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Mortality Due to Unintentional Injuries in the Netherlands, 1950–1995

SYNOPSIS

Objective. To detect and explain changing trends in incidence, case fatality rates, and mortality for unintentional injuries in the Netherlands for the years 1950 through 1995.

Methods. Using national registry data, the authors analyzed trends in traffic injuries, occupational injuries, and home and leisure injuries.

Results. Between 1950 and 1970, mortality from unintentional injuries rose, reflecting an increasing incidence of injuries. This was followed by a sharp decline in mortality due to a decreasing incidence combined with a rapidly falling case fatality rate. Starting in the second half of the 1980s, the decline in mortality leveled off as the incidence of several injury subclasses once again rose. The observed trends reflect several background factors, including economic fluctuations (influencing exposure), preventive measures (reducing injury risk and injury severity), and improvements in trauma care (lowering the severity-adjusted case fatality rate).

Conclusions. Injury mortality can be reduced through measures that lower injury risk, injury severity, or severity-adjusted case fatality rates. Beginning in the mid-1980s, such compensatory mechanisms have fallen short in the Netherlands. New policies are needed despite the impressive reductions in mortality already reached.

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Unintentional injuries represent an ongoing challenge for public health. In the Netherlands, as in other industrialized countries,[1] they are a major cause of morbidity and mortality. Annually, one-fifth of the Dutch population seeks medical treatment as a result of an unintentional injury.[2] This high rate of health care utilization is an important source of medical costs. Unintentional injuries are also an important source of temporary and permanent disabilities in the Netherlands. They constitute, for example, one of the three main causes of health-related economic production losses, outnumbered only by psychiatric disorders and locomotory diseases such as arthritis.[3] Moreover, unintentional injuries account for 2.5% of mortality in the population as a whole. This figure is much higher for children and adolescents, however, in whom about one-third of all deaths are the result of an unintentional injury.[4]

The scope of this public health problem calls for action from policy makers. Trend analysis is a tool to support priority setting in this area.[5] A trend analysis aims to detect changes in disease frequencies and their underlying determinants. It reveals which problems are on the rise and which are decreasing and offers clues to the reasons for these developments. Thus, trend analysis can generate research hypotheses about the etiology of injuries in addition to triggering preventive interventions.[6]

This article reports the results of an analysis of trends in mortality from unintentional injuries in the Netherlands for 1950–1995.

Mortality from unintentional injuries is a function of injury incidence and case fatality rates. Therefore, mortality trends reflect changes over time (trends) in injury incidence and case fatality rates. The incidence of injuries is a function of exposure (opportunities for injuries, as measured by time spent in a situation that may lead to injuries) and injury risk (risk is calculated as the number of injured people per unit of exposure). For example: the number of injured motorcyclists in the population (incidence) is a function of the number of kilometers traveled by motorcycle by the population as a whole (exposure) and the chance per kilometer of being injured on a motorcycle (risk).

Case fatality rates are a function of injury severity (the distribution of injuries by type of injury) and severity-adjusted case fatality rates of injury victims (the rate of deaths adjusted for changes in the distribution of injuries). For example: the number of deaths per 100 injured motorcyclists (case fatality rate) can drop as a result of a declining proportion of life-threatening injuries among the victims (such as a decline from a higher percentage to a lower percentage of severe head injuries, leading to a reduction in the mean injury severity of injured motorcyclists). Through improvements in trauma care, however, the case fatality rate of motorcycling injuries can be reduced faster than would be expected from changes in injury severity alone. If so, a reduction in the severity-adjusted case fatality rate is observed.

Trends in exposure, injury risk, injury severity, and severity-adjusted case fatality rates can be influenced at two levels. The first level includes various "autonomous" factors not directly influenced by public health policy, such as demographic, economic, sociocultural, and technological changes. The other level includes preventive measures and strategies aimed at improving trauma care.

A systematic analysis of trends in incidence and case fatality rates can provide insight into the major determinants of trends in mortality over a long period of time. For the present study, we first established the extent to which trends in injury incidence and case fatality rates affected mortality trends for the period from 1950 through 1995. Second, we studied the influence of trends in exposure and injury risk on trends in the incidence of injuries, and we related case fatality trends to trends in injury severity. This article reports the results of these analyses. The influence of various background factors, including preventive measures and improvements in trauma care, are addressed in the discussion section.

METHODS

Classification. Unintentional injuries include traffic injuries, occupational injuries, and home and leisure injuries. The International Classification of Diseases—the standard used in registries of causes of death and hospital admissions in the Netherlands—allows only for a distinction between traffic injuries and nontraffic injuries. Yet because research has shown that occupational injuries account for only a minor fraction of deaths (2%) or of hospital admissions (4%) among nontraffic injuries in the Netherlands,[4] the data on deaths and hospital admissions due to nontraffic injuries can be used as an estimate of deaths and hospital admissions due to home and leisure injuries.

Mortality. We acquired data on injury mortality from several sources. First, we used cause-of-death data for 1950–1995 from the Dutch Central Bureau of Statistics (CBS) to calculate trends in injury mortality and in mortality from a number of major subclasses of injuries (traf-

"Injury mortality in the Netherlands increased between 1950 and 1970, followed by a sharp decline that only began to level off in the mid-1980s."

fic injuries, nontraffic injuries, and several types of nontraffic injuries—accidental falls, accidental poisoning, and accidental drowning). We calculated crude mortality rates and mortality rates adjusted for changes in the composition of the population for each year from 1950 through 1995. We computed the adjusted mortality rates by direct standardization, using as the standard population the Dutch population of 1972—the middle of the time period under review. We multiplied the population totals of five-year age classes (0–4, 5–9, and so on) of this standard population by the specific mortality rates of these age classes for each year from 1950 through 1995 to calculate the numbers of deaths to be expected without changes in the size and structure of the Dutch population. The adjusted mortality rate was calculated as the expected number of deaths divided by the size of the total population in 1972.

We used data for the years 1950–1995 from the national registry of traffic accidents (Road Traffic Accident Registry [VOR]) to calculate injury mortality rates according to mode of transport (passenger car occupant, motor cyclist, moped rider, cyclist, pedestrian) and 1970–1991 data from the national registry of occupational accidents (Occupational Accident Registry [BOR]) to calculate injury mortality rates according to branch of industry (manufacturing, construction, service sector).

Incidence and case fatality rates of injuries. For both traffic injuries and the separate subclasses of nontraffic injuries (with the exception of accidental falls), we found quite similar trends in the crude and standardized mortality rates. We therefore calculated only crude rates for the incidence and case fatality rate of traffic and occupational injuries.

We drew on several sources for data on the incidence of injuries. The number of traffic injuries is registered by the police in the VOR. As in other countries,[7,8] a sizable number of the relevant cases fail to be registered.[9,10] The level of underreporting, however, is probably rather stable over time. During our study period no major changes in registration criteria and procedures were seen; we were thus able to perform a trend analysis using 1950–1995 data on the incidence of traffic injuries by mode of transport.

The incidence of occupational injuries by branch of industry is registered in the BOR, which also suffers from underreporting.[11] This registry includes data on injuries leading to loss of time from work, which is highly sensitive to worker compensation laws. Between 1950 and 1995, major changes were implemented in the Dutch worker compensation system, most notably at the end of the 1960s (legislation providing full compensation for each health-related absence from work) and at the beginning of the 1990s (more restrictive worker compensation legislation). For this reason, trends in occupational injuries will be presented for the period 1970–1991 only, when the reporting rate was likely to have been stable.

Data are lacking on the incidence of home and leisure injuries in the population at large. To get an impression of the incidence of home and leisure injuries and of subclasses of these injuries, we used 1972–1995 data from the National Medical Registry (LMR), which provides detailed information on the number of hospital admissions in the Netherlands. In 1972, about 60% of all hospitalized patients were registered, whereas in 1995 a coverage rate of almost 100% had been reached, according to the LMR. We used all available data to estimate national clinical incidence rates (hospitalization rates of injury victims), assuming that the participating hospitals were representative of the whole country. This procedure was not applied to earlier data, as the participation rates of hospitals prior to 1972 were too low, according to the LMR. We used the clinical incidence (rates of hospital admissions) of nontraffic injuries as estimates of the clinical incidence of home and leisure injuries, after first excluding injuries resulting from medical procedures.

We calculated case fatality rates using published data on injury mortality and the incidence of injuries. We calculated annual case fatality rates for traffic injury victims according to the mode of transport by dividing the number of traffic deaths by the number of injured people in the following subclasses: passenger car occupants, motor cyclists, moped riders, cyclists, and pedestrians. We calculated annual case fatality rates according to the branch of industry by dividing the number of occupational injury deaths by the number of injured people in the following subclasses: manufacturing, construction, and the service sector.

Exposure and injury risk. Exposure data were available for both traffic injuries and occupational injuries. As a primary measure of traffic exposure, we used the annual totals for 1960 through 1995 of kilometers traveled per 1000 person-years by mode of transport (passenger car, motorcycle, moped, or pedestrian), extracted from annual mobility surveys of the Central Bureau of Statistics. The figures on bicycling for the period 1960–1984, however, were derived from specific surveys conducted by the Foundation on Road Safety Research.[12]

We obtained exposure data by branch of industry from publications of the Occupational Accident Registry. As an indicator of exposure, we used annual population totals of the number of person-years worked in the manufacturing, construction, and service sectors.

By combining the available data on the incidence of injuries and on exposure, we were able to calculate annual injury risk by mode of transport for 1950–1995 and by branch of industry for 1970–1991. We calculated injury risk by mode of transport (passenger car, motorcycle, moped, bicycle, pedestrian) by dividing the number of injured people in each mode by the total number of kilometers traveled. We calculated occupational injury risks according to the branch of industry by dividing the annual numbers of injured people by the numbers of person-years worked in the manufacturing, construction, and service sectors.

Injury severity and severity-adjusted case fatality rates. We specifically studied trends in injury severity and the severity-adjusted case fatality rate for traffic injury victims. We used data from the National Medical Registry (LMR) on the distribution of injuries by type of injury in order to distinguish a number of broad classes with different severity levels: intracranial injuries; internal injuries of organs in the chest, pelvis, or abdominal region; fractures of the lower extremity; fractures of the upper extremity; fractures of skull, neck, or chest; open wounds and bruises; strains and sprains; burns; poisonings; other injuries. Level of severity varies widely across these classes of injury; some are accompanied by high risks of death (intracranial injuries, for example), while the case fatality rate is close to 0 in others (strains and sprains, for example).

Using National Medical Registry data on the numbers of injured people admitted to hospitals (the clinical incidence) and on the numbers of in-hospital deaths, we could calculate the crude case fatality rates of hospitalized traffic victims from 1972 until 1995. This was done for separate years by dividing the numbers of in-hospital traffic deaths by the numbers of hospitalized traffic injury victims. This offers a case fatality measure that excludes victims who died at the site of the injury event or before arrival at the hospital.

We also calculated the severity-adjusted case fatality rates of hospitalized traffic injury victims for 1972–1995 using indirect adjustment. We computed specific case fatality rates by type of injury for 1995, which we subsequently used as standard rates. For the years 1972, 1975, 1980, 1985, 1988, and 1995 (years for which data were available on hospitalized traffic victims by type of injury), we multiplied the numbers of traffic injury victims, according to the type of injury, by the type-specific standard (1995) case fatality rates. This provided numbers of deaths to be expected if the type-specific case fatality rates remained stable. By dividing observed numbers of deaths by the expected numbers of deaths a severity-adjusted case fatality rate could be calculated.

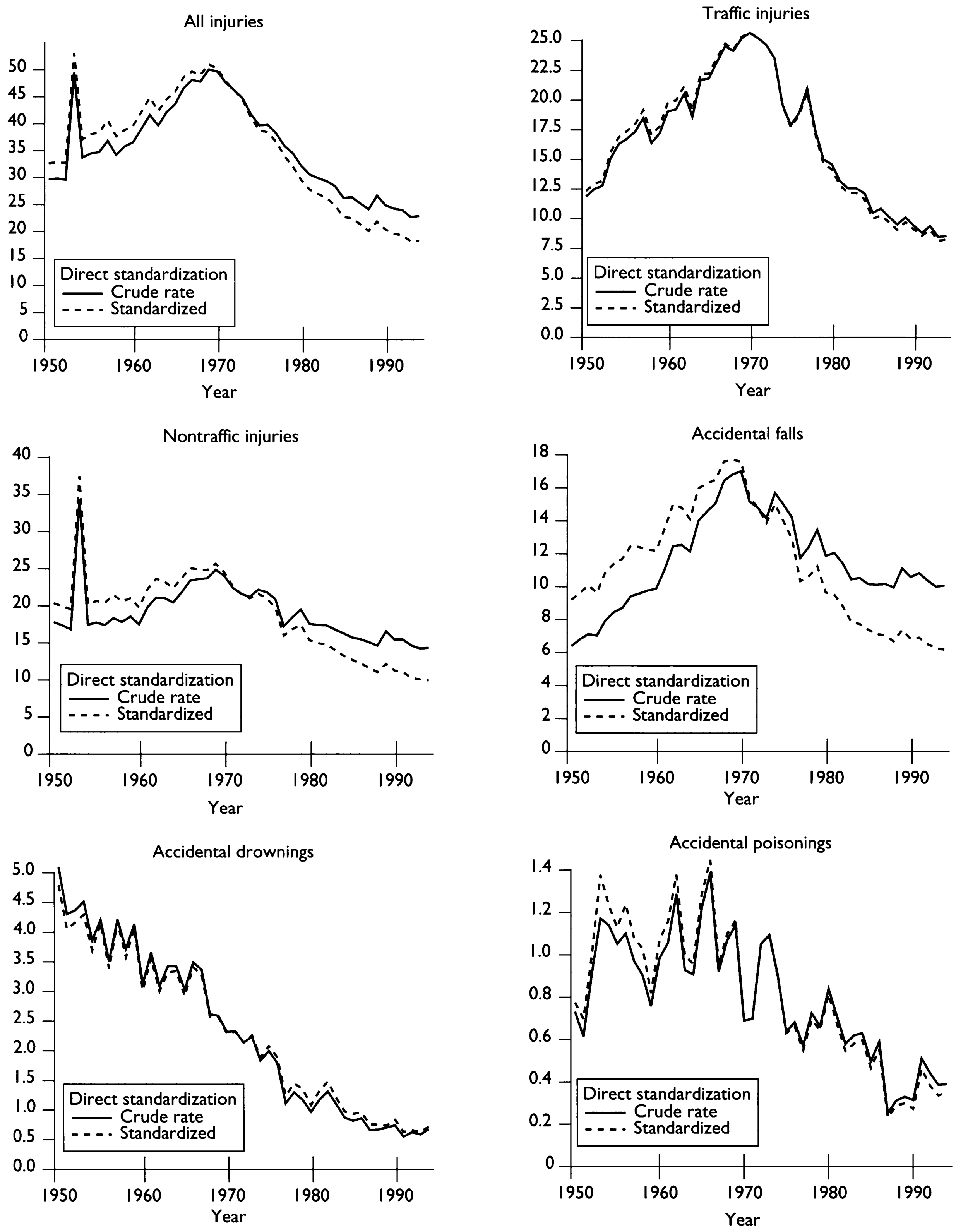
We had to rely on this procedure of indirect adjustment because type-specific case fatality rates were available for only one year (1995). This procedure offers valuable information. In comparing crude rates and severity-adjusted case fatality rates, an impression is gained of the contribution of changes in injury severity to a reduction in traffic deaths inside the hospital. A small difference means that factors other than injury severity are important.

RESULTS

Trends in injury mortality. Injury mortality in the Netherlands since 1950 has been characterized by rapid changes (see Figure 1). Injury mortality (all categories combined) increased sharply during the period 1950–1970 and subsequently embarked on a rapid decline that did not begin to level off until the mid-1980s. The peak in 1953 reflects a major flood disaster.

Traffic injury mortality follows a similar pattern, as generally do deaths from nontraffic injuries (an estimate of mortality due to home and leisure injuries), although the latter showed a less spectacular increase during the years 1950–1970.

Figure 1. Crude and standardized injury mortality rates (deaths per 100,000 person-years) in the Netherlands, 1950–1995



Mortality rates are also shown separately for three categories of nontraffic injuries in Figure 1. Trends in mortality due to accidental falls have been quite similar to trends in traffic injury mortality. Accidental drowning as a cause of death has declined since 1950. Accidental poisoning claims few fatalities and therefore shows an erratic pattern in the mortality statistics, but nevertheless seems to have declined as a cause of death from the end of the 1960s until at least the end of the 1980s.

Figure 1 shows that in all subclasses of injuries except accidental falls, the crude and standardized rates are quite similar.

Trends in the incidence and case fatality rates of injuries. The rise and fall of injury mortality in the Netherlands is the result of trends in the incidence and case fatality rates of injuries and of interactions between these parameters.

Traffic injuries. Three different periods can be identified in traffic injuries (Figure 2). Between 1950 and 1970 there was a sharp increase in traffic injury mortality (all modes of transport combined) based on a rising incidence of injuries. In the period 1970–1985 there was a spectacular decline in mortality because of rapidly falling figures for both the incidence and case fatality rate of injuries. In the period 1985–1995, mortality further decreased, but at a much slower rate than in the previous period. The decreases during 1985–1995 were due to a further decline in the case fatality rate, whereas the incidence of traffic injuries has essentially remained at the 1985 level.

Figure 2 also sheds light on specific developments for separate modes of transport. The aforementioned distinction into three periods can be clearly observed for passenger car occupants. In the Netherlands, this category accounted for about 50% of all traffic deaths, according to VOR data. The trends for passenger car occupants are quite similar to those for traffic injury mortality as a whole. It is striking to note that the incidence of injuries to passenger car occupants rose from 1985 to 1995. Thus in the case of passenger car occupants, the decline in mortality after 1985 is wholly attributable to decreases in the case fatality rate. Dynamic changes can also be observed in the other modes of transport. As with passenger car occupants, mortality trends for 1950 through 1970 for the other modes are mainly based on changes in the incidence of injuries, whereas since 1970 decreases in the case fatality rate have become a second major factor.

Occupational injuries. Trends in the incidence and case fatality rate of occupational injuries were studied for the period 1970–1991. A spectacular fall in occupational injury mortality in the Netherlands between 1970 and 1985 was based on the combined effect of decreases in incidence and case fatality rates in all branches of industry (Figure 3). After 1985 a relatively minor further decline in mortality is found. As with traffic injuries, this is completely based on a continued decline in the case fatality rate. The most recent period under review, 1985 to 1991, saw increases in the incidence of occupational injuries (with the exception of injuries in the manufacturing sector).

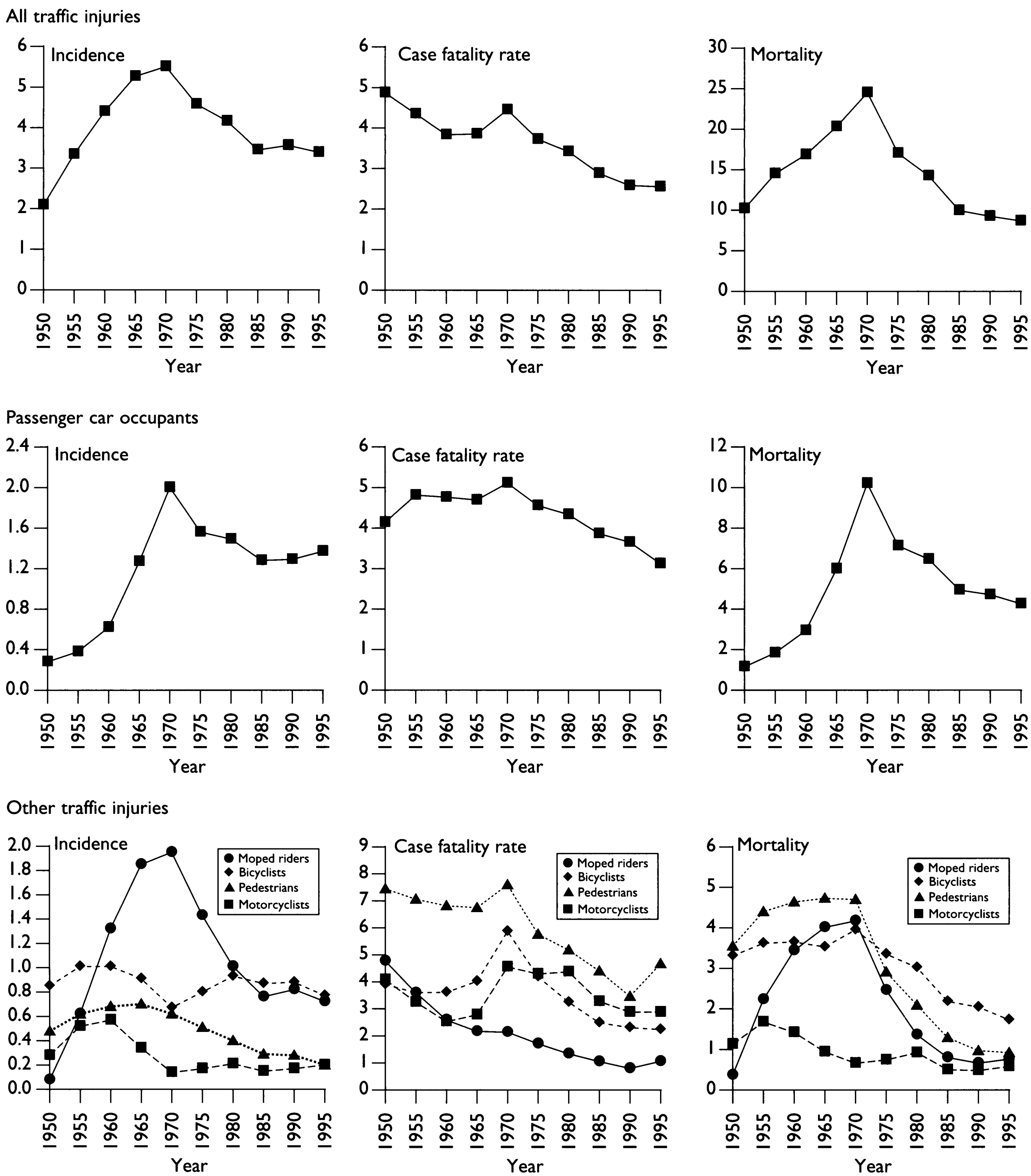
Home and leisure injuries. As already mentioned, trends in the incidence and case fatality rate of home and leisure injuries cannot be studied directly because figures from the population at large are lacking. However, figures on hospital admissions due to nontraffic injuries since the beginning of the 1970s are available for study (see Figure 4). These figures can be compared to the trends in nontraffic injury mortality already presented (see Figure 1). Such a comparison yields a broad impression of the mechanisms underlying mortality trends in this area.

The incidence of hospital admissions due to home and leisure injuries has been fluctuating since the early 1970s (Figure 4). Interestingly, the trends have developed in opposite directions for two major categories. The decreasing incidence of accidental poisonings seems to have contributed to the decline in mortality associated with home and leisure injuries (see Figure 1). The clinical incidence of accidental falls, on the contrary, has risen. This means that the decline in mortality due to accidental falls can probably not be explained by a decreasing incidence of injuries but instead by a declining case fatality rate as the major underlying parameter.

Trends in exposure and injury risk.

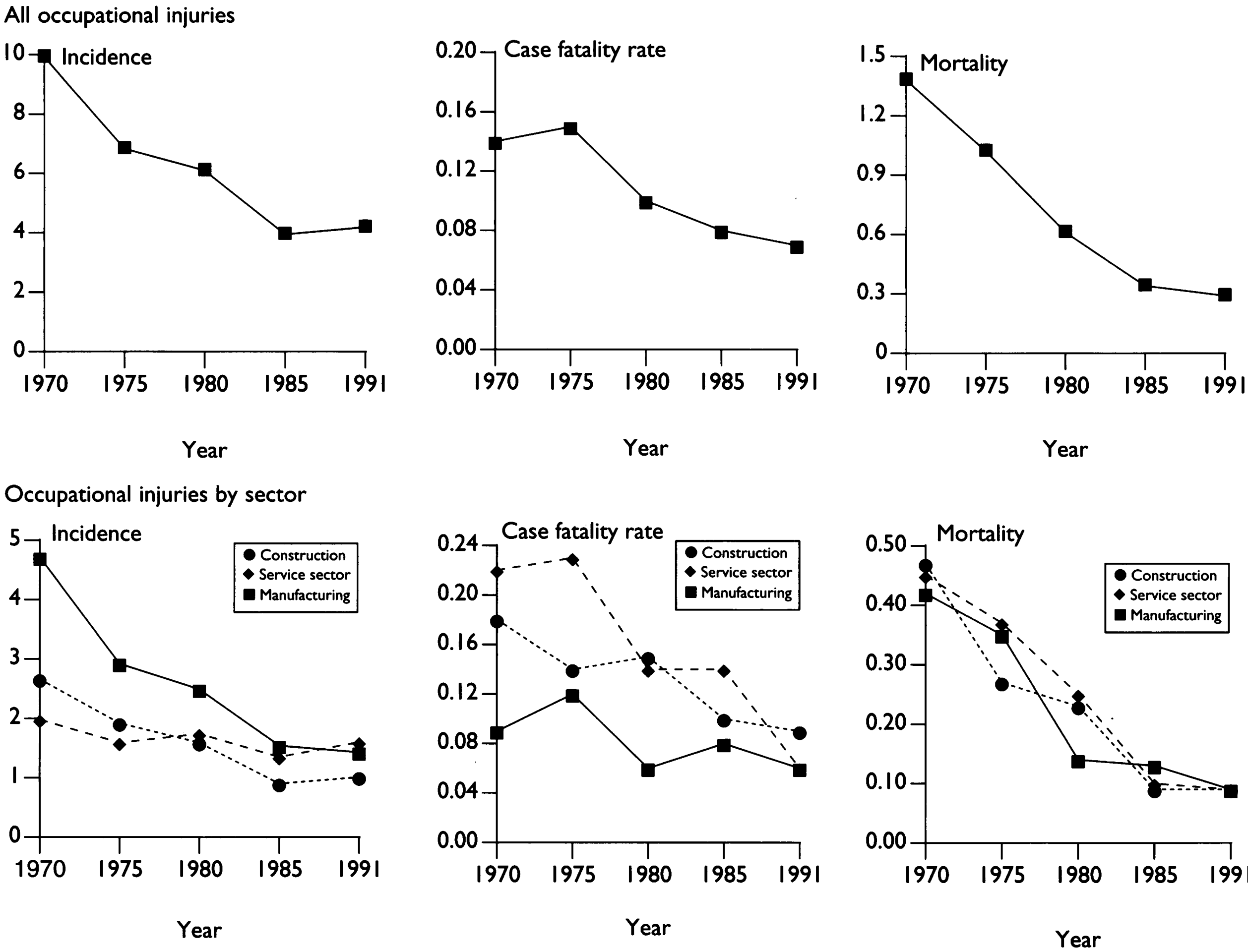
Traffic injuries. A rise in exposure (Table 1) is a major factor behind the growing incidence of injuries to passenger car occupants for 1960–1970, when the number of kilometers traveled by passenger car increased dramatically (a 141% rise between 1960 and 1965, followed by a 78% rise between 1965 and 1970). The steep rise in the use of passenger cars in the Netherlands leveled off in the 1970s; this is one of the factors behind the observed reversal in the incidence of injuries to passenger car occupants beginning about 1970 (Figure 2). A

Figure 2. Incidence, case fatality rates, and mortality associated with traffic injuries in the Netherlands, by mode of transport, 1950–1995



NOTE: Incidence is defined as number of injured people per 1000 person-years, the case fatality rate is defined as number of deaths per 100 injured people, and mortality is defined as number of deaths per 100,000 person-years,

Figure 3. Incidence, case fatality rates, and mortality associated with occupational injuries in the Netherlands, by branch of industry, 1970–1991



NOTE: Incidence is defined as number of injured people per 1000 person-years, the case fatality rate is defined as number of deaths per 100 injured people, and mortality is defined as number of deaths per 100,000 person-years.

second factor behind this reversal is the rapidly declining injury risk of passenger car occupants (Table 1). This decline was especially sharp between 1970 and 1975 (this period saw a 30% decline in injury risk, while other periods showed a constant decrease of 10%–15%). This decline, however, stopped in the early 1990s. This would appear to be one of the reasons behind the rising numbers of injuries among passenger car occupants in the most recent period. Another factor is the slight acceleration, beginning in the mid-1980s, of the rate of increases in exposures.

Table 1 further shows trends in exposure and injury risk among the other modes of transport. The use of the motorcycle, for example, has fluctuated widely over time. From 1985 to 1995, the motorcycle grew in popularity (Table 1), which is reflected in increasing incidence and mortality figures (Figure 2).

Occupational injuries. In the period 1970–1985 the number of person-years at work declined in all branches of industry except the service sector (Table 2). Injury risks declined as well (Table 2). This combination led to a declining incidence of occupational injuries during the period 1970–1985. For the most recent period under review, 1985–1990, trends in both exposure and injury risk changed. The labor force increased in all branches

"Preventive measures have...helped to reduce injury risks, in particular in the area of traffic injuries."

of industry (Table 2) while the declines in injury risk leveled off (Table 2), explaining why the incidence of occupational injuries rose.

Trends in injury severity and severity-adjusted case fatality rates.

Traffic injuries. The case fatality rate for traffic injuries declined significantly between 1970 and 1995 (Figure 2). Using direct standardization, we checked whether this could be explained by changes in the age and sex of traffic victims. We found that after adjustments for age and sex, the case fatality rate declined even faster. This means that the observed decline in the case fatality rate was caused by other factors. We studied the possible contribution of changes in injury severity by examining trends in hospital admissions resulting from traffic injuries according to type of injury (see Figure 5). Figure 5 reveals that the number of patients suffering intracranial injuries dropped very rapidly compared with the rates of decline for other types of injury, especially during the period from 1972 through 1985. Thus intracranial injuries' share declined from 43% in 1972 to 23% in 1995. This is an important observation, as the cause-of-death data from the CBS for 1950–1995 reveal that intracranial injuries account for more than half of all traffic deaths.

The case fatality rate for hospitalized traffic victims declined rapidly between 1972 and 1995 (Figure 6). There is a small difference between the crude rates and the rates adjusted for changes in the distribution of injuries. Only some 20% of the decline in case fatality rate of hospitalized traffic victims can be explained by changes in the breakdown according to type of injury.

Figure 4. Clinical incidence of home and leisure injuries (hospital admissions per 100,000 person-years) in the Netherlands, 1972–1995

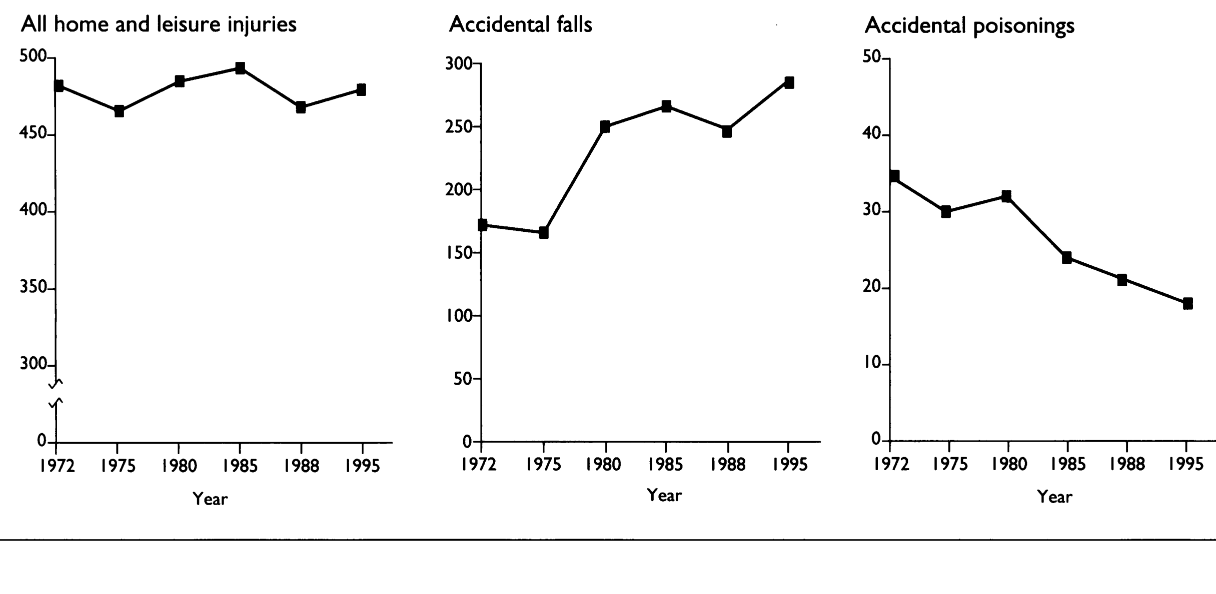


Table 1. Trends in exposure and injury risk for traffic injuries, by mode of transport, the Netherlands, 1960–1995 (percentage changes per five-year period)

	1960 to 1965	1965 to 1970	1970 to 1975	1975 to 1980	1980 to 1985	1985 to 1990	1990 to 1995
Exposure (kilometers traveled/1000 person-years)							
Passenger car occupants	+141	+78	+13	+9	+3	+12	+5
Motor cyclists	−25	−56	+25	+40	−14	+17	+28
Moped riders	+2	−23	−34	−26	−40	−17	−20
Cyclists	−11	−29	−28	0	+17	+6	−1
Pedestrians	—	—	—	—	—	−3	+6
All modes of transport, combined	+28	+25	+13	+12	+2	+12	+5
Injury risk (injured people/kilometer traveled)							
Passenger car occupants	−14	−13	−30	−13	−15	−13	0
Motor cyclists	−21	−1	−10	−12	−18	−7	−2
Moped riders	+37	+38	+9	−4	+19	+35	+13
Cyclists	−4	+6	+67	+15	−19	−6	−11
Pedestrians	—	—	—	—	—	+1	−35
All modes of transport, combined	−6	−16	−27	−19	−19	−9	−9

DISCUSSION

Using injury surveillance data, we established the effect of trends in the incidence and case fatality rate of injuries on trends in injury mortality. Injury mortality in the Netherlands increased between 1950 and 1970, followed by a sharp decline that only began to level off in the mid-1980s. Mortality for both traffic injuries and nontraffic (occupational and home and leisure) injuries reflect rapid changes in the incidence and case fatality rate of injuries.

The influence of possible reporting artifacts must be ruled out. There are several reasons for assuming that reporting error has not substantially influenced the results of our study. We found similar trends in several independent data sources. We included data from periods during which no major changes in registration criteria or procedures were implemented. And the observed trends in the incidence of injuries are plausible in the light of exposure trends. Because reporting error is probably not responsible for the observed trends in the incidence and case fatality rate of injuries, other determi-

Table 2. Trends in exposure and injury risk for occupational injuries, by branch of industry, the Netherlands, 1970–1990 (percentage changes per five-year period)

	1970 to 1975	1975 to 1980	1980 to 1985	1985 to 1990
Exposure (person-years at work/1000 person-years)				
Manufacturing	−14	−12	−14	+6
Construction	−17	0	−30	+19
Service sector	+3	0	+4	+27
All occupations, combined	−7	0	−9	+18
Injury risk (injured people/person-year at work)				
Manufacturing	−28	−3	−30	−12
Construction	−13	−17	−21	−2
Service sector	−25	+8	−23	−10
All occupations, combined	−24	−34	−28	−11

nants must have influenced exposure, injury risk, injury severity, and the severity-adjusted case fatality rate of injury victims.

We found that trends in exposure (kilometers traveled, person-years at work) greatly influenced trends in the incidence of traffic and occupational injuries. As a rule, new or increasing exposures lead to increasing numbers of injuries and deaths in the population. The rate of economic growth may well be a major underlying determinant in relation to exposure trends. Traffic mobility increased dramatically during the years of rapid economic growth (1950–1970), then leveled off when the national economy plunged into successive recessions (1970–1985) and curved upward again during the recent spell of economic recovery (1985–1995). Fluctuations in economic growth have also been important in relation to occupational injuries. The number of person-years at work declined between 1970 and 1985, followed by an upswing beginning in the mid-1980s as a result of economic recovery. The national economy is known to be a determinant of injuries at the population level.[13] In addition, however, other, "autonomous" factors have influenced exposure trends. These probably include demographic trends, sociocultural trends, and technological trends.[14]

"Autonomous" factors have probably also played an important role in relation to injury risks (injured people per unit of exposure). We found rapidly decreasing risks for both traffic and occupational injuries from 1970 through 1985. It should be noted, however, that many injury risks had already been on the wane before 1970. As in other industrialized countries, these constantly declining traffic injury risks could be based on adaptation mechanisms, including an increasing familiarity with motorized traffic.[15] The decreasing injury risks at work may have been influenced by "autonomous" factors as well, including the fact that the percentage of young (younger than 25 years) and older workers (older than 55 years) fell between 1970 and 1985; these are the age groups with by far the highest injury risks. Similar developments have been reported in other countries.[16,17] Equally, technological progress will have helped to reduce the amount of high risk employment. A final factor is the shift seen throughout the entire industrialized world toward employment in the service sector, which boasts a lower injury risk than do employment in agriculture, manufacturing, and construction.

Figure 5. Clinical incidence of traffic injuries (hospital admissions per 100,000 person-years) in the Netherlands, by type of injury, 1972–1995

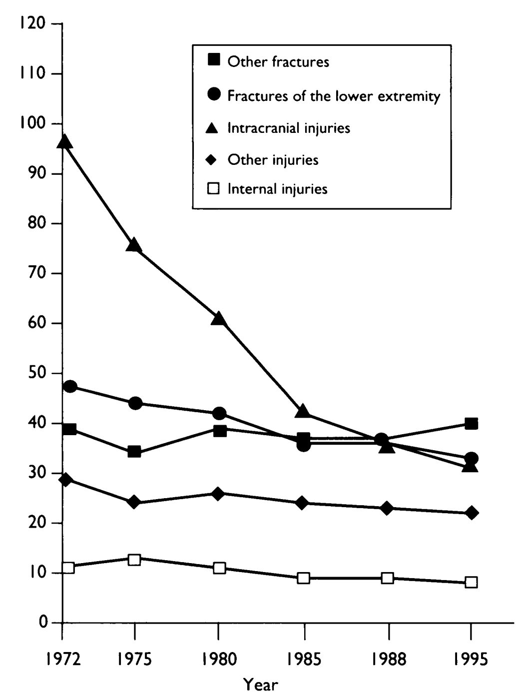
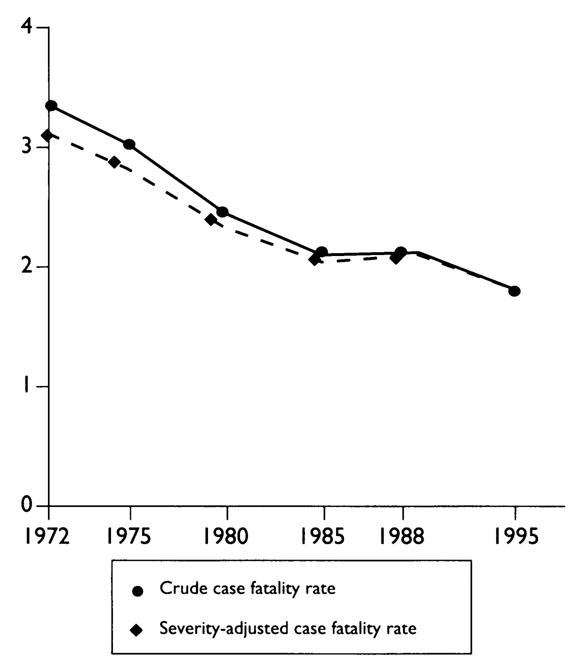


Figure 6. Crude and severity-adjusted case fatality rates (deaths per 100 injured people) of hospitalized traffic injuries in the Netherlands, 1972–1995



Preventive measures have also helped to reduce injury risks, in particular in the area of traffic injuries. First, from 1950 through 1970, infrastructure improvements such as installation of road lights and roadside barriers, construction of motorways, and segregation of categories of traffic led to reduced injury risks. Second, a range of specific measures came into effect in the period 1970–1975, which led to a much steeper reduction in injury risks than at any other time during the years studied. The most important preventive measures in this period were:

- lowering of the speed limit on roads outside built-up areas (February 6, 1974);
- the drink and driving act, prohibiting the driving of a vehicle by those with a blood alcohol level above 0.05 per milliliter (November 1, 1974);
- introduction of compulsory crash helmets for moped riders (February 1, 1975);
- introduction of the requirement that new cars be fitted with seat belts (January 1, 1971), followed by the compulsory use of seat belts (June 1, 1975).

Changes in injury severity have been important in relation to the declining case fatality rate for traffic injuries. We found a spectacular decrease in the number and share of intracranial injuries among hospitalized patients. This has meant that the incidence of one of the severest types of injury has been reduced. Some of these preventive measures have played a major role in this development. The compulsory crash helmet for moped riders aims to reduce the incidence of intracranial injuries; seatbelt use also leads to a sharper reduction of intracranial injuries than of other types of injury.[18]

Apart from changes in injury severity, a decreasing severity-adjusted case fatality rate is another important factor. Between 1972 and 1995, the crude case fatality rate of hospitalized traffic victims declined substantially. By comparing the crude case fatality rate with the severity-adjusted rate, it can be inferred that about 20% of this decrease is explained by changes in injury severity. In interpreting this finding, however, one has to consider the following. Many preventive measures (in particular crash helmets) result in a more than proportionate reduction of the severest injuries. Their implementation might have led to a decreased incidence of hospitalized (intracranial) injuries combined with a reduction in the mean severity score of those injuries.[19,20] Our data were not detailed enough to allow an adjustment for changes in the mean severity scores of the victims. Therefore, the effects of changes in injury severity on the case fatality rate of hospitalized traffic injuries are probably greater than shown by our calculations.

Nevertheless, factors other than changes in injury severity are likely to have contributed to the declining case fatality rate as well. The case fatality rate declined not only for traffic injuries (all modes of transport) but for occupational (all branches of industry) injuries and accidental falls as well. This may be partly ascribable to improvements in medical care since 1970, such as:

- improved treatment of severely injured patients through the introduction of intensive care units;
- improved diagnosis and treatment of intracranial injuries through the introduction of the CT scan;
- the increasing proportion of injury victims receiving surgery;
- the faster post-operative mobilization of injury victims.

Some evidence on the effect of medical care on the case fatality rate of injuries in the Netherlands has already been reported in the literature. Draaisma and colleagues found a significantly lower percentage of preventable fatalities in hospitals offering more advanced trauma care.[21] And in an analysis of regional mortality differences in the Netherlands, we and another colleague found a significant negative association between the presence of hospitals in the region offering advanced care and the case fatality rate of traffic injuries.[22] Hoogendoorn found that medical care plays an important role in the declining case fatality rate of injuries due to accidental falls. This holds in particular for hip fractures. The clinical case fatality rate for this type of injury, which accounts for the majority of deaths from accidental falls, declined sharply between 1970 and 1985. The most impressive reductions were achieved in the age groups with the greatest increases in the percentages of patients receiving surgery.[23]

In conclusion, our study has shown that the dynamic trends in injury mortality in the Netherlands since 1950 are based on several background factors. "Autonomous" factors, such as economic fluctuations and their influence on exposures, appear to have been of considerable importance. In addition, we found some evidence of the influence of both preventive measures (reducing the injury risk or the mean level of injury severity) and improvements in trauma care (reducing the severity-adjusted case fatality rate).

Our study has further shown that favorable trends in injury mortality can be accompanied by unfavorable trends in the incidence of injuries. Mortality trends should therefore not be monitored without analyzing data on the incidence of injuries, as unfavorable public health developments could be missed.

Our study has shown, finally, that after a rapid increase (1950–1970) and an even more spectacular fall (1970–1985), we have now entered a third phase in the post-World War II development of injury mortality: recent trends, in particular in the incidence of injuries, are unfavorable. This points to the necessity of new measures aimed at reducing the incidence and severity of injuries. If substantial reductions in injury risks and severity levels are no longer achievable, then control of exposures should be considered. For example, transport policy could focus on stimulating the least hazardous modes of traffic, and employment policy could focus on creating new jobs in the safest occupational sectors.

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