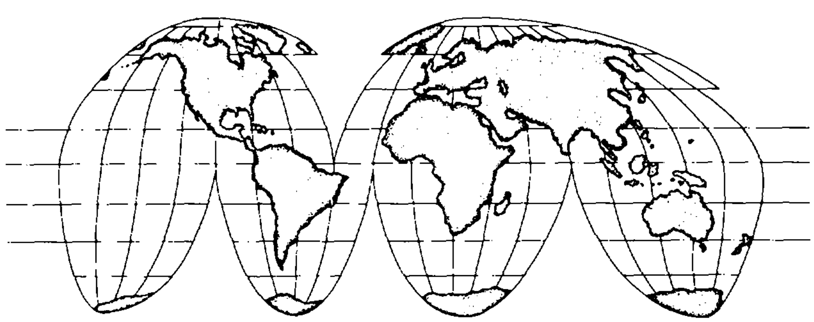
Current Problems in Producing Comparable International Mortality and Morbidity Statistics



International Comparisons of Injury Mortality: Hypothesis Generation, Ecological Studies, and Some Data Problems

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Abstract

Injury rates vary widely from one country to another. Analysis of differences in rates may suggest important new areas of research. This paper brings together a series of studies looking at the use of injury mortality data both to illustrate the potential usefulness of such analyses and to point out some of the problems in interpreting comparative data, especially in the elderly.

In two separate studies, one comparing France, Japan, West Germany and the United Kingdom, and another comparing New Zealand, Australia and United Kingdom, low unintentional injury rates were reported for the United Kingdom. Female suicides were higher in Japan and homicide rates for both males and females were much higher in the U.S. One recent study examined the association of per capita alcohol consumption and population–based injury fatality rates in the U.S., Canada, France, Finland, the Netherlands, and Switzerland. While cirrhosis deaths were highly correlated with per capita alcohol consumption, injury rates were not, except for suicide in some countries. Another study however, adjusted for exposure and found a high correlation between alcohol consumption and motor vehicle fatalities when they were calculated on the basis of deaths per 100 million vehicle–kilometers traveled.

Although their findings are interesting, these studies do not account for the many other differences between countries in injury rates. In addition to obvious exposure differences, an important factor to consider in any cross–national comparison is the quality and comparability of the data, especially that on underlying cause. France, for example, classifies a much higher proportion of its injury deaths as due to unspecified causes when compared to other countries. In addition, injury death rates in the elderly may be difficult to compare, as illustrated by large differences in fall injury mortality between New Zealand and the U.S. More in–depth analyses found similar incidence of falls as measured by rates of fall and hip fracture hospitalizations. Other studies have shown considerable under–counting of injury deaths in the elderly in the U.S. Reporting of such deaths in New Zealand appears to be more complete. Detection of large international differences in other disease rates has suggested important new hypotheses and the resulting in–depth research has advanced our understanding of disease etiology and prevention. One example is the association of diet and some cancers. Similar studies of differences in injury rates may suggest important new areas of research. However, relationships may be very complex and differences in injury classification between countries must always be considered.

Introduction

Injuries remain an important cause of death in most countries and are usually the leading cause of premature mortality in most of the more developed countries. However, injury rates vary widely from one country to another (Rockett & Smith, 1989; Taket, 1986).

Detection of large international differences in rates for other diseases such as cancer have been important in both assessing the relative magnitude of disease burden between countries and in stimulating new research efforts (Reid, 1975). Such studies have suggested major new hypotheses which led to more in–depth studies to understand both disease etiology and prevention. In cancer research, for example, major differences in cancer rates between countries (Armstrong & Doll, 1975, Schrauzer et al., 1977) stimulated hypotheses on the relationship of diet and cancer and subsequently led to major insights into the importance of dietary factors in both causative and inhibitive roles (Wilett & MacMahon, 1984). Our earlier work has suggested that similar analyses of differences in injury rates between countries may also lead to important new insights for understanding the etiology and prevention of injuries (Rockett & Smith, 1989a, b).

What can we learn by conducting studies of differences in injury rates between countries? Are some countries more successful in injury prevention efforts than others? How can we learn from success stories in other countries? Are the observed differences real or simply due to differences in the way the data are collected and analyzed? Can cross–national studies suggest ways to improve our own data and make it more useful for prevention purposes? This study brings together a series of such studies in order to illustrate the potential usefulness of comparisons, to demonstrate the need to extend the research using more detailed models to explain differences, and also to point out some of the problems in comparing data from one country to another.

A number of the examples used to illustrate these points are based on our own earlier published research. This paper summarizes much of this work and relates it to work by other researchers. The reader should refer to the original articles for more detailed findings.

Cross National Injury Mortality Studies

All–Cause Mortality, Five Countries

The first in a series of three papers comparing injury mortality between countries compared cross–national all–cause injury mortality data in five countries: The United States, France, Japan, West Germany and the United Kingdom. Marked differences in both all–cause injury death and age–adjusted years of life lost (an indicator of premature mortality) were found among the five countries (Rockett & Smith, 1987). These five countries were chosen because they had large populations, were similar in terms of levels of development and had close social, political and economic links with the U.S.

Cause–Specific Mortality, Five Countries

The purpose of the second paper, which will be discussed here in more detail, was to describe the epidemiology of specific injuries in the five countries above as a basis for formulating hypotheses for potential differences between countries. Data for 1980 were abstracted from age–, sex– and cause–specific tabulations of injury published in the World Health Statistics Annual (WHO, 1982–84). Four separate causes of injuries were examined: motor vehicle fatalities, falls, homicide and suicide. Age and sex–specific rates were compared among countries.

Motor vehicle crashes were the leading cause of male injury death in all countries except for Japan (see Figure 1). For females, motor vehicle crashes were the leading cause only in the U.S. and were surpassed by suicide, falls or both in the other countries. Age–specific motor vehicle mortality rates were bimodal in all countries with peaks at ages 15–24 years and in the oldest ages.

Fall mortality rates were low in all countries except in the elderly, among whom rates are substantially higher (see Figure 2). They varied widely, with France exhibiting the highest rates and Japan the lowest. Rates in the U.S. were also low, as will be discussed later in this paper.

Suicide rates were highest among elderly French males and lowest in the U.K. (see Figure 3). Elderly females in Japan have much higher suicide rates than female counterparts in the other countries examined. Another study found elderly female suicide rates to be even higher in China (Lei & Baker, 1991). A striking finding is that the suicide rate in U.S. females declined after ages 45–54, while it increased in the other countries studied.

The most notable differences among countries were for homicide, with most countries except the U.S. having relatively low rates and little variation by age (see Figure 4). The marked excess in rates for young U.S. males has been well described in the literature, (Fingerhut & Kleinman, 1990; Kellerman et al., 1991). However, most studies concentrate on young males, yet homicide rates are markedly elevated in the U.S. at all ages, including for females.

Injury Mortality Australia, New Zealand, United Kingdom

Our third paper compared injury rates in Australia, New Zealand and the United Kingdom, three countries with similar origins (Rockett & Smith, 1989b). Mortality rates were relatively similar in Australia and New Zealand, however, their rates were almost double those in the United Kingdom. The biggest differences were for motor vehicle crashes and suicide, which explained about 75 percent of the variation in rates.

Overall Findings

Overall, the two studies comparing France, Japan, West Germany and the United Kingdom and the third comparing New Zealand, Australia and the United Kingdom found unintentional injury rates to be much lower in the United Kingdom and Japan. Female suicide rates for Japan were high and have subsequently been studied in more detail in a recent follow-up paper (Rockett & Smith, 1993). Very high rates were reported for homicide in the U.S., for both males and females. The role of firearms in U.S. homicides has been well described (Kellerman et al., 1991), including comparisons of homicide rates between Vancouver and Seattle, two similar cities but with very different handgun control policies (Sloan et al., 1988). To date, few studies have done similar comparisons to explain markedly divergent unintentional injury rates among countries.

Ecological Studies: Alcohol as a Case Study

While these comparisons of mortality data point out large differences in injury rates between countries, they can only suggest hypotheses for factors that may be important. The next step is to examine in more detail possible exploratory factors. One important risk factor for injuries is alcohol use (Smith & Kraus, 1988). Alcohol consumption is also known to vary widely across countries (Giesbrecht & Dick, 1993). Cirrhosis death rates, for example, have been shown to be highly correlated with alcohol consumption among countries (and within countries over time).

How do injury rates correlate with alcohol use between countries? One recent paper examined the association between per-capita alcohol consumption and injury fatality rates (or casualty statistics, as they called them) from 6 countries in Europe and North America (Finland, France, the Netherlands, Switzerland, Canada and the U.S.) (Giesbrecht & Dick, 1993). These countries were chosen because they represented a range of different patterns of alcohol consumption. Alcohol consumption patterns in the U.S. and Canada are very similar, with both countries being in the medium range compared to other countries, and both showed a steady, moderate increase in per capita consumption from 1961 – 1988 (the period being studied). Beer is the beverage of choice in both countries. Alcohol consumption increased markedly in Finland and the Netherlands over the same period, from low levels to moderate or high levels. Finland has higher levels of spirits consumption while people in the Netherlands drink more wine. In France, alcohol consumption levels have actually declined, although their current levels are still in the high range compared with other countries. In Switzerland, alcohol consumption patterns have remained high and stable. Switzerland has a similar drinking culture to France except, that beer is more popular than wine.

Mortality statistics from each of the six countries for the years 1962–88 were obtained from the same WHO Statistics Annuals described earlier (WHO – multiple years). The following categories were analyzed: "Chronic liver disease and cirrhosis, motor vehicle traffic accidents, other transport accidents, accidental poisoning, falls, fires and flames, drowning and submersion, machinery, and accidents caused by firearm missiles, all other accidents including late effects, suicide and self-inflicted injury, homicide and injury purposely inflicted by other persons, and other violence." Regression time series analyses, with "filtering" to account for auto-correlation, were used to compare trends of consumption and mortality rates (Skog, 1987).

The mean rates of cirrhosis deaths and "other accidental deaths" were highest in France. Finland had the highest mean rates of other transportation deaths, poisonings (including many alcohol poisonings) and drownings. As noted also in our earlier work, the U.S. had the highest level of homicide deaths. As found in other studies, liver cirrhosis rates were most highly correlated with alcohol consumption, but the strength of association varied widely by country, being highest in Canada with a correlation coefficient of 0.75 for males (see Table 1). The only other significant associations were for suicide in Finland (males and females) and in the Netherlands for females only (data not shown), with weak associations with suicide in France for both sexes. There were no consistent associations found between per capita alcohol consumption and injury rates for the other injury causes examined.

While studies such as this can suggest potential correlations and areas for further research, they say nothing about the involvement of alcohol in particular injuries. There are also a wide variety of other factors that can influence injury mortality rates. More in depth studies are needed that examine the complex interactions among a wide variety of factors that determine injury risk. For example, the above study by Giesbrecht (1993) used only population-based mortality rates and made no attempt to adjust for important exposure differences between countries. This important methodological issue is illustrated well by another study that examined motor vehicle mortality rates using population-weighted, least-squares multiple regression rather than time series analysis (Lowenfels & Wynn, 1992). Using the same per capita alcohol consumption data as in the other study, Lowenfel and Wynn found a very strong correlation between per capita alcohol consumption and motor vehicle fatalities in 19 countries (Figure 5). An important difference however, was that the authors used the annual mortality rate per 100 million vehicle-kilometers travelled rather than just per 100,000 population. The relationship was moderately strong ($r=0.62$, $p<.001$) but was increased considerably when another potential confounder, percent of roads paved, was added to the regression equation ($r=0.83$, $p<.001$). These two factors alone were related to 70 percent of the variation in vehicular fatalities and the fit of the model was not improved measurably by the addition of other potential explanatory variables such as population density, blood alcohol level of the driver or percent of alcohol consumed as spirits.

The wide discrepancy of findings between the studies by Giesbrecht & Dick (1993) and that by Lowenfels & Wynn (1992) illustrate well the need to consider a variety of factors when attempting to explain differences between countries and illustrates some of the problems in doing ecological studies (Peek & Kraus, 1992). Are the differences in injury mortality rates due to differences in alcohol consumption or due to a variety of other factors that also vary in the same direction between countries – for example the use of seatbelts, airbags, improved highway design and better access to emergency care. The strength of the Lowenfels & Wynn article is that it attempts to address many of the potential confounding factors. However, like other ecological studies, it relies on available data and more in-depth studies collecting data on individual crashes are needed to examine other factors such as type of vehicle involved, emergency care provided and different types of driving exposure such as night versus daytime (Peek & Kraus, 1992). Never-the-less, as illustrated above, there are a wide variety of important factors that can be examined using currently available data, particularly when information from different sources are linked together.

Data Comparability Problems

Another potential problem in comparing injury deaths between countries may lie in coding differences such as variable conventions used in recording external causes on the death certificate. Are the differences between countries real or artifactual due to coding differences? We use two examples to illustrate how differences in coding can affect international comparisons. The first is the use of "unspecified accidents" in France, and the second involves international differences in the classification of delayed deaths subsequent to injury in the elderly. This paper does not claim to review all the problems in data collection, but rather to illustrate with these examples that the potential for artifactual differences in cross-national injury mortality rates must be considered.

Unspecified Accidents

In our analysis of French injury data, we found that the percentage of injury deaths coded as "other accidental deaths" was much higher in France. This was also noted by Giesbrecht (1993), who found that the injury mortality rate for the category "other accidental deaths" in France ranged during the years 1962-1988 from 16.7 – 29.2/100,000 for males, as compared with other selected countries where the rates ranged from 1.9 – 13.1/100,000 population (see Table 2). The average from 1962 – 1988 for French males was 23.1/100,000 population while the corresponding average figures for the U.S., Canada, Finland, the Netherlands, and Switzerland ranged only from 2.9 to 7.9. Upon further inquiry into possible reasons for this discrepancy, we learned that French physicians reportedly often write only "un accident" for motor vehicle crashes, and thus the unspecified accident group includes among them many undocumented motor vehicle fatalities (Dr. R.L. Salmi, Personal Communication Feb. 3, 1989). In addition, a number of injury deaths (especially in young people) are coded to this unspecified category because of strict confidentiality rules in France prohibiting use of more specific data from medico–legal investigations (which are done in a different government department from Vital Statistics) in revising the cause of death on the death certificate. In these cases, what in the U.S. would be initially coded as a pending cause will be classified as an unspecified accident and never updated even if the medicolegal investigation for example determines the death was a suicide. Similar problems are known to exist in a number of other countries such as Jamaica where many violent deaths investigated by the police are not even recorded by the vital statistics system. (Personal Communication, Dr. Cleone Rooney, Office of Population Census and Surveys, United Kingdom at I.C.E. meeting, May 18, 1994).

Injuries in the Elderly

Evaluation of disease–specific mortality data in the elderly, including injuries, may be even more problematic because deaths are commonly associated with a variety of co–morbid conditions, and a single underlying cause of death may not accurately reflect the true burden of a specific condition in the elderly. Because of these problems, analysis of multiple causes of death has been advocated to examine various factors related to the death (Israel et al., 1986). Previous studies have noted that injury death rates in the elderly are much higher in New Zealand than in Australia, the United Kingdom (see Figure 6) (Rockett & Smith, 1989b) and in the United States (Langley & McLoughlin, 1989).

The highest overall injury mortality rates are for elderly females and males in New Zealand, with rates much higher than corresponding rates in either Australia or the U.K. (see Figure 6). Paradoxically, injury rates were more similar in younger age groups where it is expected that differences in risk such as lifestyles and exposure to hazards are likely to be much greater than in the elderly.

We recently completed a study that sought to examine in more detail potential reasons for the apparent excess of injury mortality in the elderly in New Zealand (Langlois, Smith, Baker & Langley – submitted). Mortality data tapes were obtained from the New Zealand Health Information Service and the U.S. National Center for Health Statistics. Average annual rates were calculated for New Zealand from 1980–1987 and the U.S. from 1980–1986. Mid–range (1983) population estimates were used to calculate injury rates. Standard ICD E (External Cause) code groupings were used for specific injury groups. In order to compare injury incidence rather than just mortality rates we used hospital discharge data and data from other published studies to estimate differences in fall hospitalization rates between the two countries. Estimates of fall hospitalizations for the U.S. were available only from the "Cost of Injury" study (Rice, MacKenzie & Associates, 1989) due to incomplete E–coding of hospital data. Discharge rates for hip fractures (ICD 820) were also used as a proxy measure of fall injury incidence.

The most apparent difference between the two countries was the much higher proportion of injury deaths in New Zealand attributed to falls (52 percent) as compared to the U.S., where falls comprised only 28 percent of all injury deaths in the elderly (see Figure 7).

The age–adjusted (to U.S. 1983 population) fatal fall rate in New Zealand (92.0/100,000 population) was nearly three times higher than the U.S. rate (32.0/100,000) for both sexes combined. (see Table 3) For females, the discrepancy between the fall injury death rate in New Zealand, compared to the U.S., was much greater in the oldest age group. However, the age–adjusted fall and hip fracture hospitalization rates in New Zealand were relatively similar to the U.S. rates. There was however, an apparently higher in–hospital death rate from hip fractures in New Zealand, although the mean length of stay is more than double that of the U.S. reflecting in part very different patterns of hospitalization, rehabilitation and discharge patterns (such as to nursing homes). The data for males show a similar pattern, but with lower rates (data not shown).

The markedly different injury death rates for the elderly in New Zealand and the U.S. can be largely accounted for by the wide discrepancies in fall mortality rates, with falls comprising 52 percent of all injury deaths in those 65 years and over in New Zealand while comprising only 28 percent of injury deaths for the elderly in the U.S. The age–adjusted fall mortality rate was 92.0/100,000 population in New Zealand almost three times that of the U.S.

(32.0). Three potential factors could explain this excess – a higher risk of falls resulting in injury; a higher case fatality rate; or differences in classifying injury deaths.

Higher Risk of Injury Producing Falls in New Zealand?

Intrinsic factors appear to be an important determinant of the incidence of falls in the elderly. Community–based studies of the prevalence of risk factors report similar results in both New Zealand and the U.S. (Campbell et al., 1981, Tinetti et al., 1988). In addition, environmental factors such as housing and activities of the elderly, are likely to be relatively similar between countries. As measured by hip fracture discharge rates and estimates of fall injury hospitalizations, the incidence of fall injuries is very similar between two countries. Thus, differences in fall mortality do not appear to be due to a higher incidence of serious falls in New Zealand.

Higher Case–Fatality Rates?

Because of deficiencies in E–code data in the U.S., the figures for fall hospitalizations are only estimates, and it is not possible to analyze U.S. hospital discharge data tapes for in–hospital fall mortality (Rice, MacKenzie & Associates 1989, Sniezek et al., 1989). We analyzed hip fractures as a surrogate, since more than 90 percent of hip fractures are attributed to falls (Campbell et al., 1981, Tinetti et al., 1988, Nevitt et al., 1989, Sattin et al., 1990). However, only about 45 percent of fall hospitalizations among the elderly in New Zealand are due to hip fractures. The proportion of female hip fracture cases dying in–hospital was greater in New Zealand (8.8 percent) than in the U.S. (3.3 percent). (see Table 3) However, the mean length of stay was more than double in New Zealand (34.2 versus 14.2 days), which is likely to explain much of the difference in mortality. Compared with older Americans, older New Zealanders spend more time in a hospital rather than in other post–discharge settings because of greater pressure in the U.S. for early transfer to non–acute care hospitals for recuperation (Nevitt et al., 1989). Thus, New Zealanders are more likely to develop fatal complications in the hospital. It is also possible that reimbursement decisions, related to diagnostic–related groups (DRGs) (Cohen et al., 1987, Hsia et al., 1988), may also reduce the coding of hip fractures on discharges for in–hospital deaths. However, the magnitude of this association is unknown. It seems unlikely that differences in case–fatality rates could explain much of the cross–national difference in fall injury mortality rates.

Differences in Coding of Injury Deaths?

By comparing single cause–of–death information with multiple cause of death data, Fife (1987) determined that among those age 75 years and older, injury deaths may be underestimated by as much as 50 percent overall. The problem occurs when people die of multiple and often late complications of the injury, such as acute respiratory syndrome, cardiac failure or infection. Often these causes are listed in Part 1 of the death certificate, and the fall is only mentioned in Part II of the certificate. In many cases the fall may not even be mentioned on the death certificate (Waller, 1978). Injury causes listed in Part II can only be considered as the underlying cause under special circumstances (Fife 1987, NCHS 1984). Despite these limitations, international comparisons of injury mortality must rely on underlying cause data since few countries outside of the U.S. have data on multiple causes (Israel et al., 1986).

There are a number of factors that on further analysis suggest that variations in coding practices between the countries may explain at least in part the discrepancies in fall mortality rates between New Zealand and Australia. Fife (1987) found that the under–coding of fall deaths was common in the elderly and increased with age: 53 percent for ages 65–74, 61 percent for ages 75–84 and 65 percent for those 85 years and over (see Table 4). The discrepancy between injury deaths in the elderly between New Zealand and the U.S. also widened dramatically with increasing age, as indicated by increasing rate ratios as age increases. These findings suggest that coding differences may be a factor in the higher fall mortality among the elderly in N.Z.

There are several important differences between New Zealand and the U.S. in the recording and processing of mortality data that may explain potential differences in coding fall deaths in the elderly. New Zealand physicians probably have better knowledge of the coding of causes of death since training materials on how to complete death certificates are included as part of their medical education (Personal Communication, Geraldine White, N.Z. Information Service, Nov. 24, 1992). U.S. physicians on the other hand, receive little or no training in certifying causes of death (Comstock, 1986). In addition, the N.Z. Health Information Service coders routinely use medical examiner records, hospital charts and other sources of data to code the cause of death, and also frequently query physicians directly to check information on the cause of death. Such procedures are rare in the U.S. but have been shown to greatly enhance the identification of injuries as a cause of death, including falls (Hopkins et al., 1989; Kircher et al., 1985; Moyer et al., 1989). The training of the persons investigating injury deaths also varies widely from one state or county to the other in the U.S. Some jurisdictions have highly trained forensic pathologists while others only have lay coroners with no medical training. In the U.S., coders rely on information on the certificate, including the section "how injury occurs." The New Zealand certificate has no such a section, but relies on coders going back to original source documents for more information. In addition, autopsy rates in New Zealand are about double those of the U.S. High autopsy rates are known to improve the quality of cause of death certification for all causes of death including both the nature of the injury and the underlying cause. (Fife, 1987; Kircher et al., 1985).

In conclusion, we believe that improved coding practices for injury deaths in New Zealand are responsible for much of the apparent excess of fall deaths in elderly New Zealanders, especially since the rates for fall hospitalization appear to be similar. A number of other studies have shown that for other diseases differences in coding practices can be large, and result in wide variations in the certification of a single underlying cause (Jougla et al., 1992; Percy et al., 1981; Percy & Muir, 1989; Kelson & Farebrother, 1987). The potential for differences in coding practices between countries must always be considered when analyzing injury data.

Implications for Future Cross–national Studies

International comparisons of injury data between countries can be very useful for suggesting hypotheses for future studies. The apparently low injury rates in the United Kingdom, for example, needs further explanation. This in turn may suggest successful interventions, as yet unrecognized (Smith & Rockett, 1989b). There are wide variations in injury rates not only between developed countries, but also in the less developed countries (Smith & Barss; 1991 Taket, 1986; Li & Baker, 1991). Many of the less developed countries also have high injury rates and relatively good injury data which could be used in cross–national comparisons. This is especially true for Latin America countries. Variations in hospitalization rates are also an important but largely ignored area of research. Hip fracture hospitalization rates have been shown to vary widely from one region of the U.S. to another, for example (Bacon, Smith & Baker, 1989).

More in–depth cross–national studies are needed that examine differences in the factors that influence injury risk. Among these factors are societal norms, behavioral and socio–cultural factors activities, risk taking behaviors, and amount of exposure to hazardous situations. In addition, emergency medical care and prevention activities vary widely from one country to the next. The earlier mentioned study (Giesbrecht & Dick, 1993) comparing only one factor—alcohol consumption—is just one example of the potential problems of only examining a single factor. Very different results were obtained in the other study of motor vehicle fatalities and alcohol consumption that attempted to control for important differences in exposure (Lowenfels & Wynn, 1992). In order to provide more meaningful comparisons more complex models which incorporate multiple factors are needed. One example is that proposed by Holder (1989). His model includes factors for communities to consider in preventing alcohol–related injuries, which could also be used in comparing and interpreting differences in international mortality data. Among these factors are vehicle and driving conditions, environmental conditions, equipment characteristics, and a variety of other risk factors. He also includes more extensive alcohol variables such as cultural norms and control factors such as price and availability. Such factors should be included in future studies to more completely account for the obviously wide discrepancies in injury rates seen from one country to the other.

In any study comparing data between countries, care must be taken to ensure that similar coding practices are used in each country. A number of studies have shown wide variations in the practice of coding a single underlying cause for other diseases. The use of multiple cause of death data (Israel et al., 1986) can overcome some of these difficulties, and may improve the comparability of data between countries. However, few countries routinely use multiple cause coding. Comparative studies can also reveal problems in current data collection methods, and suggest areas for improvement. The use of multiple sources of information for cause of death certification, and better training and regular querying of physicians by nosologists in vital statistics offices, for example, may account for the much higher fall mortality rate in New Zealand compared to the U.S. The need for more general application of these methods to improve the quality of U.S. mortality data has also been recognized by others (Comstock & Markush, 1986; Rosenberg, 1989; Moriyama, 1989). Comparison of injury data in the elderly are likely to be especially problematic because of the difficulty of assigning a single underlying cause. However, despite the many potential problems, we believe that careful comparisons of injury data between countries can lead to important new insights into both the etiology and prevention of injuries.

References

1. Bacon WE, Smith GS, Baker SP. Geographic variation in the occurrence of hip fractures among the elderly white US population. American Journal of Public Health 1989;79:1556–8.

2. Baker SP, O'Neill B, Ginsburg MJ, Li G. The Injury Fact Book (Second Edition). New York: Oxford University Press, 1992.

3. Campbell AJ, Reinken J, Allan B, Martinez GS. Falls in old age: a study of frequency and related clinical factors. Age Ageing 1981;10:264–270.

4. Cohen B, Pokras R, Meads MS, Krushat WM. How will diagnosis–related groups affect epidemiologic research. American Journal of Epidemiology 1987;126:1–9.

5. Comstock GW, Markush RE. Further comments on problems in death certification. American Journal of Epidemiology 1986;124:180–1.

6. Fife D. Injuries and deaths among elderly persons. American Journal of Epidemiology 1987;126:936–41.

7. Fingerhut LA, Kleinman JC. International and Interstate Comparisons of Homicides Among Young Males. Journal of the American Medical Association 1990;263:3292–3295.

8. Fitzgerald JF, Moore PS, Dittus RS. The care of elderly patients with hip fractures: changes since implementation of the prospective payment system. New England Journal of Medicine 1988;319:1392–7.

9. Giesbrecht N, Dick R. Societal norms and risk–taking behavior: inter–cultural comparisons of casualties and alcohol consumption. Addiction 1993;88:867–876.

10. Holder H. Drinking, alcohol availability and injuries: a systems model of complex relationships. In: Giesbrecht, N. et al., (Eds) Drinking and Casualties: Accidents, Poisonings and Violence in an International Perspective. New York, Tavistock and Routledge, 1989, pp. 133–148.

11. Hopkins DD, Grant–Worley JA, Bollinger TL. Survey of cause–of–death query criteria used by state vital statistics programs and the efficacy of criteria used by the Oregon vital statistics program. American Journal of Public Health 1989;79:570–4.

12. Hsia DC, Krushat WM, Fagan AB, Tebbutt JA, Kusserow RP. Accuracy of diagnostic coding for medicare patients under the prospective payment system. New England Journal of Medicine 1988;318:352–5.

13. Israel RA, Rosenberg HM, Curtin LR. Analytical potential for multiple cause–of–death data. American Journal of Epidemiology 1986;124:161–181.

14. Jencks SF, Williams DK, Kay TL. Assessing hospital–associated deaths from discharge data: the role of length of stay and comorbidities. Journal of the American Medical Association 1988;260:2240–6.

15. Jougla E, Papoz L, Balkau B, Maguin P, Hatton F. EURODIAB Subarea C Study Group: Death certificate coding practices related to diabetes in European countries: the 'Eurodiab Subarea C' Study. International Journal of Epidemiology 1992;21:343–51.

16. Kellerman AL, Lee RK, Mercy JA, Banton J. The epidemiologic basis for the prevention of firearm injuries. Annual Review of Public Health 1991;12:17–40.

17. Kelson M, Farebrother M. The effect of inaccuracies in death certification and coding practices in the European Economic Community on international cancer mortality statistics. International Journal of Epidemiology 1987;16:411–14.

18. Kircher T, Nelson J, Burdo H. The autopsy as a measure of accuracy of the death certificate. New England Journal of Medicine 1985;313:1263–9.

19. Kleinman JC: Age–adjusted mortality indexes of small areas: applications to health planning. American Journal of Public Health 1977;67:834–840.

20. Langley JD, McLoughlin E: Injury mortality and morbidity in New Zealand. Accident Analysis and Prevention 1989;21:243–54.

21. Langlois JA, Smith GS, Baker SP, Langley J. International comparisons of injury mortality in the elderly: issues and differences between New Zealand and the United States. Submitted for publication, March 1994.

22. Li G, Baker SP. A comparison of injury death rates in China and the United States, 1986. American Journal of Public Health 1991;81:605–609.

23. Lowenfels AB, Wynn PS. One less for the road: international trends in alcohol consumption and vehicular fatalities. Annals of Epidemiology 1992;2:249–256.

24. Meade MS: Potential years of life lost in countries of Southeast Asia. Social Science and Medicine 1980;14D:277–281.

25. Moriyama IM. Problems in measurement of accuracy of cause–of–death statistics. American Journal of Public Health 1989;79–1349–50.

26. Moyer IA, Boyle CA, Pollock DA. Validity of death certificates for injury–related causes of death. American Journal of Epidemiology 1989;130:1024–

27. Nevitt MC, Cummings SR, Kidd S, Black D. Risk factors for recurrent nonsyncopal falls: a prospective study. Journal of the American Medical Association 1989;261:2663–2668.

28. National Center for Health Statistics. Instructions for classifying the underlying cause of death 1978 (part 2A). U.S. Department of Health Education and Welfare. Hyattsville, MD: National Center for Health Statistics, 1984.

29. Peek C, Kraus JF. International findings on alcohol consumption and vehicle crash fatalities: the role of the ecologic study. Annals Epidemiology 1992;2:339–341 (editorial).

30. Percy C, Muir C. The international comparability of cancer mortality data. American Journal of Epidemiology 1989;129:934–46.

31. Percy C, Stanek E, Gloeckler L. Accuracy of cancer death certificates and its effect on cancer mortality statistics. American Journal of Public Health 1981;71:242–50.

32. Reid DD: International studies in epidemiology. American Journal of Epidemiology 1975;102:469–76.

33. Rice DP, MacKenzie EJ, and Associates: Cost of Injury in the United States: Report to Congress. San Francisco, CA: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University, 1989.

34. Rockett IRH, Smith GS. Covert suicide among elderly Japanese females: Questioning unintentional drownings. Social Science and Medicine 1993;36:1467–72.

35. Rockett IRH, Smith GS. Injuries in relation to chronic disease: An international view of premature mortality. American Journal of Public Health 1987;77:1345–1346.

36. Rockett IRH, Smith GS. Homicide, suicide, motor vehicle crash, and fall mortality: United States' experience in comparative perspective. American Journal of Public Health 1989(a);79:1396–1400.

37. Rockett IRH, Smith GS. Injuries and the Australian mortality mosaic: a comparison with the United Kingdom and New Zealand. Public Health 1989(b);103:353–61.

38. Romeder JM, McWhinnie JR. Potential years of life lost between ages 1 and 70: An indicator of premature mortality for health planning. International Journal of Epidemiology 1977;6:143–151.

39. Rosenberg HM. Improving cause of death statistics. American Journal of Public Health 1989;79:563–4.

40. Sattin RW, Lambert–Huber DA, DeVito CA, et al. The incidence of fall injury events among the elderly in a defined population. American Journal of Epidemiology 1990;131:1028–1037.

41. Skog OJ. Trends in alcohol consumption and death from diseases. British Journal of Addiction 1987;82:1033–41.

41. Sloan JH, Kellermann AL, Reay DT, et al. Handgun regulations, crime, assaults and homicide: a tale of two cities. New England Journal of Medicine 1988;319:1256–1262.

42. Smith GS, Kraus JF. Alcohol and residential, recreational, and occupational injuries: A review of the epidemiologic evidence. Annual Review of Public Health 1988; 9:99–121.

43. Smith GS, Barss PG. Unintentional injuries in developing countries: the epidemiology of a neglected problem. Epidemiologic Reviews 1991;13:228–266.

44. Sniezek JE, Finklea JF, Graitcer PL. Injury coding and hospital discharge data. Journal of the American Medical Association 1989;262:2270–2.

45. Taket A. Accident mortality in children, adolescents, and young adults. World Health Statistics Quarterly 1986;39:232–256.

46. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. New England Journal of Medicine 1988;319:1701–1707.

47. Waller JA. Falls among the elderly: human and environmental factors. Accident Analysis and Prevention 1978;10:21–33.

Table 1. Correlation of per capita alcohol consumption with male cirrhosis and injury rates by country 1962–1988 (correlation coefficients)

Country	Cirrhosis	MVA	Drowning	Suicide	Homicide
Canada	0.75****	0.34*	0.16	0.04	0.27
Finland	0.09	0.21	0.05	0.48***	0.07
France	0.35*	0.06	0.35*	0.30*	0.23
Netherlands	0.28*	0.20	0.11	0.18	0.36
Switzerland	0.19	0.01	0.10	0.25**	0.23
U.S.	0.42***	0.26	0.11	0.07	0.26

****=p<.005, ***=p<.025, **=p<0.05, *=p<.10

Source: Giesbrecht, 1993. Addition

Table 2. Potential for misclassification among injury causes. "Other accidents" mortality rates/100,000 for males from 1962–1988, WHO Statistics Annuals

Country	Average	(Range)
France	23.1	(16.7 – 29.2)
U.S.	7.9	(6.6 – 9.8)
Switzerland	7.1	(4.3 – 13.1)
Canada	6.9	(2.8 – 9.9)
Finland	6.5	(2.8 – 9.9)

Table 3. Comparison of elderly female fall death and hospitalization rates/100,000 population for falls and hip fractures, U.S. 1980–1986 and New Zealand

Injury rates/100,000		N.Z.	U.S.
Fall Deaths:			
Total (M & F)*		92*	32
Age:	65–74	14	8
	75–84	100	34
	85+	600	141
Hospitalizations:			
Falls		2,005*	1,678
Hip fracture		1,000	1,040
In hospital deaths		8.8%	3.3%
Mean length stay		34.2 days	14.2 days

*Age adjusted to U.S. Population, males included with females for this line only

Table 4. Under–counting of fall deaths in the U.S. compared to the rate ratio of fall deaths in New Zealand vs. U.S., by age

	Age (years)		
Fall Mortality	65–74	75–84	85+
Under–counting U.S. (Fife, 1987)	53%	61%	65%
Rate ratio N.Z. vs U.S.	1.8	3.0	4.2

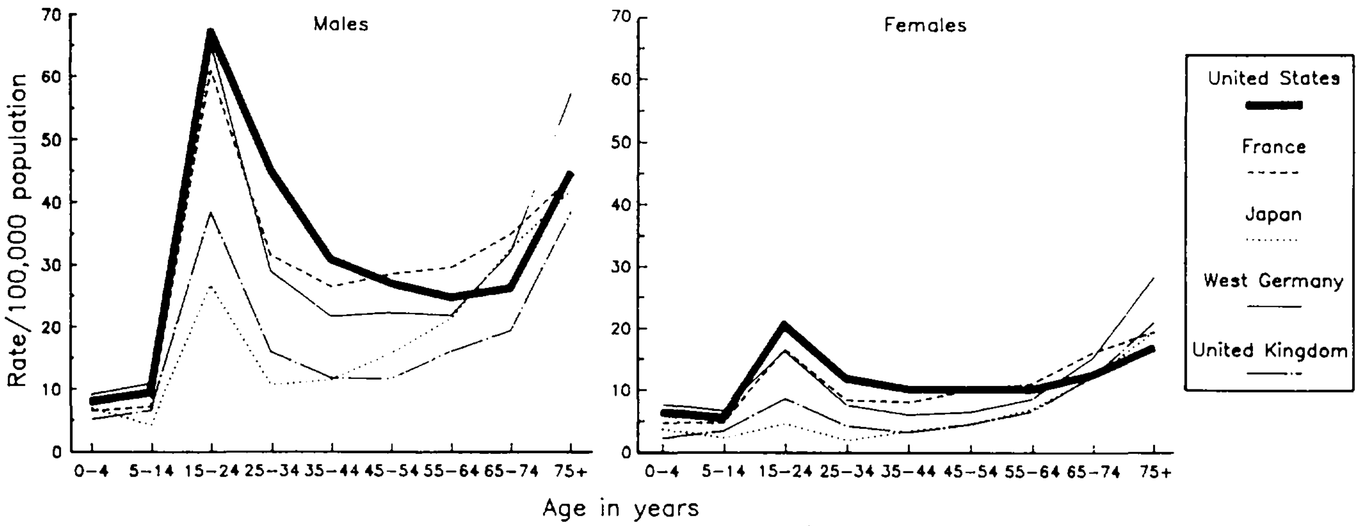

FIGURE 1—Age-Specific Motor Vehicle Crash Death Rates by Sex and Country, 1980

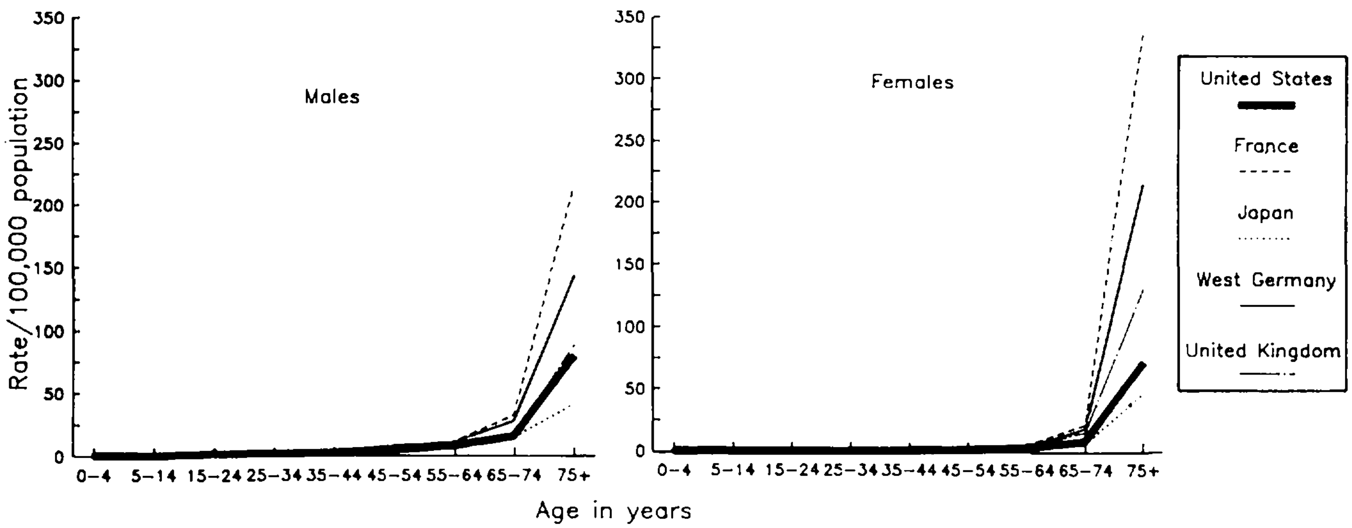

FIGURE 2—Age-Specific Fall Death Rates by Sex and Country, 1980

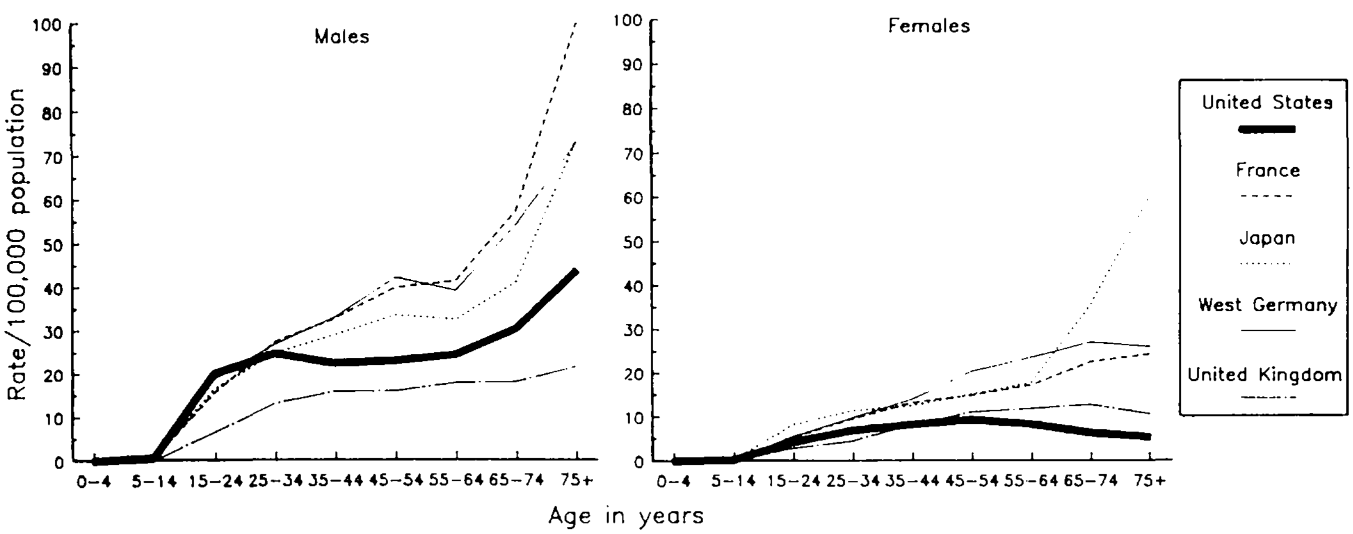

FIGURE 3—Age-Specific Suicide Rates by Sex and Country, 1980

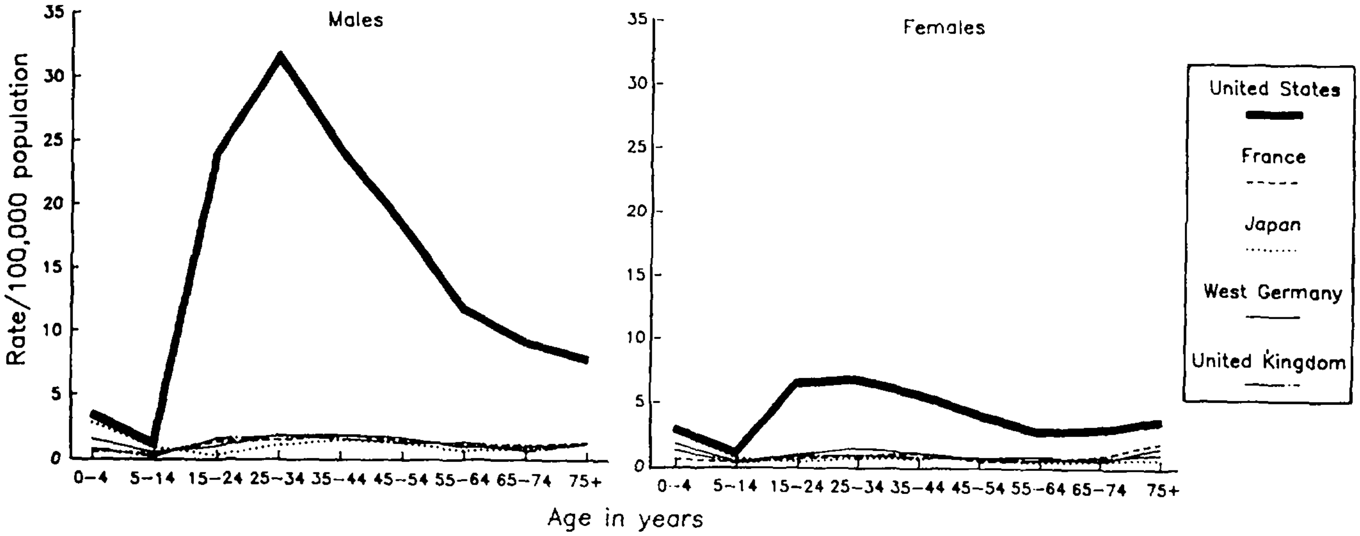

FIGURE 4—Age-Specific Homicide Rates by Sex and Country, 1980

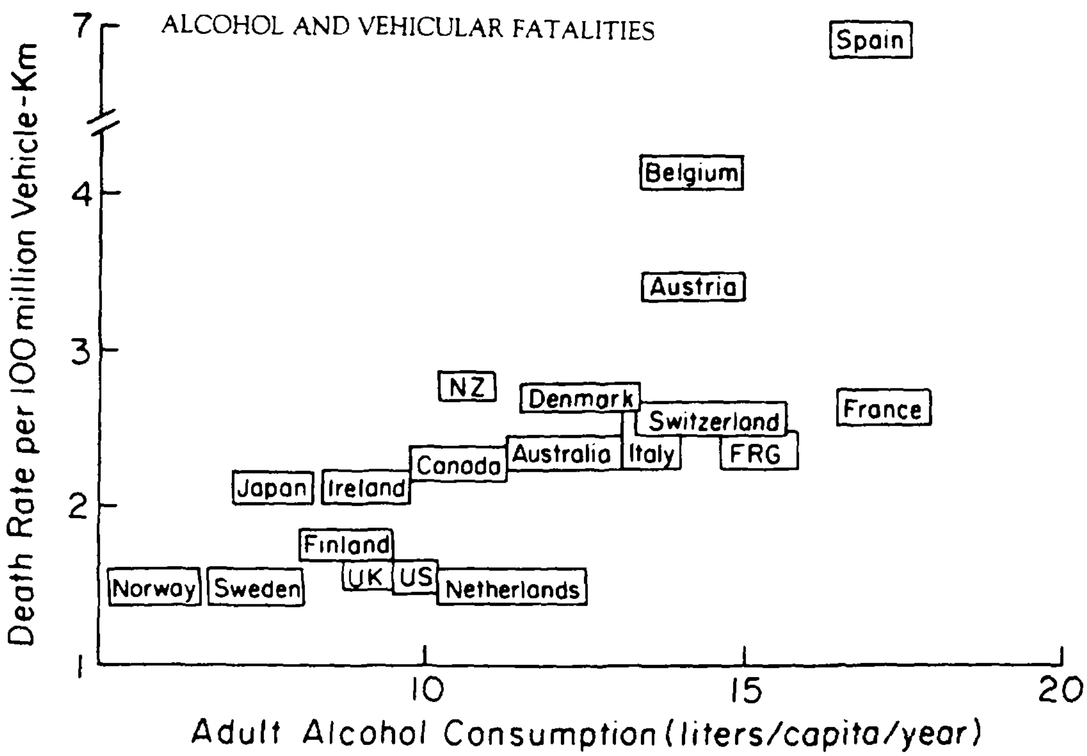

Figure 5. Scattergram showing relationship between death rate from vehicular accidents per 100 million vehicle-kilometers (Y) and adult alcohol consumption in liters per capita per year (1987 data or most recent available year). Source: Lowenfels & Wynn, Annals of Epidemiology 1992;2:249-256.

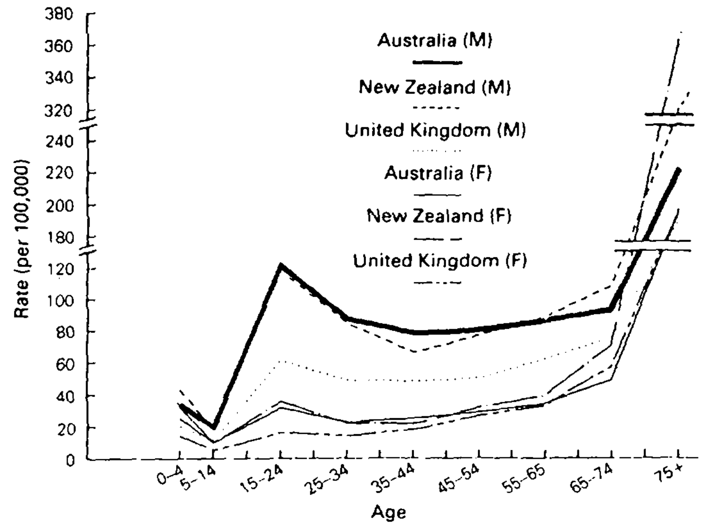

Figure 6 Sex/age-specific injury death rates for Australia, New Zealand, United Kingdom, c.1980.

Figure 7
Percent of Injury Deaths by Cause Among People Aged 65+ in New Zealand (1980-87) and the United States (1980-86)