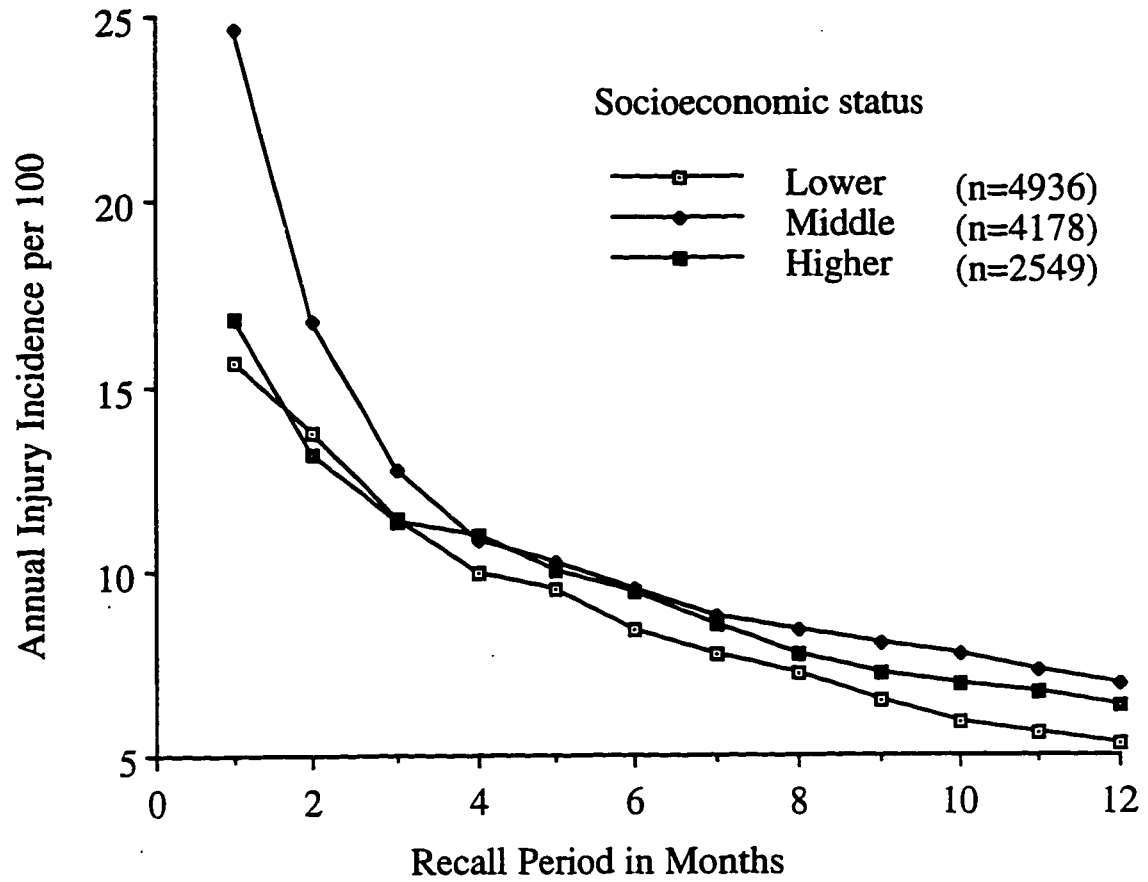


FIGURE 7. Estimated annual injury rates by one month recall periods for urban communities, classified by socio-economic status.

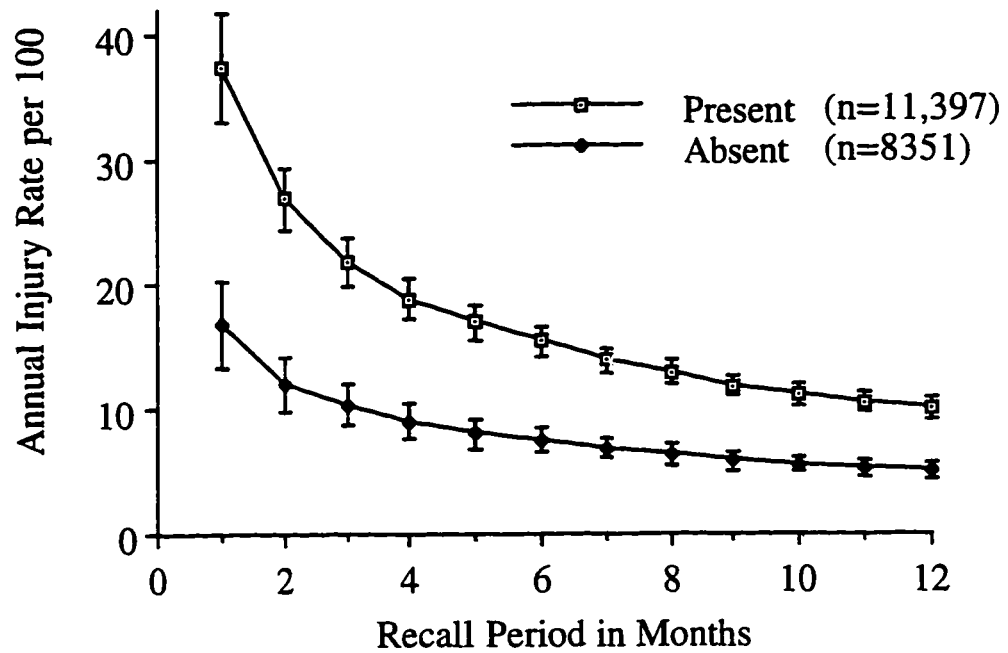


FIGURE 8. Estimated annual injury rates by one month recall periods for type of respondent (present vs absent). Data on type of respondent not recorded for 1357 members of the denominator.

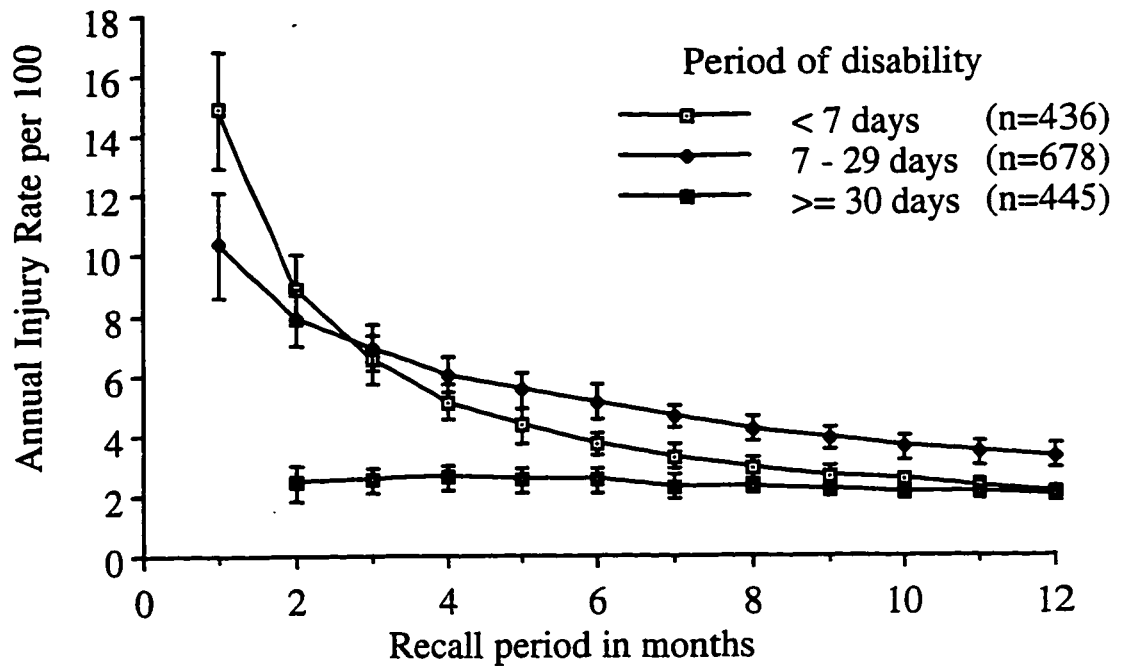


FIGURE 9. Estimated annual injury rates by one month recall periods for severity of injury based on days of disability. Data missing for 37 injured persons. Bars indicate 95% confidence intervals.

CHAPTER II: EPIDEMIOLOGY OF TRANSPORTATION RELATED INJURIES IN URBAN GHANA

ABSTRACT

To better elucidate the incidence, nature, and consequences of transportation related injuries in a developing urban area, we undertook an epidemiologic survey in Kumasi, Ghana. 656 (5.6%) of 11,663 persons surveyed had sustained an injury in the preceding year. Transportation related mechanisms accounted for 16% of these injuries, but were more severe than other mechanisms in terms of length of disability and cost of treatment. The majority of injuries were either to passengers involved in crashes of mini-buses or taxis (29%) or to pedestrians struck by these vehicles (21%). Prevention strategies may need to be fundamentally different from those of developed nations and need to target professional drivers more than private road users.

INTRODUCTION

Injury is well known as a major cause of death and disability in industrialized nations. However, its significance in developing nations is often not fully appreciated. Traditionally, infectious diseases have predominated as a cause of mortality in such developing nations. Injury, nonetheless, is often a major cause of mortality and disability among working aged adults and older children. Transportation related injuries stand out as being one of the leading contributors to such losses. This is especially true in those developing nations which have undergone increased motorization in recent years [3].

Efforts to combat the problem of injuries in developing nations are hampered, in part, by lack of data. As regards transportation related injuries, data sources typically include police reports and health care records. In developing nations, such secondary data sources are often incomplete. A minority of crash events are reported to the police. Tabulation of such data is frequently incomplete and often delayed for years. Many

injured persons may never seek formal medical care, rendering health care records an incomplete source of data as well.

Due to such difficulties with existing data sources, we undertook a primary epidemiologic survey of transportation related injuries in Ghana. We sought to more directly determine the incidence, characteristics, economic consequences, and outcomes of such injuries in an urban area of this nation. In so doing, we hoped to elucidate priorities for prevention strategies.

METHODS

The setting for the study was the Kumasi Metropolitan Area in the Ashanti Region of Ghana. This city has a population of 650,000. It is the second largest city in Ghana and the economic center of the northern 2/3 of the nation. Ghana itself has a population of 17 million and a per capita gross national product of \$390 per annum. In Kumasi, the majority of motorized transport is provided by taxis and mini-buses. Long distance inter-urban and rural travel is usually provided by government run buses and by privately run mini-buses.

Data on transportation related injuries occurring in Kumasi was obtained by a primary epidemiologic survey using household visits and interviews. Those selected to be interviewed were chosen using two stage cluster sampling with probability proportional to size (PPS). This sampling methodology has been used extensively in developing nations, where accurate listings of individual persons or individual households are not available. It has been found to provide a high degree of statistical precision while minimizing expenditures of person-time in the sampling process [16-18].

In the first stage of the sampling process, the individual sections of Kumasi were listed by their population. The Enumeration Areas employed by the Ghana Statistical Service for the 1984 Census were utilized. Each area had between 500 - 5000

inhabitants. A subset of these was randomly selected for sampling with probability proportional to their population size [16, 17].

In the second stage of the sampling process, each selected Enumeration Area was visited. Based on maps provided by the Ghana Statistical Service, a random location within the Enumeration Area was chosen and the nearest household to this location was then selected. Household members were interviewed regarding any injuries which occurred to themselves or other household members during the preceding year. For those for whom there were no such injuries, demographic denominator information on the household was obtained. Information was gathered for all persons who usually lived at the given household and not for visitors.

For those to whom an injury had occurred, a six page questionnaire was verbally administered in the vernacular language (Ashanti Twi). This questionnaire concerned the mechanism of injury, injury sustained, treatment sought, cost of treatment, economic consequences of the injury to the individual and his/her family, and outcome in terms of length of disability. Information was obtained from either the injured person themselves or from their relatives if the injured person was absent or under age.

Information was obtained on: (i) any injury during the preceding year which resulted in one or more days of lost activity or for which paid treatment was sought; (ii) any injury related fatality occurring during the preceding year to a person who had been living in that household; (iii) any disability which had resulted from an injury > 1 year ago and from which the person was still disabled. Such long-term disabilities were classified as "Major" or "Minor" based on a modification of the scale developed by MacKenzie et al [36, 37]. "Major disability" included patients with self care limitations or injuries which impaired ability to grasp with the hand or ability to walk more than 1/4 mile. "Minor disability" included patients with some limitation of function which was not severe enough to be classified as major.

Field workers worked for a minimum of 2 hours and surveyed a minimum of 30 persons for the denominator at each site. Larger numbers of persons were included at each site if time permitted. Ten percent of sites were randomly chosen and revisited by the principal investigator (CM) to confirm the findings of the field workers.

Economic data have been converted from the local currency (cedis) and expressed as US dollars. Statistical analysis of the results was by chi-square for categorical data and the unpaired Student's t-test and analysis of variance (ANOVA) for continuous data. Incidence rates have been calculated using appropriate personal weights as described in Chapter 1.

Incidence rates are expressed with 95% Confidence Intervals (CI) [17, 18, 38]. The study was approved by the Ministry of Health of Ghana. It was exempt from Federal Regulations, per Article 45-CFR-46 and per the University of Washington Institutional Review Board.

RESULTS

INJURIES DURING THE PRECEDING YEAR - Data was obtained on 11,663 individuals in 263 separate sites throughout Kumasi. 656 individuals (5.6%) had sustained 681 injuries which resulted in one or more days of loss of normal activity or for which paid treatment had been sought during the preceding year. 110 (16.2%) of these injuries were transportation related, for an annual incidence of 990 / 100,000 persons / year (95% CI: 773/100,000 - 1224/100,000).

Mechanisms of Injury - The most common mechanisms were motor vehicle crashes (47%) and pedestrian injuries (38%), with smaller numbers of motorcycle or bicycle crashes (Table 1). The mean age of all transport injured persons was 29.9 ± 18.1 (S.D.) years. Injured pedestrians were younger than those injured in other mechanisms ($p=0.012$), with a mean age of 23.1 ± 20.5 years and a median age of 13 years. 12% of injured pedestrians were ≤ 5 years old and 31% were 6 - 10 years old. The mechanisms

of injury were evenly distributed between the sexes, except for injured motorcyclists and bicyclists, who were all male (Table 1).

The category "Other" included three persons who fell from moving vehicles, two who were injured while pushing stalled vehicles, and one who was injured when a loaded tractor fell on him.

The majority of motor vehicle crashes (58%) involved buses and mini-buses (Table 2). There were smaller numbers of crashes involving taxis, private automobiles, and cargo trucks. Seventeen of the victims of crashes of buses/mini-buses could estimate the occupancy of the vehicles at the time of the crashes. Such occupancy ranged from 4 to 45, with a mean of 22.1 ± 10.4 occupants. There was a preponderance of mini-buses, with 59% of the vehicles having 20 or less occupants at the time of the crash, 18% with 21 - 30 occupants, and 24% with greater than 30 occupants.

Of those persons injured in motor vehicle crashes, only 10 (19%) were drivers, with the majority (81%) being passengers. Moreover, 80% of injured drivers were professional drivers.

The greatest number of injured pedestrians were struck by taxis (48%), buses (7%), and cargo trucks (7%). The injured motorcyclists and bicyclists were all driving their vehicles and none of these crashes involved collisions with other motorized vehicles.

Location and Time of the Injuries - The majority of injuries (82%) occurred on paved roads. Thirteen percent occurred on dirt roads, including either rural roads or unpaved residential streets in urban neighborhoods. The remainder (5%) occurred in off road locations. There were no differences between mechanisms for type of road.

Over half (60%) of the injuries occurred in the Kumasi Metropolitan Area. The other 40% occurred to Kumasi residents while they were traveling outside of Kumasi. There were major differences between the mechanisms of injury in their locations. Virtually all pedestrian injuries (97%) occurred within the city itself. However, only 28% of motor

vehicle crashes occurred in the city, the remainder occurring in other cities or on inter-urban and rural roads ($p < 0.001$).

Half (49%) of transportation related injuries occurred between Friday and Sunday inclusive, with no differences between mechanisms.

Most (71%) of injuries occurred during daylight hours (6AM to 6PM). The percent of injuries occurring during daylight was slightly higher for pedestrian injuries (73%) than for motor vehicle crashes (59%), but the difference was not statistically significant.

Outcome and Consequences of the Injuries - In the entire study, 8 deaths were reported. Six of these were transportation related, which accounts for 5% of all transportation related injuries in the study (vs 0.3% mortality for all other injuries in the study, $p < 0.001$). This gives an annual incidence of 67 deaths / 100,000 persons / year (95% CI: 14 / 100,000 - 120 / 100,000) for transportation related mortality in the urban population as a whole.

Five of the six fatalities occurred at the scene of the crash and relatives could not provide accurate details of the injuries sustained. Anatomic location of the injuries sustained were assessed for the nonfatal injuries. These were primarily injuries to the extremities, the face, and the head (Table 3).

Nonfatal transportation related injuries resulted in a mean of 64.0 ± 76.0 days of disability. These injuries were more severe than all other injuries combined, which resulted in a mean of 36.6 ± 84.3 days of disability ($p < 0.01$). Injuries sustained in motor vehicles crashes tended to have longer disability periods (mean of 86.9 ± 93.8 days) compared to pedestrian injuries (50.7 ± 56.0 days), motorcyclists (14.8 ± 11.9 days) and bicyclists (21.0 ± 34.0 days) ($p = 0.06$).

Seventy (64%) of those injured by transportation related mechanisms were working prior to their injury, 24% were students, and 12% were unemployed or at the extremes of age (≤ 5 or ≥ 65 years). Moreover, 27 (25%) of the injuries were occupationally related, primarily to traders ($n = 11$) or professional drivers and their assistants ($n = 11$).

Those 65 persons who had been working prior to nonfatal transport related injuries lost a mean of 80.5 ± 81.1 days of their usual activity. Forty two (65%) of these reported wage loss as a result of their injury. Thirteen individuals could estimate the amount at a mean of $\text{US}\$57.00 \pm \61.91 . This is in comparison to the minimum wage of $\$1.50$ per day in Ghana.

The majority of injured persons sought formal medical care, whether at a hospital (62%), private clinic (16%), other primary care site (4%), or some combination of these (6%). Sixteen percent of the injured sought the care of traditional indigenous practitioners, including herbalists and bone-setters. All except one of the latter also sought some form of formal medical care. Fourteen percent of the injured received no formal medical care, including five of the six fatalities. Interestingly, there was only a minimal difference in the severity of injury, as assessed by length of disability, between those nonfatal injuries for which formal medical care was sought (66.3 ± 72.7 days) and those nonfatal injuries for which no such formal care was sought (57.4 ± 71.5 days).

Cost for medical treatment was assessed to include payment for medical services, whether by hospital, private doctor/clinic, or traditional healer, and to include drugs and other materials purchased by the injured persons and their families. In Ghana, although the government does subsidize the operating costs of public hospitals, there is virtually no health insurance. Hospital fees and supplies are paid for out of pocket by patients and their relatives. Such out of pocket medical payments were estimated to be a mean of $\$100.05 \pm \228.80 per transportation related injury. This was significantly higher than that of all other mechanisms combined, for which costs were a mean of $\$19.83 \pm \58.71 ($p < 0.001$).

The economic effects of the transportation related injuries on the families of the injured persons were notable. 57% of the families noted a decline in family income, either on the part of the injured person or those who missed work to care for them. 36% of families reported a decline in food consumption as a result of the injury. 39% reported

borrowing money and going into debt to pay for medical care or to make up for lost income. The amount borrowed averaged $\$106.33 \pm \132.17 and 70% of respondents indicated that they were still repaying these debts. An additional 11% of respondents indicated that they had pawned or sold possessions to help obtain needed money as a result of the injury.

Permanent disability could not be assessed for injuries incident in the preceding year. However, of 26 persons who had been working prior to their injury and who were injured greater than 6 months previously, 31% had not yet returned to normal activity, indicating the potential for long-term disability and continued economic losses.

LONG-TERM DISABILITIES - Ninety four (0.81%) of those surveyed reported a disability which had resulted from an injury occurring greater than one year previously. Transportation related mechanisms accounted for 40 (43%) of these, with motor vehicle crashes causing 29 and pedestrian injuries 9. As with injuries sustained during the preceding year, the majority of motor vehicle crashes involved buses/mini-buses (66%). Pedestrians had been struck primarily by buses/mini-buses (56%) also. Only 4 (10%) of those disabled by transportation related injuries had been drivers of vehicles.

Persons with these disabilities due to transportation related injuries ranged in age from 7 to 90 years with a mean age of 44.9 ± 18.70 years. The disability producing injuries had occurred over a range of one year and one month to 35 years previously, with a mean period of 7.6 ± 8.9 years previously.

The nature of the disabilities was: decrease in ability to use arm or hand (58%); decrease in use of lower extremities (25%); impairment of vision (5%); and others (13%). Fifty percent of these disabilities were classified as major and 50% as minor. Transportation related mechanisms accounted for 53% of all major disabilities identified in the study.

Due to the long recall periods since these injuries, detailed information on mechanisms of injury and costs of treatment were not obtained.

DISCUSSION

Infectious diseases have historically been the leading health problem in developing nations. However, injury related mortality rates are often higher than rates in developed nations and injury primarily affects the most economically productive segment of the population, namely working aged adults. Moreover, while rates of infectious diseases are falling in many nations as a result of better public health measures, injury related death and disability are climbing in many nations due to increased industrialization and motorization [3, 5, 6].

Efforts to combat the problem of injuries in developing nations are hampered by restrictions of financial resources and also by lack of adequate data. Many developing nations can afford to spend only \$5 - 10 per capita per year for health [39], compared to \$3000 for the USA. In light of such limitations, prevention emerges as the most cost effective strategy to decrease the toll of death and disability from injuries. However, adequate data is often lacking to address where prevention priorities should be placed or to design effective prevention strategies.

Vital registry data is frequently incomplete in many developing nations, with a minority of the deaths of any cause being reported to the governments [3]. Crash statistics are rudimentary, if available at all. In Ghana, such statistics are collected from police records by the Building and Roads Research Institute [40]. The process takes 3 - 4 years between time of crash and the availability of collated data for statistical analysis. Health service data is also not reliable. Many injured persons may not receive formal medical care due to financial restrictions or to preference for traditional indigenous healers. Moreover, many hospitals in developing nations keep only rudimentary records.

Given these limitations of existing data sources, primary epidemiologic data gathering represents a method to obtain more accurate information on all injuries, including transportation related mechanisms. This was the goal of the current study.

Although this methodology offers advantages to existing data sources, it also has its own limitations. These must be addressed before drawing any inferences from the data. First, the study relied on self reports by respondents. There was no way to independently validate the veracity of their answers, especially as regards disability time or costs of treatment.

Second, the retrospective nature of the data gathering almost certainly led to some degree of recall bias. Injury events would more likely be forgotten as further time elapses from the time of injury. This "memory decay" results in incomplete reporting of injury events and is more pronounced for less severe injuries, especially those occurring a greater time in the past [11, 12]. There is reason to believe that such memory decay would be less in this study than for studies involving medical illnesses. Household visit and survey work from other developing nations have indicated that memory is typically better for discrete events such as injuries, than for medical illnesses [14]. Moreover, the year period used in this study offers a well defined period for recall.

Nonetheless, it could be anticipated that the study may have resulted in some under-reporting, especially of the less severe injuries. This possibility is suggested by the fairly high mean disability times found for transportation related injuries (64.0) and for all other injuries (36.6 days). The study had sought information on all injuries which resulted in one or more days of disability. However, only 25% of the transport injury victims in this study had a week or less of disability time. As these more minor injuries would be expected to be occurring with greater frequency than the more severe injuries, it seems the study has under-reported the less severe injuries and hence has relatively over-represented the more serious injuries. Although this may lead to the reported injuries being more severe than the "average" injury, it actually would lead to lower estimates of the overall incidence of injury and its consequences and costs. Hence, this study is more likely to under-estimate the significance of injury as a health problem rather than over represent it.

Third, the economic consequences of injuries are difficult to fully assess. Medical costs reported by the respondents may not be accurately remembered. The governmental contribution to medical care is not assessed by the study methodology. The economic consequences of lost work time are especially difficult to assess. Lost wages on the part of the injured persons represent a definite deleterious effect on the persons and their families. However, the loss to the economies of the developing nations is even more difficult to quantitate.

Lastly, despite the large sample size and large number of injuries reported in this study, there were only 110 transportation related injuries to analyze for the preceding year. This relatively small number limits the extent of the analysis which can be done, especially as regards geographic pattern and timing of injury events. Obviously, more complete surveillance data, rather than one time sampling data, is needed for such purposes.

Despite these limitations, the data from this study do allow some conclusions regarding the impact of transportation related injuries in this society and also allow some recommendations regarding prevention priorities and potential strategies.

Transportation related mechanisms accounted for only 16% of all injuries in this study. However, they accounted for 75% of the deaths in the study. In fact, the transport related mortality incidence of 67 / 100,000 / year is considerably higher than the corresponding rate of 20 / 100,000 / year in the USA [24]. The Ghanaian rate is an estimate with fairly wide confidence intervals and reflects only an urban population, which has greater exposure to traffic related risk factors than does the rural population. Nonetheless, these rates point out that transportation related injuries and deaths are at least as serious a public health problem in Ghana as in the USA, and likely more so.

The nonfatal transportation related injuries were also more severe than other mechanisms. Transportation related injuries resulted in longer mean disability times and higher treatment costs than did all other mechanisms. Likewise, transportation related

mechanisms accounted for the majority of those with major, long-term (> 1 year) injury related disability.

These data are in keeping with the findings of population based data from other developing nations for which such data exists, such as Latin America and east Asia, which show the pre-eminence of transportation related mechanisms of injury [3, 41, 42]. For example, injuries are now the leading cause of death in persons aged 1 - 44 years in many of the more advanced developing nations, including Taiwan, Mexico, Thailand, and parts of China. Transportation related mechanisms are the leading causes of such injury related mortality [3]. In Taiwan, motor vehicle crashes account for nearly half of all injury related deaths in persons over 14 years old and motor vehicle mortality rates have increased by three fold from 1967 to 1986 [41].

Population based data from the least developed nations, such as Africa, are extremely limited. However, hospital based data do suggest that transportation related injuries are one of the leading causes of more severe injuries in these societies. In an urban area of Nigeria, Elechi and Etawo found injuries to be the leading cause of hospital based death (10%) and the main reason for emergency visits (29%). Road traffic related injuries accounted for 26% of such injury related emergency visits, but 68% of injury related deaths [43].

In a rural area of Ghana, Mock et al reported that injuries accounted for 4% of hospital based deaths, but 9% of deaths in the 10 - 30 year age group. Transportation related injuries accounted for 29% of injury admissions and were the leading cause of injury related mortality (41%) even in a rural area with minimal distances of paved roads. In addition, 22% of survivors of injuries had some form of long-term, potentially permanent disability, with transportation related injuries being the leading cause of such disabilities (27%) [37, 44].

The current study also shows the relative importance of the different transportation related mechanisms of injury. Pedestrian injuries were nearly as numerous as motor

vehicle crashes. Their relative importance stands out in comparison to developed nations, where crashes predominate [24]. The other striking difference compared to developed nations is the predominance of crashes of vehicles involved in public transportation, especially the mini-buses. In developed nations, crashes involve a far higher percent of drivers and passengers of private vehicles.

The data from this study also stand out in comparison to that reported from some developing nations in other regions of the world. In many of these nations, especially in Asia, injuries to riders of motorcycles predominate [1, 3]. These data hence show the importance of looking at local factors and not assuming that the findings from developed nations or even other developing nations will hold in any given locality [45].

Nonetheless, some aspects of transport related injuries in Ghana are common to many other developing nations. The preponderance of buses, taxis and other publicly used vehicles in comparison to private cars has been noted in India, the Caribbean, Thailand, Ethiopia, and other nations [1, 46, 47]. The relatively high number of injured pedestrians in comparison to motor vehicle crashes has been reported from India [46], Papua New Guinea [48], and, in particular, Addis Ababa, Ethiopia, where pedestrians accounted for 91% of all motor vehicle related injuries [47].

In terms of development of strategies for prevention of transportation related injuries, this study shows two main target groups: child pedestrians and professional drivers. Children accounted for over half of the injured pedestrians in this study. The safety of child pedestrians has received considerable attention in developed nations. In developing nations, several have pointed out the high rates of pedestrian injuries, as noted above, and low cost preventive measures have been proposed and tested [49]. Some of these should be widely applicable, such as separation of pedestrian pathways from vehicle routes, greater use of pedestrian crossing signs, and improved urban roadway lighting [50]. Although these measures are being used to variable extents in many developing locations,

pedestrian safety has generally received low priority on the policy agendas in most developing nations [1].

Although drivers constituted a small minority of those injured in transport related mechanisms, the majority of victims of crashes were occupants in vehicles being driven by professional drivers, whether taxis, buses/mini-buses, or cargo trucks (Table 2). Similarly, the great majority of pedestrians were injured by vehicles driven by such professional drivers. Such a pattern is, in part, reflective of the vehicle fleet of Ghana. However, the pattern is considerably different from that seen in developed nations and indicates that special attention needs to be focused on professional drivers in prevention efforts. More needs to be known about their knowledge and attitudes concerning safety. Alcohol has been found to be a major preventable factor in motor vehicle crashes in developed nations, especially among private road users. Alcohol's role in developing nations has been scarcely evaluated [1], especially in situations such as Ghana's, in which professional drivers predominate.

As regards motor vehicle safety in general, other safety measures which have worked in developed nations and in some developing locations deserve mention, including: seatbelts, speed reduction, and improved vehicle maintenance. Many of the publicly used vehicles in Ghana are not equipped with seatbelts. Laws requiring seatbelts in vehicles imported into African nations have been proposed [50]. Speed reduction could be improved by both greater speed limit enforcement and by use of speed bumps at especially dangerous locations. Vehicle inspection in most developing nations is fairly lax [1, 40]. More attention needs to be directed to assuring proper maintenance of brakes, lighting, and signals. Such maintenance especially needs to be addressed for publicly used vehicles, which predominated in this study.

Although many of these safety approaches have been used extensively in developed nations, strategies for their implementation in developing nations may need to be different. In developed nations, efforts to promote the safety of private drivers and their

passengers have predominated. Importation of such techniques to developing nations may not be fruitful due to the entirely different nature of transportation related injuries here. The individual circumstances of each region and nation must be considered when designing these interventions.

Finally, a major impediment preventing wider adoption of transportation safety measures in developing nations remains lack of awareness of their importance on the part of the public and of many policy makers [1, 51]. Data on the human and economic consequences of injuries, as briefly reported in this study, needs to be brought to light on a wider scale. More data need to be collected on economic losses from lost work and from long-term losses from fatalities and permanent disabilities; on private and governmental expenditures for injury treatment; and on the costs of vehicle damage from crashes. These data will allow a better idea of the economic costs of transportation related injuries and hence a better idea of the ultimate savings to be realized by investments in prevention. Such data will ultimately be useful in lobbying and advocating for increased attention to the problem of injuries and road safety on the part of governments and organizations involved in international health.

CONCLUSION

Transportation related injuries account for a significant portion of all injuries in this developing urban area and are the most significant injuries in terms of disability time and economic consequences. In terms of prevention, the mechanisms of injury are fundamentally different from those of developed nations. The majority of injuries were to either passengers involved in crashes of public buses/mini-buses or pedestrians struck by taxis. Hence prevention strategies may need to target professional drivers more than private road users.

Among organizations involved in international health, low priority is typically given to injury control. The incidence rate, disability times, and treatment costs indicate that

injuries should receive greater attention, with transportation related injuries being of prime importance.

Table 1. Mechanisms of Transportation Related Injuries in Kumasi, Ghana.

| <u>Mechanism</u> | <u>N (%)</u> | <u>Age (years)*</u> | | <u>% male</u> |
|------------------|---------------|---------------------|-------------|---------------|
| | | <u>Mean</u> | <u>SD</u> | |
| MVC | 52 (47%) | 35.4 | 15.0 | 49% |
| MCC | 4 (4%) | 39.5 | 8.1 | 100% |
| Pedestrian | 42 (38%) | 23.1 | 20.5 | 60% |
| Bicycle | 6 (5%) | 23.2 | 14.1 | 100% |
| <u>Other</u> | <u>6 (5%)</u> | <u>31.3</u> | <u>19.0</u> | <u>50%</u> |
| TOTAL | 110 | 29.9 | 18.1 | 57% |

MVC = Motor vehicle crash; MCC = Motorcycle crash;

Pedestrian = Pedestrian struck by motorized vehicle;

SD = standard deviation.

*p=0.012 for differences between groups (ANOVA, df=4).

Table 2. Vehicles Involved in 110 Transportation Related Injuries in Kumasi, Ghana.

| <u>Vehicle</u> | <u>All injuries (%)</u> | <u>MVC (%)</u> | <u>Pedestrian (%)</u> |
|---------------------|-------------------------|----------------|-----------------------|
| Taxi | 27 (25%) | 5 (10%) | 20 (48%) |
| Car - private | 12 (11%) | 8 (15%) | 4 (10%) |
| Car - NFS | 4 (4%) | 2 (4%) | 2 (5%) |
| Bus/mini-bus | 34 (31%) | 30 (58%) | 3 (7%) |
| Cargo Truck | 12 (11%) | 6 (12%) | 3 (7%) |
| Motorcycle | 5 (5%) | 0 | 1 (2%) |
| <u>Other or NFS</u> | <u>16 (15%)</u> | <u>1 (2%)</u> | <u>9 (21%)</u> |
| Total | 110 | 52 | 42 |

MVC = Motor vehicle crash; NFS = Not further specified.

Table 3. Anatomic Location of Injuries in 104 Nonfatal Transportation Related Injuries in Kumasi, Ghana

| <u>Location</u> | <u>N (%)</u> |
|------------------------|-----------------|
| Head | 21 (20%) |
| Face | 22 (21%) |
| Neck | 5 (5%) |
| Chest | 15 (14%) |
| Abdomen | 4 (4%) |
| Upper Extremity | 33 (32%) |
| <u>Lower Extremity</u> | <u>52 (50%)</u> |
| TOTAL | 152 |

Total number of injuries adds to more than 104 due to injured persons with multiple injuries.

CHAPTER III. HEALTH CARE UTILIZATION BY INJURED PERSONS IN GHANA

ABSTRACT

Background: Assessment of the societal importance of trauma relies, in large part, on hospital and other health service data. Such data are of limited value in developing nations if a significant proportion of injured persons do not receive formal medical care.

Methods: We undertook an epidemiologic study of trauma in Ghana. Via household visits, we surveyed 21,105 persons living in 431 urban and rural sites.

Results: During the preceding year, there had been 13 fatal injuries (69/100,000) and 1597 nonfatal injuries resulting in ≥ 1 days of lost activity (7.8/100). Of the fatally injured, only 31% received formal medical care (hospital or clinic). Of the nonfatal injuries, 58% received formal care, but with major differences between urban and rural sites. Only 51% of rural injured received formal medical care, compared with 68% of urban injured ($p < 0.001$). Even among those with more severe injuries (disability time ≥ 1 month), 26% of rural injured never had formal care. Overall hospital use was especially low, with only 27% of all injured persons using hospital services. Among those with more severe injuries, 60% of urban, but only 38% of rural injured received hospital care ($p < 0.001$).

Conclusions: These data indicate low utilization of formal medical services by injured persons in this developing nation. Even many of those with severe injuries do not receive medical care, especially in rural areas. Assumptions which rely on health service data, especially hospital data, underestimate the importance of trauma. Appropriate commitment of health care resources might thus be affected. Population based data are needed to fully assess the extent and societal impact of injuries in developing nations.

INTRODUCTION

Assessment of the importance of trauma as a health problem relies on accurate sources of data concerning its incidence and outcome. In the United States and other developed nations, a variety of sources provide such data. Trauma deaths are recorded in state and national vital statistics registries, including the Fatal Accident Reporting System (FARS). Assessment of the importance of trauma also relies heavily on hospital and other health service data, including hospital records, hospital based trauma registries, and state wide hospital admissions data. Data on less serious injuries are also available from emergency room records [24, 25].

In developing nations, similar data sources may be unreliable. Vital registry data are frequently incomplete, with a minority of deaths from any cause being reported to the government [1, 3]. The limited data on trauma that do come from developing nations are heavily dependent on use of health care records, primarily from hospital admissions and emergency department visits [1, 3, 37, 43, 44, 52]. These data are of limited value, however, if many injured persons do not receive formal medical care. In addition to not fully representing the extent and consequences of trauma, such data may also distort understanding of the nature of the trauma problem by relatively under-representing particular mechanisms of injury, particular types of injuries, and particular segments of society. These suspect data are frequently utilized to direct the flow of limited medical and financial resources. Appropriate commitment of health care resources might thus be affected.

In order to more fully determine the extent of injury and its societal impact in a developing nation, we undertook an epidemiologic survey utilizing household visits and interviews with injured persons, whatever type of treatment they had received. We also sought to ascertain the extent to which injured persons do or do not receive formal medical care, in order to assess the reliability of health care data in this setting.

METHODS

Study setting: The study setting included an urban and a rural area in Ghana. This nation has a population of 17,000,000 and a per capita gross national product of \$325, compared with \$24,580 for the USA. Ghana's health care expenditures are \$8 per capita per year, compared with \$3,300 for the USA [39, 53]. The urban area involved the Kumasi Metropolitan Area (population 654,000) and the rural area involved all or portions of four contiguous districts of the Brong-Ahafo Region: Berekum, Jaman, Wenchi, and Dormaa (combined population 425,000).

Health care in Kumasi is delivered by two government hospitals, several government clinics, and numerous private clinics and private doctor's offices. Health care in the rural area is delivered by district hospitals and primary health care (PHC) clinics. The rural hospitals and clinics are jointly administered by the government and church organizations. The district hospitals all have surgical capabilities and are staffed by general practitioners, with no surgeon permanently on staff. The network of PHC clinics employ exclusively nonphysician health care providers (medical assistants, nurses, and community health workers). Two districts have one private doctor each. Each of the districts also has several licensed private clinics run by nurses or midwives.

In neither urban nor rural areas is there any pre-hospital emergency medical system. Patients are brought to the hospital by relatives, primarily using public transportation. At all government hospitals and clinics, staff are paid by the Ministry of Health. However, patients are required to pay user fees. At some locations, such payment is required prior to receiving care.

Sampling strategy: Those selected to be interviewed were randomly chosen using two stage cluster sampling with probability proportional to size. This sampling methodology has been used extensively in developing nations, where accurate listings of individual persons or households are not available. It has been found to provide a high degree of statistical precision while minimizing expenditures of person-time [16-18].

In the first stage, a subset of the individual sections (Enumeration Areas) of Kumasi and the villages and towns of the rural areas was randomly selected with probability proportional to their populations [16, 17]. In the second stage, a random location within each selected Enumeration Area or village/town was chosen and the nearest household selected to begin the interviewing process. Adjacent households were added as needed to reach a minimum of 30 persons for the denominator at each site or "cluster".

Interview process: Information was obtained on any injury during the preceding year which had resulted in one or more days of lost activity or for which paid treatment was sought. For those for whom there were no such injuries, demographic information on household members was obtained. For those to whom an injury had occurred, a six page questionnaire was verbally administered in the vernacular language (Ashanti Twi). This questionnaire concerned the mechanism of injury, injury sustained, treatment obtained, cost of treatment, and length of disability. Information was obtained from either the injured person or from their relatives, if the injured person was absent or was a child. Ten percent of sites were randomly chosen and revisited by the principal investigator (CM) to confirm the findings of the field workers. Data gathering was conducted from May to October, 1995.

Data management: Injured persons were classified as having used a "Hospital" if they used either inpatient or outpatient services at a hospital. They were classified as having used a "Clinic" if they used any other formal health care site, including urban government clinics, private clinics (including multi-doctor clinics and private doctor's offices), official rural PHC sites, and licensed private non-physician clinics. If an injured person visited both a hospital and a clinic, that person was grouped in the "Hospital" group. "Formal" medical care was considered as that rendered by either a hospital or a clinic. For persons sustaining more than one injury in the preceding year, the treatment rendered for each injury was considered separately.

Anatomic location of injury was assigned according to the 1990 Abbreviated Injury Scale [54]. Snakebites are included in this study, but as they are not coded by the Abbreviated Injury Scale, they are not included in analysis of anatomic location of injury.

In Kumasi, each cluster was categorized into high, medium, or low socioeconomic status, based on housing type [23]. In rural areas, clusters were ranked by access to motorized transportation: 1 (most access): paved road; 2: major unpaved road; 3: secondary unpaved road, indicating at least one motorized vehicle per day; 4: tertiary unpaved road, indicating motorized transportation less than daily or footpath access only.

Statistical analysis was by chi-square and logistic regression analysis, using Egret (Statistics and Epidemiology Research Corporation, Seattle, WA, 1991) and Epi Info Version 6 (Centers for Disease Control, Atlanta, GA, 1994). Incidence rates are expressed with 95% Confidence Intervals (CI), with the cluster sampling study design taken into account [17, 18, 38]. Appropriate personal weights were used in the calculation of incidence rates, as described in Chapter 1. The study was approved by the Ministry of Health of Ghana. It was exempt from Federal Regulations, per Article 45-CFR-46 and per the University of Washington Institutional Review Board.

RESULTS

Denominator surveyed: A total of 21,105 persons living in 431 separate sites (clusters) were surveyed. These represented 2.0% of those living in the areas from which the sample was drawn. The urban sample included 11,663 persons in 263 clusters and the rural sample, 9442 persons in 168 clusters. Fifty eight percent of the persons sampled for the denominator were present at the time of the interview and 42% were absent, with information about them being obtained from their relatives.

Incidence of injuries: A total of 1610 injuries were reported for the year preceding the interview. This included 13 fatalities, for a trauma mortality rate of 69/100,000/year

(95% CI 30 - 108 /100,000). There were 1597 nonfatal injuries occurring to 1534 persons, for trauma morbidity rate of 7.8/100/year (95% CI: 7.3 - 8.3/100).

Time lost from normal activities (disability time) averaged 28.5 ± 48.4 days for the nonfatal injuries. Disability time was used to characterize a subset of the nonfatal injuries as "severe": those with ≥ 1 month of disability. The percent of severe injuries was the same for urban (30%) and rural (27%) sites.

Overall health service utilization: Among the fatally injured persons, only 31% (n=4) received formal medical care. The majority (n=9) were reported to have died too soon after injury to be taken to a health care site. Among the four who did receive formal medical care, two died while hospitalized and two died at home after hospital treatment. Hence, only 15% of all trauma related fatalities would have been recorded in hospital based data.

Among the nonfatal injuries, 58% received formal (Hospital and Clinic) medical care (Table 4). This was less in rural areas (51%) than in urban areas (68%; $p < 0.001$). Even among the more severe injuries (disability time ≥ 1 month), 26% of rural injuries never had formal care. Hospital use was especially low, with only 27% of all injuries receiving hospital care. This was likewise lower in rural (20%) than urban (38%, $p < 0.001$) areas. Among the more severe injuries, 60% of urban, but only 38% of rural injuries received hospital care ($p < 0.001$).

Thirty one percent of injuries which received hospital services involved admissions to the hospital for one or more days. Among the severely injured group, 48% of those using hospital services were admitted. There was no difference between rural or urban areas as regards percent of hospital users admitted. However, as there were differences in overall hospital use, the percent of all injured who were admitted was higher in urban areas (11%) than in rural (7%, $p = 0.004$). Differences persisted when considering only the severely injured, 28% of whom were admitted to hospitals in urban areas compared with 19% in the rural area ($p = 0.04$).

A small number (3%) of the injuries received care from both hospitals and clinics. This was not different between urban and rural areas. All such injuries are included in the category "Hospital" in the tables.

In Kumasi, 220 injuries received care at clinics (whether alone or in combination with hospital care). These included: 74% by a private doctor or clinic; 24% at an urban government run clinic; and 2% at a rural PHC clinic outside of Kumasi. In the rural areas, 311 injuries received care at clinics: 88% at an official PHC site; 7% at a private non-physician clinic; and 5% by a private doctor.

Altogether, 225 injuries (16%) received care by practitioners not classified as formal medical care. These included 162 injuries (10%) treated by traditional indigenous healers, most often termed herbalists or bonesetters. The remaining 93 injuries (6%) received care from individuals of miscellaneous or questionable qualifications. These included sites whose identify or official status could not be substantiated (n=19) and pharmacies at which some medical care, other than the sale of medications alone, was rendered (n=26). In 37 cases, care had been delivered by a variety of individuals working in unofficial capacity, such as "drug peddlers," "private health workers," or relatives with some degree of medical training.

Utilization of formal medical services by demographic characteristics: There was no difference in utilization of formal medical services by sex. Utilization did vary slightly with age. For the 740 injuries involving persons aged less than 20 years, use of formal services was less (54%) than for the 857 injuries involving persons aged 20 or greater (61%, $p=0.005$). This also held true for severe injuries alone: 72% of 146 injuries to those aged less than 20 years received formal treatment vs. 81% of the 296 injuries to those aged 20 or greater ($p=0.03$).

In urban areas, there was a slight association between socioeconomic status and use of formal medical services. However, this did not pertain to hospital based care and did not pertain to formal medical care for more severe injuries (Table 5).

In rural areas, there was a strong association between transportation access for the community and use of formal medical services, both overall (Figure 10) and for severe injuries alone (Figure 11). In the more isolated areas, only 59% of severely injured persons had any sort of formal care and only 16% had hospital based care.

Utilization of formal medical services by mechanism of injury: Causes of injuries differed between urban and rural locations (Tables 6 and 7). In Kumasi, there were proportionally more falls (31%), transportation related injuries (15%), and assaults (9%), than in rural areas (falls 20%, transportation 9%, assaults 3%). Non-intentional penetrating injuries accounted for 17% of urban injuries, but in rural areas they constituted the largest single group (44%), the majority (68%) of which arose from non-mechanized agricultural work. (For overall differences in mechanisms between urban and rural sites: $p < 0.001$, $df = 6$.)

In both locations, there were significant differences among the mechanisms for use of any formal health service and for use of hospitals. In both locations, transportation related injuries and assaults were more likely to receive formal care and especially hospital treatment. These differences persisted when considering only severe injuries (Tables 6 and 7).

In the rural areas, there were especially large differences in the use of hospital facilities among the mechanisms (Table 7). Such discrepancies became more pronounced when considering only severe injuries, among which use of hospital services ranged from 10% (burns) to 70% (transportation related). The most frequent mechanism producing severe injuries in the rural areas, non-intentional penetrating injuries, had only 24% hospital utilization.

Utilization of formal medical services by anatomic location of injury: There was a predominance of extremity injuries in both locations (Tables 8 and 9). However, in the urban area, the proportion of persons sustaining injuries to the head (27%) or torso (10%) was higher than in rural areas (head 13%, torso 4%; $p < 0.001$ for each).

In both areas, injuries involving the head or torso were more likely to receive formal medical care and hospital care, even among the group with severe injuries. Variations in formal care and hospital care were moderate in urban areas (Table 8). However, in rural areas, there was wide variation in hospital use (Table 9), which became more pronounced in the severely injured group, where hospital use ranged from 10% (skin/burns) to 94% (torso). The most frequent site of severe injury in the rural areas, lower extremity injuries, had only 30% hospital utilization.

Multivariate analysis: As there were differences between urban and rural sites in several of the variables which were associated with use of formal medical services, a multivariate logistic regression analysis was carried out. The dependent variables rural location, age ≥ 20 years, mechanisms of injury, presence of injury to the head or torso, and disability time ≥ 1 month were investigated for their independent associations with use of formal health services and with hospital use (Table 10). Transportation related mechanisms, presence of injury to the head or torso, and severity of injury were independently associated with increased use of both formal health services and hospitals. Rural location remained independently associated with decreased use of both formal health services (odds ratio=0.51) and hospitals (odds ratio=0.40).

Reasons for not using formal medical care: Among the 676 nonfatal injuries for which no formal medical care was sought (urban and rural together), the most frequently stated reasons for not seeking such care were: financial restrictions (52%), preference for other treatments (37%), and too great a distance to travel to sites of formal treatment (8%). In rural areas, the proportion of those citing financial restrictions (58%) was higher than in urban areas (39%, $p < 0.001$).

DISCUSSION

Trauma's importance as a health problem in developing nations is frequently under-recognized. In such nations, infectious diseases and maternal-child health have

received considerable international attention. These problems are obviously of great importance. However, trauma is also a significant cause of death and disability [1-3]. When adequately studied, trauma has been found to be a leading cause of adult mortality in most developing nations, with mortality rates frequently higher than in industrialized nations [5, 6]. Trauma has also been found to be a significant contributor to both permanent and temporary disability. As those affected are frequently working aged adults, the economic effect of injuries is also likely to be substantial [1, 2]. Nonetheless, the attention which trauma receives in terms of research efforts and funding is minuscule in comparison to other health problems [1, 3, 55]. The old adage of trauma being the neglected disease of modern society is especially true in today's developing nations.

The magnitude of trauma as a health problem is not well recognized, in part, because of a paucity of adequate information and data sources. Similar difficulties obviously hinder efforts to combat other health problems in developing nations. However, for many of these problems, especially infectious diseases and maternal-child health, concerted international efforts have addressed such shortcomings in information and have utilized primary epidemiologic data gathering to discern the extent of the problems [1-3, 51].

Such epidemiologic studies have been infrequent for the topic of injuries in developing nations. The few such studies which have been done have been undertaken primarily in Asia [3, 28-30] and Latin America [31-33]. In a study in rural India in 1962, Gordon et al found an incidence rate of 116 injuries / 1000 persons / year, using a definition of any injury which disrupted normal activity [29]. In a more recent study in rural India, Mohan et al demonstrated a high incidence of extremity injuries from mechanized farm equipment [30]. Neither study reported on health care utilization rates. A verbal autopsy study in Papua New Guinea revealed injuries to be the leading cause of death in the 15 - 44 year age group, a fact which was not reflected in official national health statistics [3]. In a study utilizing both hospital and community based data in four

Latin American nations, Bangdiwala et al found that 40 - 60% of childhood injuries were missed by hospital based statistics [31, 32]. Similar population based studies for sub-Saharan Africa have been rare and have focused mainly on burns [34, 35].

The purpose of this study was to obtain a better understanding of the extent of trauma as a health problem in this African nation and to ascertain the extent to which injured persons utilized formal medical services. Before drawing inferences from the data, the limitations of the study methodology must be addressed. First, there is likely to have been some under-reporting of injuries due to forgetting or "memory decay" during the one year recall period. However, memory decay is less likely for more severe injuries, which were analyzed as a separate category [11, 12].

Second, the study relied on self report by respondents. There was no way to independently validate the veracity of their responses. It is likely that there was under-reporting of injuries due to mechanisms which would be sensitive to discuss, such as domestic violence and suicide. Both memory decay and hesitancy in reporting sensitive topics are likely to have resulted in under-reporting of injuries. Hence, the data presented represent a bare minimum estimate of the incidence of injury in the society.

Third, despite the sample size of 21,105, death from any cause is a relatively rare event. Although the confidence intervals for the overall trauma related death rate were fairly narrow, the study was not sufficiently powered to allow in depth analysis of different causes of trauma related deaths.

Finally, grading of severity of injuries by disability time might lead to differential ascertainment of severity in the groups with and without formal treatment. Those receiving formal treatment were likely to have the period of their disability shortened by the treatment. Hence, the group considered as "severely injured" might be biased towards containing a higher number of those not receiving formal treatment. Within the confines of the self reporting methodology, however, disability time remains the best available means to grade the relative severity of injuries.

Despite these limitations, the data presented allow an increased understanding of the extent and nature of trauma as a health problem in this developing nation, compared with what is available from existing sources. In terms of the extent of the problem, trauma related mortality in developing nations has been reported to range from 30 - 140/100,000/year [3]. The trauma related mortality in this study (69/100,000/year) is nearly identical that in the USA (60/100,000/year) [24]. This information would have been impossible to ascertain from established data. Vital registry data are incomplete in most developing nations. In the rural areas in this study, the only deaths typically recorded are those occurring in the hospitals [37, 44]. In urban areas, a greater proportion of deaths are registered, but assignment of cause of death is present for only a fraction. As discussed above, the potential biases of under-assessment in this study indicate that the mortality rate which is presented is a bare minimum estimate. Hence, it can be concluded that the trauma related death rate is at least as high as that in the USA, and likely higher.

In terms of trauma related morbidity, there are estimated to be 2.8 million hospital admissions for trauma annually in the USA, or 1,160 trauma related hospital admissions per 100,000 persons per year [24]. Data compiled from the National Health Interview Survey in the USA indicate a nonfatal injury rate of 5.8 injuries / 100 persons per year (for injuries which resulted in a half a day or more loss of activity, required hospitalization, or required some form of surgical treatment, including suturing and bone setting) [56]. Given the lower utilization of formal health services in Ghana, it is difficult to compare these numbers to those obtained from this study. However, the nonfatal injury rate of 7.8/100 per year (for injuries resulting in one or more days of loss of normal activity or for which paid treatment was sought), indicates that trauma related morbidity rate is at least as high in this society as in the USA, and likely higher. The trauma related mortality and morbidity rates reported in this study indicate that trauma in

developing nations should receive greater attention and should be placed higher on the agenda of international health policy.

In terms of the nature of the trauma problem in this nation, transportation related mechanisms stand out in the urban population. Increased rates of injury associated with increased use of motorized transportation has been noted in several developing nations [1, 3, 5, 57]. The findings from this study corroborate hospital based data from urban areas in Africa [43], and indicate transportation related mechanisms of injury to be of prime importance for prevention efforts. In rural areas, lacerations sustained during non-mechanized agricultural work predominated. Such injuries have received scant attention worldwide, despite their likely effect on food production [29, 58]. Greater attention in the form of research and prevention efforts is obviously warranted.

The data from this study also allow greater understanding of health service utilization in this environment, with resultant health service policy implications. In rural areas, use of the network of Primary Health Care clinics equaled hospital use for those with severe injuries. Training for the non-physician personnel who staff these clinics has typically emphasized preventive medicine and infectious diseases [59]. Such an emphasis is obviously warranted given the other health problems in the society. However, the high utilization of these clinics by severely injured persons indicate that greater attention should be paid to training in basic first aid and more in depth aspects of injury treatment.

Finally, this study points out the importance of epidemiologic data gathering and shows the relative value of different types of health service data in this environment. Trauma related deaths would be greatly underestimated by use of hospital based data, as only 15% of the trauma deaths recorded in this study occurred at a hospital. In the urban area, hospital use was reasonably high (60%) for severe, nonfatal injuries. Hence use of hospital data would allow meaningful conclusions to be drawn about this aspect of the injury problem. In rural areas however, hospital records would greatly underestimate the importance of trauma, with only one third of severe injuries receiving hospital treatment.

In addition to under-representing the extent of trauma, reliance on health service data would distort understanding of several aspects of the trauma problem. It would relatively under-represent certain mechanisms of injuries, such as agricultural injuries, and certain anatomic sites of injury, such as extremity injuries. The potential for such under-representation is evidenced by prior hospital based studies from the same rural area as in the present study [37, 44]. Lacerations sustained during agricultural work accounted for 10% of injury admissions [44], whereas the rural population based data showed such wounds to account for 40% of all severe injuries. Likewise, 38% of injury related admissions involved the extremities as region of principal injury [37], whereas the rural population based data showed 81% of severe injuries to involve the extremities. Reliance on health service data would also under-represent the significance of trauma among certain segments of the population, including poorer persons in urban areas and especially people living in more remote rural areas.

TABLE 4. Utilization of formal medical services for nonfatal injuries in an urban and a rural area in Ghana.

| | All injured* | | | | Severely injured* | | | |
|-------|--------------------|---------|----------|--------|-------------------|---------|----------|--------|
| | Number (n=1597) | No care | Hospital | Clinic | Number (n=445) | No care | Hospital | Clinic |
| Urban | 673 | 32% | 38% | 30% | 200 | 17% | 60% | 23% |
| Rural | 924 | 49% | 20% | 31% | 245 | 26% | 38% | 36% |

*p<0.001 for urban vs rural. Hospital indicates inpatient or outpatient. Severely injured indicates \geq 1month of disability.

TABLE 5. Utilization of formal medical services for nonfatal injuries in an urban area, based on socioeconomic status.

| Socioeconomic | All injured | | | | Severely injured | | | |
|---------------|-------------------|----------|----------|--------|-------------------|---------|----------|--------|
| | Number (n=673) | No care* | Hospital | Clinic | Number (n=200) | No care | Hospital | Clinic |
| Low | 244 | 37% | 37% | 25% | 75 | 20% | 55% | 25% |
| Medium | 282 | 32% | 40% | 28% | 87 | 14% | 67% | 20% |
| High | 147 | 29% | 37% | 34% | 38 | 18% | 58% | 24% |

*p=0.08 (X^2 for trend) for differences in presence or absence of formal medical care (Hospital and Clinic together) among the different socioeconomic strata. Hospital indicates inpatient or outpatient. Severely injured indicates \geq 1 month of disability.

TABLE 6. Utilization of formal medical services for nonfatal injuries in an urban area, based on mechanism of injury.

| Mechanism | All injured* | | | | Severely injured** | | | |
|--------------------------------|-------------------|---------|----------|--------|--------------------|---------|----------|--------|
| | Number (n=673) | No care | Hospital | Clinic | Number (n=200) | No care | Hospital | Clinic |
| Transportation | 104 | 10% | 69% | 21% | 55 | 7% | 76% | 17% |
| Burns | 60 | 30% | 45% | 25% | 13 | 0% | 61% | 39% |
| Assaults | 62 | 16% | 42% | 42% | 18 | 6% | 61% | 33% |
| Falls | 207 | 47% | 31% | 22% | 58 | 33% | 57% | 10% |
| Snakebites | 3 | 0% | 100% | 0% | 0 | | | |
| Non-intentional penetrating | 115 | 34% | 20% | 46% | 23 | 26% | 30% | 44% |
| Non-intentional blunt/Misc. | 122 | 40% | 34% | 26% | 33 | 12% | 61% | 27% |

* $p < 0.001$ (df=12); ** $p < 0.001$ (df=10) for differences between mechanisms for all categories of medical care. Hospital indicates inpatient or outpatient. Severely injured indicates ≥ 1 month of disability.

TABLE 7. Utilization of formal medical services for nonfatal injuries in a rural area, based on mechanism of injury.

| Mechanism | All injured* | | | | Severely injured* | | | |
|--------------------------------|-------------------|---------|----------|--------|-------------------|---------|----------|--------|
| | Number (n=924) | No care | Hospital | Clinic | Number (n=245) | No care | Hospital | Clinic |
| Transportation | 87 | 29% | 39% | 32% | 30 | 7% | 70% | 23% |
| Burns | 46 | 67% | 9% | 24% | 10 | 20% | 10% | 70% |
| Assaults | 31 | 33% | 35% | 32% | 13 | 8% | 69% | 23% |
| Falls | 182 | 59% | 18% | 23% | 43 | 49% | 33% | 19% |
| Snakebites | 55 | 40% | 27% | 33% | 20 | 20% | 45% | 35% |
| Non-intentional penetrating | 409 | 50% | 13% | 37% | 97 | 26% | 24% | 50% |
| Non-intentional blunt/Misc | 114 | 46% | 27% | 27% | 32 | 28% | 47% | 25% |

* $p < 0.001$ (df=12) for differences between mechanisms for all categories of medical care.

Hospital indicates inpatient or outpatient. Severely injured indicates ≥ 1 month of disability.

TABLE 8. Utilization of formal medical services for nonfatal injuries in an urban area, based on body part injured.

| Body part** | All injured | | | | Severely injured | | | |
|------------------|-------------------|---------|----------|--------|-------------------|---------|----------|--------|
| | Number (n=670) | No care | Hospital | Clinic | Number (n=200) | No care | Hospital | Clinic |
| Head*† | 179 | 20% | 48% | 32% | 50 | 8% | 74% | 18% |
| Torso*† | 67 | 13% | 61% | 25% | 24 | 0% | 83% | 17% |
| Upper extremity | 178 | 34% | 39% | 27% | 75 | 20% | 55% | 25% |
| Lower extremity* | 272 | 41% | 33% | 26% | 85 | 25% | 59% | 18% |
| Skin/burn | 60 | 30% | 45% | 25% | 13 | 0% | 62% | 38% |

**Sum of number of individual sites of injuries equals more than total number of injuries, as some injured persons had more than one body part injured. Snakebites excluded from this analysis. * $p \leq 0.05$ (df=2) for differences in medical care for presence vs absence of injury to this body part for all injured persons. † $p \leq 0.05$ (df=2) for differences in medical care for presence vs absence of injury to this body part for severely injured persons. Head includes face and neck. Hospital indicates inpatient or outpatient. Severely injured indicates ≥ 1 month of disability.

TABLE 9. Utilization of formal medical services for nonfatal injuries in a rural area, based on body part injured.

| Body part** | All injured | | | | Severely injured | | | |
|------------------|-------------------|---------|----------|--------|-------------------|---------|----------|--------|
| | Number (n=869) | No care | Hospital | Clinic | Number (n=225) | No care | Hospital | Clinic |
| Head*† | 119 | 36% | 35% | 29% | 29 | 10% | 69% | 21% |
| Torso*† | 40 | 33% | 53% | 15% | 16 | 0% | 94% | 6% |
| Upper extremity | 230 | 48% | 22% | 30% | 80 | 31% | 35% | 27% |
| Lower extremity* | 467 | 52% | 14% | 34% | 103 | 29% | 30% | 41% |
| Skin/burn* | 46 | 67% | 9% | 24% | 10 | 20% | 10% | 70% |

**Sum of number of individual sites of injuries equals more than total number of injuries, as some injured persons had more than one body part injured. Snakebites excluded from this analysis. * $p \leq 0.05$ (df=2) for differences in medical care for presence vs absence of injury to this body part for all injured persons. † $p \leq 0.05$ (df=2) for differences in medical care for presence vs absence of injury to this body part for severely injured persons. Head includes face and neck. Hospital indicates inpatient or outpatient. Severely injured indicates ≥ 1 month of disability.

Table 10. Results of multivariate logistic regression analysis for factors influencing use of formal health services and use of hospital services for nonfatal injuries.

| Factor | Formal care | | | Hospital care | | |
|------------------------------|-------------|------|------------|---------------|------|------------|
| | p value | OR | 95% CI | p value | OR | 95% CI |
| Rural site | <0.001 | 0.51 | 0.40, 0.64 | <0.001 | 0.46 | 0.36, 0.60 |
| Age \geq 20 years | 0.25 | 1.14 | 0.91, 1.44 | 0.23 | 1.18 | 0.90, 1.53 |
| Transportation* | <0.001 | 2.81 | 1.73, 4.57 | <0.001 | 2.12 | 1.36, 3.31 |
| Burns* | 0.47 | 1.20 | 0.73, 1.98 | 0.38 | 1.28 | 0.74, 2.22 |
| Assaults* | 0.10 | 1.69 | 0.92, 3.04 | 0.79 | 0.93 | 0.54, 1.60 |
| Falls* | 0.003 | 0.59 | 0.41, 0.84 | 0.10 | 0.72 | 0.49, 1.07 |
| Snakebites* | 0.026 | 2.05 | 1.09, 3.86 | 0.11 | 1.72 | 0.88, 3.38 |
| Non-intentional penetrating* | 0.05 | 1.40 | 0.99, 2.00 | 0.016 | 0.61 | 0.41, 0.92 |
| Head injury | <0.001 | 2.96 | 2.11, 4.16 | <0.001 | 2.15 | 1.56, 2.98 |
| Torso injury | <0.001 | 2.74 | 1.59, 4.72 | <0.001 | 2.87 | 1.80, 4.58 |
| Severe injury | <0.001 | 3.67 | 2.81, 4.81 | <0.001 | 3.70 | 2.84, 4.80 |

*Mechanisms of injury; non-intentional blunt/miscellaneous used as comparison group.

Formal health services indicates hospital or clinic. Severe injury indicates \geq 1 month of disability. OR = odds ratio. CI = confidence interval.

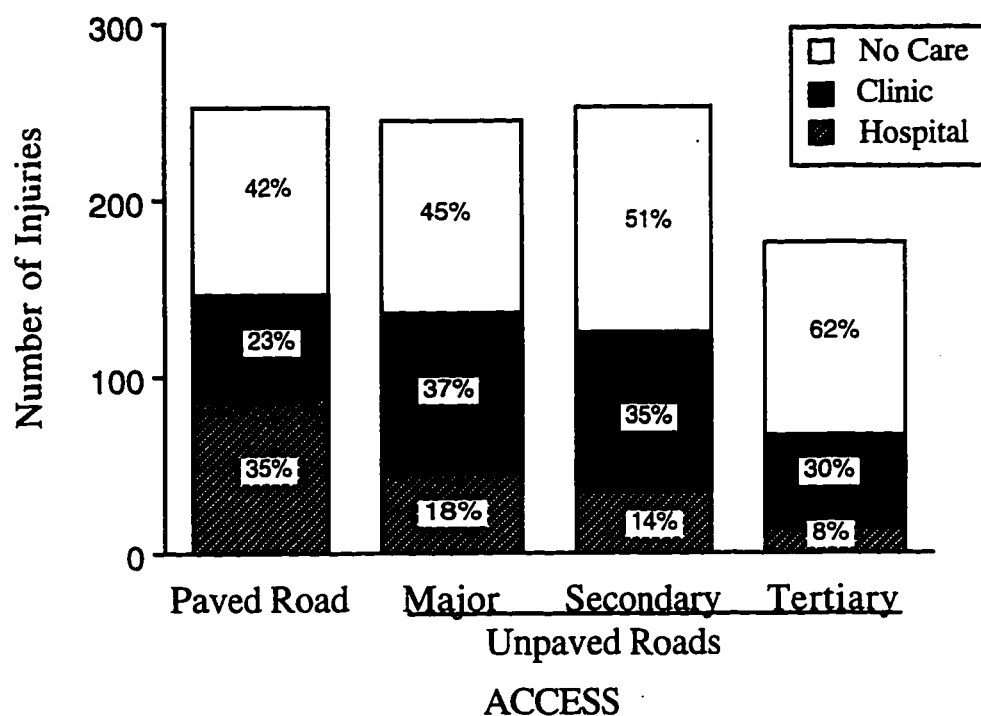


Figure 10. Utilization of formal medical services for nonfatal injuries in a rural area, based on transportation access for the community of residence of the injured persons. $p < 0.001$ ($df=8$) for differences between groups for types of medical care. Hospital indicates inpatient or outpatient. Secondary unpaved road includes those having at least one motorized vehicle passing per day. Tertiary indicates unpaved road with motorized transportation less than daily or footpath access only.

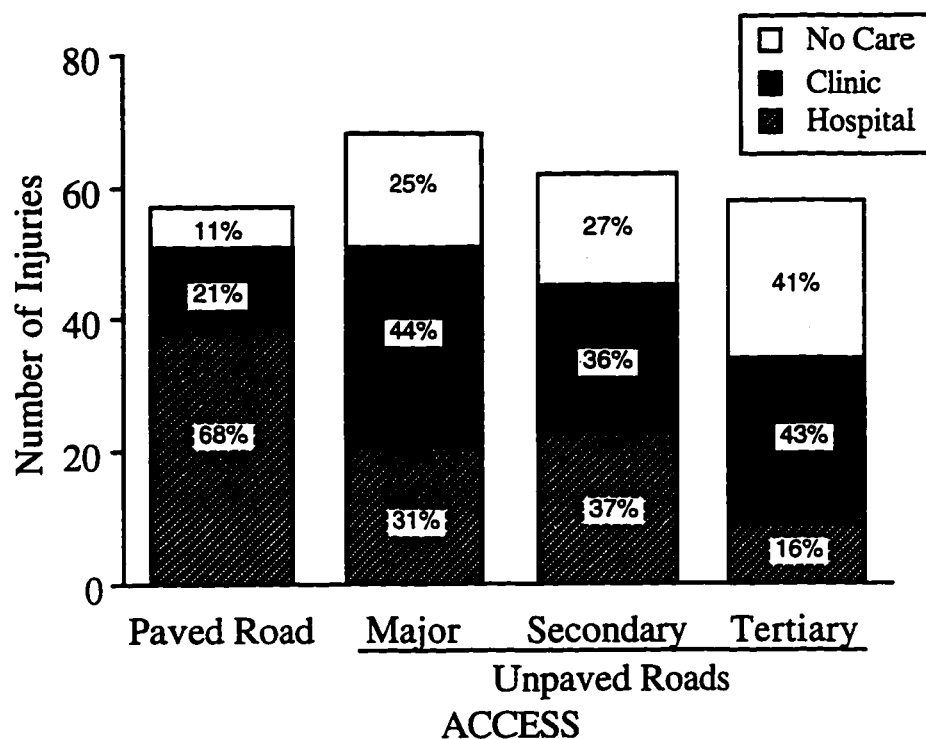


Figure 11. Utilization of formal medical services for severe (disability time ≥ 1 month) nonfatal injuries in a rural area, based on transportation access for the community of residence of the injured persons. $p < 0.001$ ($df=8$) for differences between groups for types of medical care. Hospital indicates inpatient or outpatient. Secondary unpaved roads includes those having at least one motorized vehicle passing per day. Tertiary indicates unpaved road with motorized transportation less than daily or footpath access only.

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Vita

Charles Mock

Brown University, Sc.B. (Biology), June, 1977

Brown University School of Medicine, M.D. June, 1980

University of Washington , School of Public Health, M.P.H., March, 1994